Nelson Wastewater Treatment Plant – Surface Water Quality Assessment

PREPARED FOR NELSON CITY COUNCIL | JUNE 2023

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Revision schedule

Rev No	Date	Description	Signature of Typed Name (documentation on file)			
			Prepared by	**Checked by**	**Reviewed by**	**Approved by**
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Abbreviations

Enter Abbreviation	Enter Full Name
ANZG	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
DRP	Dissolved Reactive Phosphorus
EC	Electrical conductivity
E.coli	*Escherichia coli*
EcIA	Ecological Impact Assessment
EIANZ	Environment Institute of Australia and New Zealand
FMU	Freshwater management unit
LAWA	Land Air Water Aotearoa
MfE	Ministry for the Environment
the Council	Nelson City Council
NIWA	National Institute of Water and Atmospheric Research
NPS	National Policy Statement for Freshwater
NRMP	Nelson Resource Management Plan
NWWTP	Nelson Wastewater Treatment Plant
REC	River Environment Classification
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen
TSS	Total Suspended Solids

1 Introduction

The Nelson Wastewater Treatment Plant (NWWTP) located at Boulder Bank Drive, Nelson is owned by Nelson City Council (the Council) and has been operated by Nelmac since 2011.

The NWWTP receives wastewater from the northern catchment of Nelson City, which is primarily residential with a small percentage of commercial/industrial discharges. The NWWTP is an oxidation pond-based treatment system, comprising preliminary treatment (grit removal and screening), pre-treatment (clarification and trickling filter used as required), facultative pond, maturation pond and wetland system. Treated wastewater is discharged via an ocean outfall into Tasman Bay.

The NWWTP obtained consents on 23 November 2004 to, inter alia:

- Discharge treated wastewater to Tasman Bay.
- Discharge wastewater onto or into land, namely the existing oxidation pond and proposed wetlands and flow buffer storage pond.
- Discharge contaminants, namely wastewater treatment plant gases to air from a wastewater treatment plant.
- Use, maintain and renew a pipeline and outfall structure and to occupy the seabed.
- Deposit in or on the seabed substances from the outfall pipe.
- Carry out where applicable, vegetation clearance, soil disturbance and earthworks for the construction of the treatment plant upgrade works.

The current resource consents for NNWTP expire on 1 December 2024 and Council requires new consents to continue to operate at its current location. The Council shall be applying for consents for:

- Discharge treated wastewater to coastal water.
- Discharge treated wastewater to land (in a manner it may enter water, being groundwater and surface water).
- Discharge contaminants to air (odours), including during desludging.
- Placement and use of outfall pipe and diffuser within the, coastal marine area (CMA), including replacing existing diffuser.

This technical assessment has been undertaken to inform the consenting process.

1.1 Qualifications / experience

This surface water quality assessment has been completed under the direction and supervision of Jessica Grinter, Principal Environmental Scientist (Stantec, Auckland). Jessica is a suitably experienced and qualified practitioner in the field of environmental science and impact assessment, she has over 14 years' experience in undertaking water quality effects assessments and related work and holds the following industry-recognised qualifications:

- Certified Environmental Practitioner (CEnvP) – Impact Assessment Specialist (Seal No. IA11063)
- Professional Member of the Environment Institute of Australia and New Zealand (EIANZ) since 2011
- Master of Integrated Water Management (MIWM: University of Queensland, 2014)
- Bachelor of Science (Physical Geography and Environmental Science; BSc, University of Auckland, 2009).

The majority of the work presented in this report was undertaken by Emma Gibbs (Senior Environmental Scientist, Stantec Christchurch) and Ellen Wilson-Hill (Graduate Environmental Scientist, Stantec Christchurch); both of whom have experience and qualifications relevant to water quality analysis and environmental impact assessment.

1.2 Scope of this technical assessment

The overall purpose of this report is to provide a baseline summary of the existing water quality within the freshwater receiving environment utilising data collected during the November 2020 to December 2021 monitoring period, as well as providing an assessment of effects to support the upcoming reconsenting work. Hillwood Stream is the primary receiving environment for discharges from the NWWTP treatment ponds. In particular, the assessment of effects will focus on determining whether the existing NWWTP treatment ponds are having a tangible effect on receiving environment water quality.

Assessments of the potential effects of the existing and proposed discharges on marine water quality in the coastal receiving environment, and on groundwater quality, have been undertaken separately (and concurrently) to this report and will be appended to the over-arching Assessment of Environmental Effects being prepared for the resource consent application.

The following were also completed as part of this report:

- a summary of the existing freshwater receiving environment
- a summary of relevant historical water quality data for the freshwater receiving environment
- analysis of the influence of groundwater on the existing treatment pond and freshwater receiving environment
- analysis of the influence of seawater (tidal regime) on the existing treatment pond and freshwater receiving environment
- consideration of potential climate change effects on water quality to 2059.

1.2.1 Exclusions

Exclusions pertaining to this report are outlined below:

- assessment of effects of the discharge on the marine environment
- assessment of the quality of treated wastewater discharge
- assessment of effects of the discharge on aquatic ecology and benthic habitat
- public health risk assessment of the discharge
- assessment of the effects of the discharge on cultural values, including on the mauri of freshwater environments (see further comments regarding this in Section 7 of this report).

1.3 Plant History

Historically wastewater from Nelson was discharged without treatment into Boat Harbour. In the 1960s, new pumping stations and an ocean outfall were constructed to convey the wastewater to NWWTP, with untreated wastewater discharged into Tasman Bay at the current location from 1970.

The current oxidation pond was established in 1979 to treat wastewater prior to discharge into Tasman Bay. In 1996, the oxidation pond was sub-divided into two interlinked ponds to improve the treated wastewater discharge quality, however, the resulting organic loading on the primary pond (14 Ha) was too high, so the pond system reverted to one pond (26 Ha) in 2000. The pond system was originally installed without upfront pre-treatment.

The NWWTP underwent its most recent upgrade in 2007-2009 to comply with the current resource consents and increase the plant capacity to accommodate the anticipated population increase. The upgrade included a new pre-treatment facility (i.e., primary clarifier, trickling filter, flow buffer), partitioning of the existing oxidation pond into 16ha facultative and 10ha maturation areas, and a new downstream wetland.

Minor modifications at NWWTP have occurred since, including addition of aerators and monitoring probes (for dissolved oxygen (DO) and oxidation-reduction potential, ORP) in the facultative pond and covering the trickling filter. The facultative pond was de-sludged in 2014, with sludge initially stored on-site in geobags in the flow buffer area and then disposed off-site at the landfill. The flow buffer area was taken offline while used to store sludge and then returned to its original purpose of providing flow buffering when all the stored sludge had been removed.

2 Site Identification

2.1 Site location

The project site is located approximately 14 kms north of the centre of Nelson township and is adjacent to SH6 (Figure 2-1). The surface water monitoring locations established in relation to the NWWTP project site are identified in Figure 2-1 below and are located within the Hillwood Stream (close to the Nelson Haven, and further upstream within the reserve land) and Hillwood Stream North. Sampling locations SW 01 WW and SW 02 Res are considered most likely to be potentially affected by discharges from the wetland treatment pond at NWWTP, while SW 03 Hav is further downstream. The degree to which any potential discharges from the treatment ponds are mixed prior to reaching the Nelson Haven has not been quantified but is expected to be high given the size of the stream channel and volume of discharge (both historically and proposed for the future).

Figure 2-1: NWWTP (including oxidation ponds and wetlands and indicated by green polygon) site in relation to surface water monitoring locations (SW 01 WW, SW 02 Res and SW 03 Hav)

3 Existing Freshwater Receiving Environment(s)

3.1 Aquatic ecosystems

The following sections (3.1.1 to 3.2) describe the existing aquatic ecosystem of the freshwater receiving environment based on desktop research and knowledge of the site.

3.1.1 Freshwater receiving environment catchment description

The Hillwood Stream is a lowland stream habitat which is described by LAWA[1] as being 'very degraded'. The surrounding land use includes a dairy farm close to the site and a 'clean' landfill[1]. The stream is channelised in sections to manage flooding of the State Highway and reclaimed lowland agricultural coastal flats[1]. The Hillwood Stream is part of the Mahitahi / Maitai Freshwater Management Unit (FMU)[2] and includes the Hillwood Stream North tributary.

The Maitai/Mahitahi/Maitahi River is the largest in the Nelson Region with a catchment of over 9,000 Ha. The river rises in the Bryant Range behind Nelson City and the upper catchment has two branches draining conservation and water supply protection land. The North Branch is dammed just upstream of the confluence with the South Branch to form the main Nelson water supply storage reservoir. The mid catchment is an important recreational and production forest area, and the lower catchment runs through the heart of Nelson City, before flowing into the Nelson Haven[2] which is a tidally influenced inlet.

The River Environment Classification (REC)[3] applicable for the Hillwood Stream and Hillwood Stream North is outlined in Table 3-1 below.

Table 3-1: REC Summary for Hillwood Stream and Hillwood Stream North

Category	Code Assigned	Class	Description (as per[4])
Climate	WD	Warm & dry	*Mean annual temperature < 12°C* *Mean annual effective precipitation < 500mm.*
Geology	Al	Alluvium	*Rainfall infiltration is high which tends to reduce flood frequency. There tends to be a high degree of surface water and ground water interaction. Base flows may be sustained by seepage or springs or may reduce in the downstream direction as water flows into the groundwater system. Water chemistry reflects the nature of the parent material. Note that the source information on catchment geology, the LRI, does not discriminate the parent material for alluvium. This makes the geochemistry of the Alluvium category variable.*
Landcover	W	Wetland	*Includes land cover classes 'Coastal Wetlands' and 'Inland Wetlands' from the New Zealand Land Cover Database.*
Network position	LO	Low-Order	*Headwater streams (Stream order 1 and 2) with little upstream storage. Fluxes of water and water borne constituent (e.g. sediment) move rapidly through with little attenuation.*
Topography	L	Low elevation	*50% rainfall below 400 m above sea level (ASL).*
Valley landform	LG	Low-Gradient Channels	*For given higher order classes, LG categories are characterised by relatively greater meandering, greater depth relative to width and lower water velocities.*

[1] https://www.lawa.org.nz/explore-data/nelson-region/river-quality/mahitahi-maitai/hillwood-at-glen-rd/
[2] http://www.nelson.govt.nz/environment/water-3/freshwater-working-groups/
[3] River Environment Classification (REC2 (version 5.0))
[4] Snelder T., Biggs B. & Weatherhead, M. 2010. *New Zealand River Environment Classification User Guide*, published March 2004 (updated June 2010), produced for the Ministry for the environment by the National Institute of Water and Atmospheric Research (NIWA), 160pp.

It should be noted that the upstream (adjacent to the large dairy farm) habitat of the Hillwood Stream and Hillwood Stream North are categorized by the REC[3] as being a 'Cool-Dry' climate class and "Pasture" landcover class.

3.1.2 Fish Community

The full detailed assessment relating to the fish community is provided in the Ecological Impact Assessment Report[5] accompanying the main consent application. The report[5] found that the fish community present within the freshwater receiving environment is typical of a community associated with coastal, low gradient rivers and streams that generally have moderately high nitrogen loads and low indigenous catchment cover.

3.1.3 Macroinvertebrate Community

A detailed assessment of the existing macroinvertebrate community within the freshwater receiving environment is provided in the separate ecological report[5]. In summary, macroinvertebrate sampling results indicated severe organic pollution and severe loss of ecological community integrity[5]. Environmental DNA (eDNA) results collected as part of the investigation showed that pollutant tolerant taxa dominate the macroinverbrate community within the lower Hillwood Stream[5]. Furthermore, none of the detected taxa were classified as at-risk or threatened within the New Zealand Classification System (NZTCS)[5].

3.2 Surrounding land use

The land use surrounding the freshwater receiving environment in the east, comprises predominantly of a large dairy farm operation which is located approximately 300 m upstream of the SW 01 WW and SW 02 Res sampling locations (Figure 3-1). The dairy farm has been present since 1940 (Figure 3-2). The New Zealand Land Cover Database (LCDB, V5.0)[6] describes the dairy farm operation as *High Producing Exotic Grassland*.

Additionally, the Wakapuaka Sandflats Esplanade Reserve is located adjacent to the freshwater receiving environments (Figure 3-3) and is described as one of the largest esplanade / foreshore reserves managed by Council, which covers an old estuarine mudflat and saltmarsh wetland area[7] The sandflats reserve area has been highly modified through past drainage and reclamation activities[6]. There is currently a dike waterflow gate at the Nelson Haven edge which prevents tidal inundation, and two modified streams drain freshwater from the site. Modifications such as the prevention of some tidal influx (desalination) stop the area reverting back to its natural saltmarsh state, which in turn encourages weeds and discourages natural regeneration[6]

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[5] *NWWTP Discharge consent renewal Ecological Impact Assessment*, Stantec (2023)
[6] https://lris.scinfo.org.nz/data/
[7] Esplanade and Foreshore Reserves Management Plan (2008), Nelson City Council.

Figure 3-1: Surrounding land use, including large scale dairy farm operation (indicated by yellow polygon) in relation to NWWTP and monitoring locations.

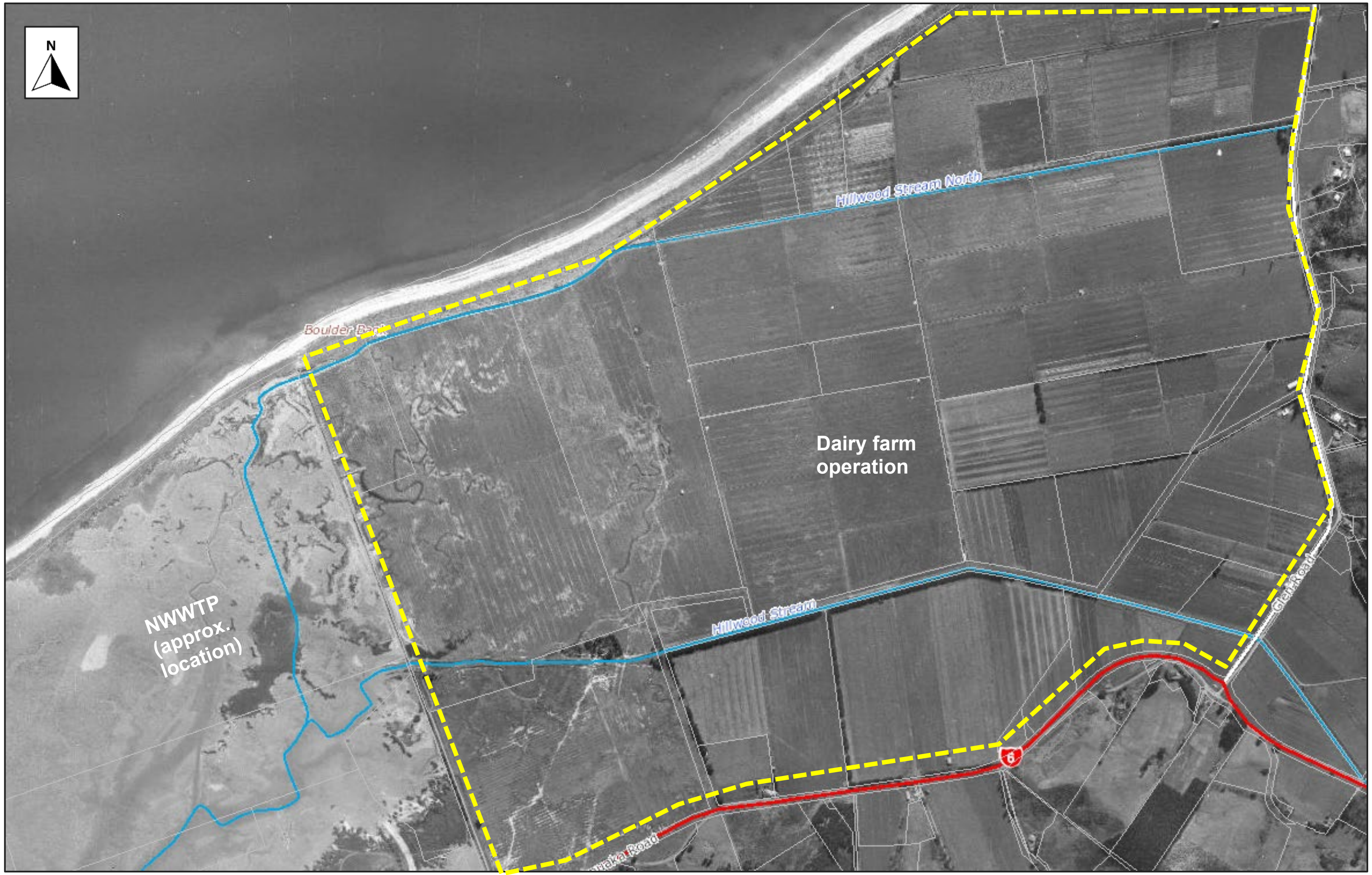

Figure 3-2: 1940 - 1949 aerial8 of large-scale dairy farm (indicated by yellow polygon) upstream of NWWTP site.

[8] https://www.topofthesouthmaps.co.nz/app/

Figure 3-3: Wakapuaka Sandflats Esplanade Reserve (indicated by green shading).

4 Assessment Methodology

4.1 Relevant Guidelines

4.1.1 Nelson Resource Management Plan

The Nelson Resource Management Plan (2012), from here on referred to as the NRMP, contains freshwater standards that have legal effect. **Policy DO19.1.6.i** states that: *Appendix 28.4 (classification of Nelson water bodies) lists the current classification of each water body from A to E (from excellent to very degraded). This classification draws on the monitoring undertaken since 2000 and the key factors which are influencing each classification are listed. The table also shows what uses and values the water body currently has. Appendix 28.4 is included in the Plan to assist applicants and decision-makers to assess the potential effects of proposed activities.*

Table 4-1 outlines the classification states under Appendix 28.4 of the NRMP which is considered relevant to this assessment.

Table 4-1: Classification of Nelson Water Bodies (AP28.4)

River	Reach	Riparian Margin Management Values (from Appendix 6)	Associated Land Uses and Values Identified	Water Quality Classification (2007*)	Priority for Improvement
Hillwood Stream	N/A	N/A	• Stock water • Native fisheries • Iwi values • Discharge into Wakapuaka wetland (sensitive receiving environment)	D	Second

The NRMP seeks all streams to be improved if in a degraded state (Class D and E) to at least Class C, as outlined in **Policy DO19.1.5.vi**. Assessment of results collected as part of this investigation against relevant water quality criteria (set out in AP28.5 of the NRMP) is provided in Section 5.4.

4.1.2 Freshwater Quality Guidelines

The National Policy Statement for Freshwater 2020[9] (NPS-FM), includes the national objectives framework which sets out states to be achieved for a range of water quality and ecological attributes. These attribute states are assigned on the basis of various statistics calculated from representative data, including medians, 95th percentile values and minima or maxima. Lengthy and substantial datasets are required in order to assess against the majority of attributes, and this can present a challenge when determining the status of a freshwater site if data availability is limited. Most NPS-FM attribute states assign classes from A-D (with 'A' representing the best possible state for an attribute, and 'D' the worst) and have an associated 'National Bottom Line' which indicates a minimum condition to be achieved for each attribute. The water quality results available for the three monitoring locations described above have been compared to NPS-FM attributes and National Bottom Lines where these have been defined.

Where an NPS-FM attribute state was not available for a parameter, results were compared to the relevant Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018) utilising the appropriate REC classification as per Section 3.1.1 above. Comparisons to the ANZG (2018) have been made for toxicants (where possible) at the 95th percentile (95%ile) and 80th percentile (80%ile) levels of species protection. The 95%ile is typically recommended for slightly to moderately disturbed ecosystems, while the 80%ile is the lowest default guideline value provided by the ANZG (2018), applicable to highly modified ecosystems.

Guideline values applicable to this assessment are outlined in Table 4-2.

[9] Amendment version, December 2022

Table 4-2: Guideline Values Applicable for Water Quality Parameter Assessment

Parameter	Reference	Guideline Level[10]	Guideline Value used for this Assessment
Total Suspended Solids (TSS) g/m^3	ANZG (2018)	80%ile species protection *(default guideline values for physical and chemical stressor)*	4.6 g/m^3
Escherichia coli (E.coli) (*E.coli* / 100 mL)	NPS-FM (2020)	Attribute state and National Bottom Line	Numeric attribute states: Excellent: < 130 *E.coli* /100mL Good: >130 and <260 *E.coli* /100mL Fair: >260 and <540 *E.coli* /100mL Poor: >540 *E.coli* /100mL National Bottom Line: 540 *E.coli* / 100 mL
Dissolved Reactive Phosphorus (DRP) g/m^3	NPS-FM (2020)	Attribute state	Median: A band (<0.006 g/m^3) B band (>0.006 g/m^3 and <0.010 g/m^3) C band (>0.010 g/m^3 and <0.018 g/m^3) D band (>0.018 g/m^3)
Total Nitrogen (TN) g/m^3	ANZG (2018)	80%ile species protection *(default guideline values for physical and chemical stressor)*	0.281 g/m^3
Nitrate-N (g/m^3)	NPS-FM (2020)	Attribute state and National Bottom Line	Annual medians: A band (<1.0 g/m^3) B band (>1.0 g/m^3 and <2.4 g/m^3) C band (>2.4 g/m^3 and <6.9 g/m^3) D band (>6.9 g/m^3) National Bottom Line: 2.4 g/m^3
pH	ANZG (2018)	80%ile species protection *(default guideline values for physical and chemical stressor)*	7.8 (pH units)
Total Ammoniacal-N (g/m^3)	NPS-FM (2018)	Attribute state and National Bottom Line	Annual medians: A band (<0.03 g/m^3) B band (>0.03 g/m^3 and <0.24 g/m^3 C band (>0.24 g/m^3 and <1.30 g/m^3) D band (>1.30 g/m^3) National Bottom Line: 0.24 g/m^3
Total Kjeldahl Nitrogen (TKN) g/m^3	None	N/A	N/A
Dissolved oxygen (DO) mg/L	NPS-FM (2020)	Attribute state and National Bottom Line	1-day minimum A band (>7.5 mg/L) B band (>5.0 mg/L and <7.5 mg/L) C band (>4.0 mg/L and <5.0 mg/L) D band (<4.0 mg/L) National Bottom Line: 4.0 mg/L
Electrical conductivity (EC) µS/cm	ANZG (2018)	80%ile species protection *(default guideline values for*	86 µS/cm

[10] REC category applied to derive guideline value: *Warm Dry Low-Elevation*

Parameter	Reference	Guideline Level[10]	Guideline Value used for this Assessment
		physical and chemical stressor)	
Temperature	None	N/A	N/A
Chemical Oxygen Demand (COD) gO_2/m^3	None	N/A	N/A
Chloride (g/m^3)	None	N/A	N/A

4.2 Data analysis

Water quality data were collected over the course of approximately one year (between November 2020 to December 2021) and therefore it was considered appropriate to calculate the 13-month median for each parameter, as well as providing the minimum and maximum result for each sampling location. The 13-month median was determined to be appropriate to include as part of the results analysis due to some parameters showing a particular trend during the 13th month that was considered important to include in order to outline the overall occurring trend, The only exception to this was for the *E.coli* results which were collected over a 9-month period (February 2021 to December 2021)) as well as DO which was also collected over a 9-month period (November 2020 – July 2021). Further details on this are provided in Sections 5.2.12 and 5.2.7.

4.3 Water quality sampling methodology

This assessment characterises the existing water quality within freshwater receiving environment in order to determine any potential effects from the neighbouring NWWTP operation, namely due to discharges from the treatment ponds. Surface water sampling was undertaken monthly from November 2020 to December 2021 at three sampling locations shown in Figure 4-1 and described in Section 3.1.1 above. Photos of the sampling sites are provided in Figure 4-2, Figure 4-3,and Figure 4-4 below. The grab sampling methodology for taking the water samples is demonstrated in Figure 4-5.

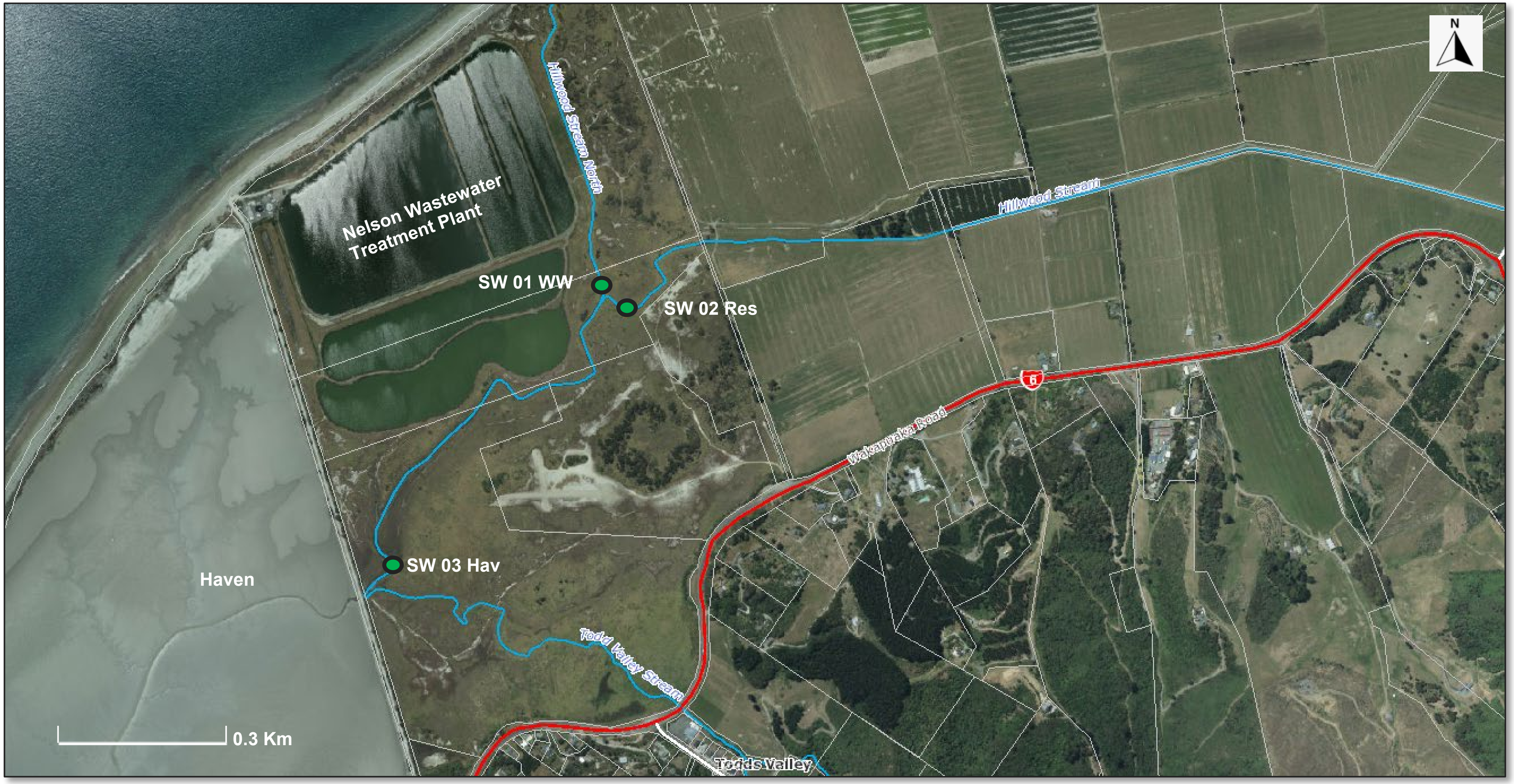

Figure 4-1: Sample locations (indicated by green circles) within freshwater receiving environment, in relation to the NWWTP operation.

Figure 4-2: Sampling location SW 01 WW (upstream orientation)

Figure 4-3: Sampling location SW 02 Res (upstream orientation).

Figure 4-4: Sampling location SW 03 Hav (downstream orientation).

Figure 4-5: Grab sampling methodology demonstrated at sampling location SW 03 Hav

Monthly water samples were collected from each of the sample locations, utilising the sampling methodology shown in Figure 4-5. All water samples were collected with laboratory supplied, sterilised containers using an extendable grab sampling pole, with the containers fully submerged under water until they were filled (with the exception of jars containing preservatives). Filled containers were sent to an IANZ accredited laboratory[11] for analysis.

Water samples were analysed for the parameters listed below, with the **bold** parameters chosen for analysis as part of this report due to their direct relevance for determining potential effects.

- **Chloride**
- Nitrite-N
- **Nitrate-N**
- ***E.coli***
- **TSS**
- **DRP**
- **TN**
- Nitrite-N + Nitrate-N
- **Total ammoniacal-nitrogen**
- **TKN**
- Total phosphorus
- **COD**
- **Faecal coliforms**
- Enterococci
- Chlorophyll-α

A summary of results pertaining to the parameters that are not bolded above, is provided in Table 5-1 of Section 5.3 in this report. These parameters were still useful to monitor in terms of establishing historic trends and providing context for further/future analyses.

[11] Both Hill Laboratories and the Cawthron Institute laboratory were utilised to complete surface water quality analyses throughout the monitoring programme

4.3.1.1 Physical parameters

Physical parameters were also measured during the monthly sampling events. Physical parameters were measured in-situ at each sampling location utilising a YSI ProQuatro handheld meter.

Parameters measured upon each sampling event included the following:

- Dissolved oxygen (mg/L),(DO)
- Electrical conductivity (µS/cm), (EC)
- Ambient water temperature (°C)
- pH (pH units).

4.3.2 Rainfall data

A NIWA weather station (Nelson Aero (station number: 4241)) is located approximately 16 km south of the project site and measures various climate data, including rainfall. Table 4-3 summarises daily rainfall totals for the 3 days (72 hours) preceding each sampling event, including the day of sampling.

Table 4-3: Rainfall (mm) Data Obtained from NIWA[12] (*Nelson Aero Weather Station*). Sampling Dates are Indicated in Bold.

Date	Rainfall (mm) within a 24-hour period
17/11/2020	0.0
16/11/2020	0.0
17/11/2020	0.0
18/11/2020	**0.4**
12/12/2020	0.0
13/12/2020	0.0
14/12/2020	0.8
15/12/2020	**0.3**
23/01/2021	0.0
24/01/2021	0.0
25/01/2021	0.0
26/01/2021	**0.0**
21/02/2021	0.0
22/02/2021	0.0
23/02/2021	0.0
24/02/2021	**0.0**
20/03/2021	0.0
21/03/2021	0.0
22/03/2021	0.0
23/03/2021	**0.0**
24/04/2021	0.0
25/04/2021	0.0
26/04/2021	0.0
27/04/2021	**0.3**
22/05/2021	0.0
23/05/2021	0.0

Date	Rainfall (mm) within a 24-hour period
24/05/2021	0.0
25/05/2021	**0.0**
13/06//2021	0.3
14/06/2021	6.1
15/06/2021	0.0
16/06/2021	**0.0**
16/07/2021	2.5
17/07/2021	44.5
18/07/2021	9.0
19/07/2021	**12.4**
21/09/2021	0.0
22/09/2021	5.7
23/09/2021	51.8
24/09/2021	**21.1**
23/10/2021	0.0
24/10/2021	0.0
25/10/2021	4.5
26/10/2021	**0.1**
20/11//2021	0.0
21/11/2021	0.0
22/11/2021	6.0
23/11/2021	**0.0**
13/12/2021	0.0
14/12/2021	1.0
15/12/2021	23.5
12/16/2021	**16.3**

4.3.3 Tidal information

The freshwater receiving environment is tidally influenced to some degree. Table 4-4 outlines the tidal stage in relation to each sampling event and the time at which each sample was taken at each sampling location. The table has been populated using modelled tidal heights for the sampling period, available from the NIWA Tide Forecaster[13]. It is noted that the sampling program was not initially designed to target specific tidal conditions; this is an aspect which has come to light during the course of this assessment.

Sampling events in **bold** indicate where a wider range of tidal conditions was covered by samples, in comparison with other events. On 26 January 2021, sampling was undertaken over a 4-hour period which encompassed both incoming (flood) and outgoing (ebb) tides. The majority of sampling events took place during mid-tide (on either a flood or ebb tide) which meant that samples likely represented conditions where the tide was influencing water quality and quantity. However, this influence has not been verified against a hydrodynamic model or with targeted sampling.

[12] Raw data accessed from: https://cliflo.niwa.co.nz/ on 08th May 2023.

[13] NIWA 2023 Tide Forecaster; tidal heights in MSL, 10 minute intervals (Latitude -41.279, Longitude 173.25 [Tasman Bay at NWWTP]), data accessed on 4 May 2023 at https://tides.niwa.co.nz/

Table 4-4: Tidal Conditions during each Sampling Event, 2020/21

Sampling Location	Date Sampled	Time Sampled	Tidal Stage (tidal height in MSL[14]), Tasman Bay
SW01 WW	18/11/2020	14:00	Ebb (1.53)
	15/12/2020	10:20	Flood / high (1.81)
	26/01/2021	10:55	Ebb (0.74)
	24/02/2021	10:32	Ebb (0.61)
	23/03/2021	09:51	Ebb (-0.37)
	27/04/2021	10:59	Ebb (1.66)
	25/05/2021	11:30	Ebb (0.13)
	16/06/2021*	10:35	Flood (0.03)
	19/07/2021	11:05	Low / slack tide (-1.23)
	24/09/2021	09:05	Flood (0.48)
	26/10/2021	11:05	Flood (0.15)
	23/11/2021	10:30	Flood (0.51)
	16/12/2021	11:00	Ebb (0.58)
SW02 RES	18/11/2020	14:35	Ebb (1.06)
	15/12/2020	09:20	Flood (1.3)
	26/01/2021	07:57	Flood (0.91)
	24/02/2021	08:00	High (0.95)
	23/03/2021	10:53	Ebb / low (-0.59)
	27/04/2021	11:49	Ebb (1.02)
	25/05/2021	09:18	High / Ebb (1.64)
	16/06/2021*	09:17	Flood (-0.76)
	19/07/2021	11:55	Low / Flood (-1.06)
	24/09/2021	07:50	Flood (-0.67)
	26/10/2021	09:32	Flood (-0.77)
	23/11/2021	08:36	Flood (-0.78)
	16/12/2021	13:10	Ebb (-0.61)
SW03 HAV	18/11/2020	14:50	Ebb (0.92)
	15/12/2020	08:47	Flood (0.91)
	26/01/2021	11:44	Ebb (0.35)
	24/02/2021	11:14	Ebb (0.32)
	23/03/2021	10:33	Ebb (-0.53)
	27/04/2021	13:01	Ebb (-0.15)
	25/05/2021	12:17	Ebb (-0.63)
	16/06/2021*	09:40	Flood (-0.58)
	19/07/2021	12:35	Flood (-0.8)
	24/09/2021	08:10	Flood (-0.39)
	26/10/2021	09:55	Flood (-0.59)
	23/11/2021	09:00	Flood (-0.56)
	16/12/2021	11:45	Ebb (0.12)

4.4 Assessment of effects on receiving environment surface water quality

The effects of discharges from the treatment ponds at NWWTP (both currently, and with the proposed changes to the consent) have been assessed using a methodology aligned with the 2018 EIANZ guidelines for Ecological Impact Assessment[15]. As that methodology is primarily focused on the direct assessment of ecological value (which is undertaken separately to this report, for the NWWTP consent application), it has been necessary to adapt the approach somewhat in order to make a relevant assessment for water quality values.

A risk matrix approach has been applied to assess the values associated with water quality and the magnitude of potential effect on those values to determine the potential level of effect that may occur as a result of continued discharges to 2059 (with a 35 year consent term sought). The definitions for each 'continuum' of values and magnitude are detailed in Table 4-5 and Table 4-6 below, respectively. The final matrix used to determine the potential level of effect is shown in Table 4-7. The findings of the assessment are presented in Section 7 of this report.

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[14] MSL is long term sea level average (tidal height in relation to datum, in metres) The values presented in Table 4-4 denote tidal height as distance from MSL.
[15] *Ecological Impact Assessment (EcIA) EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems*, 2nd Edition, May 2018, Environment Institute of Australia and New Zealand.

Table 4-5: Definition of Categories Denoting Values Associated with Surface Water Quality in the Freshwater Receiving Environment

Category	Definition / Assumptions

Very high	• Near-pristine condition; water quality is close to that of background condition where known.
	• High availability of aquatic ecosystem services such as:
	  ○ Suitable conditions for maintenance of a range of aquatic habitats.
	  ○ Physico-chemical parameters within range specified by applicable guidelines such as ANZG 2018 95th percentile species protection (e.g. pH, ambient water temperature, electrical conductivity).
	  ○ Dissolved oxygen within acceptable range (i.e. Not enriched or depleted).
	  ○ Aquatic ecosystem is highly sensitive to change (i.e. not heavily modified; sensitive indicator species may be present, such as EPT taxa).

High	• Historic water quality is good but is at risk of decline due to ongoing land use, environmental changes; for example, would achieve attribute state A or B under the NPS-FM 2020. • Natural features (as evident from background or 'control' locations elsewhere in the same catchment) are mostly intact but at risk of degradation. For example, sections of riparian margin vegetation have been removed or grassed, banks still intact but likely to erode in near future. • Physico-chemical parameters within range specified by applicable guidelines such as ANZG 2018 80th percentile species protection (e.g. pH, ambient water temperature, electrical conductivity). • Dissolved oxygen within acceptable range (i.e. Not enriched or depleted).
Moderate	• Water quality has begun to decline in recent decades (last 30 years) but still remains acceptable (for example, attribute state B or C under the NPS-FM 2020). • Water body is showing initial signs of modification such as sediment deposition, reduced water clarity, bank erosion, invasion of aquatic weeds (impinging on valuable habitats), reduced aquatic biodiversity. • Some physico-chemical parameters may not be compliant with relevant ANZG 2018 guidelines (or other applicable guideline) such as 80th percentile species protection.
Low	• Water body is heavily modified in localised areas; some natural features may remain but are in a poor state (e.g. highly eroded banks). • Sustained lack of aquatic biodiversity in the long term (e.g. more than five years). • Contaminants have occasionally been present at levels which present a risk to human health and/or aquatic life. • Water quality is poor; for example, would only achieve attribute state C or D under the NPS-FM 2020).
Negligible	• Water body is artificial (human-made) and/or channel has been straightened or modified to a degree that it is unrecognisable from that of background or 'control' locations elsewhere in the same catchment. • Water quality has historically been very poor; presents a risk to human health (e.g. consistent, prolonged and extremely high levels of faecal contamination (>10,000 CFU/100mL) or to aquatic life (e.g. sustained high concentrations of known toxic substances such as heavy metals (e.g. dissolved mercury, copper) and pesticides; pH consistently outside the recommended range as per relevant water quality guidelines). • National bottom line has consistently not been met for multiple attributes (NPS-FM 2020), and/or meets criteria for attribute state E (or equivalent lowest band) under the NPS-FM 2020.

Table 4-6: Definition of Categories Representing Magnitude of Effect on Water Quality

Category	Definition / Assumptions
Very high	Very major (adverse) alteration to the existing baseline conditions, such that aquatic ecosystem services are highly impacted or lost entirely (for example, pH changes from within acceptable range to well below minimum threshold, resulting in loss of fish population) AND/OR Natural character is diminished across the majority of the receiving environment (i.e. change in physical form of the watercourse to the extent it is not recognisable from baseline condition)
High	Major loss or major alteration to existing baseline conditions such that aquatic ecosystem services will be fundamentally changed; AND/OR Elements of natural character are diminished, but changes are limited to localised areas
Moderate	Loss or alteration to one or more key elements/features of the existing baseline conditions, such that one or more aquatic ecosystem services will be partially changed; AND/OR Adverse changes to natural character in one or two localised areas
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 natural reference condition; AND/OR Change is having a minor effect on aquatic ecosystem services
Negligible	Very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation; AND/OR Change is having a negligible effect on aquatic ecosystem services
Positive	Improvement from the existing baseline condition.

Magnitude (as defined in Table 4-6) also takes into account possible timescales for duration of effects (from temporary to long term and permanent) as per Table 9 in EIANZ 2018 (p3). This reflects the likelihood of the freshwater receiving environment recovering from adverse effects to a state equal to or very near existing baseline condition, and the effort required for that recovery to occur.

Table 4-7: Level of Effect Matrix (adapted from Table 10 in EIANZ 2018, p84)

	Values Associated with Surface Water Quality (freshwater)				
Magnitude	**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

5 Results

5.1 Background water quality

A review of publicly available information identified existing data for several microbiological parameters measured in Hillwood Stream at Glen Road (Figure 5-1). These data are sourced from regional and local councils and presented on the national Land Air Water Aotearoa website[16]. Given that the monitoring location at Glen Road is well upstream of the WWTP, results from that location are considered to indicate background water quality within the lower portion of the Hillwood Stream catchment.

Figure 5-1: LAWA Water Quality Monitoring Site in Relation to Surface Water Monitoring Locations within the Hillwood Stream Catchment.

5.1.1.1 *E.coli*

The five-year (2013 – 2021) median count/concentration for *E.coli* was 1,000 n/100 mL[17]. There were some large exceedances of this median value, for instance an event in 2016 showed *E.coli* concentrations were around 3,300 n/100mL. The overall trend is described as very likely degrading and is within the “E” band as outlined by the NPS-FM (2020). The “E” band is attributed to sites where **for more than 30% of the time**, the predicted infection risk is >=50 people [infected] in every 1000 (>5% risk) and the **average** predicted infection risk is >7%. The site at Glen Rd is also described as being within the worst 25% of all sites across New Zealand in relation to *E.coli* concentrations.

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[16] https://www.lawa.org.nz/explore-data/nelson-region/river-quality/mahitahi-maitai/hillwood-at-glen-rd/
[17] https://www.lawa.org.nz/explore-data/nelson-region/river-quality/mahitahi-maitai/hillwood-at-glen-rd/

5.1.1.2 Total Nitrogen

Total nitrogen in rivers is not a parameter that is currently included in the NPS-FM (2020) national objectives framework. However, for completeness the total nitrogen concentrations obtained from the LAWA database have also been assessed against the relevant ANZG 2018 default guideline values.

The five-year (2013 – 2021) median concentration for total nitrogen is 0.54 mg/L[17] which exceeds the ANZ guideline value (80%ile species protection) of 0.281 g/m^3. Results from October 2020 to December 2021 ranged from 0.2 mg/L (April 2020) to 2.4 mg/L (May 2021)[17]. The highest result within the five-year monitoring period occurred in May 2021 with total nitrogen concentrations recorded at 2.4 mg/L which greatly exceeds the ANZ guideline value (80%ile species protection).

5.1.1.3 Ammoniacal-Nitrogen

The five-year (2013-2021) median concentration for ammoniacal-nitrogen is 0.02 mg/L[17]. Results from November 2020 to December 2021 range from <0.01 mg/L to >0.03 mg/L. The highest result within the five-year monitoring period of ammoniacal-nitrogen concentrations occurred in March 2015 with a concentration of >0.08 mg/L. Ammoniacal-nitrogen concentrations at this monitoring location currently reflect the "B" attribute state (required by the NPS-FM (2020)). The definition for the "B" attribute state indicates 95% species protection level: *Starts impacting occasionally on the 5% most sensitive species*. However, the overall trend for this parameter is described by LAWA as "very likely degrading".

5.1.1.4 Dissolved reactive phosphorus

The five-year (2013-2021) median concentration for dissolved reactive phosphorus (DRP) is 0.014 mg/L[17]. Results from November 2020 to December 2021 range from >0.005 mg/L to >0.035 mg/L. The highest result within the five-year monitoring period of dissolved reactive phosphorus occurred in December 2019 with a reading of >0.07 mg/L.

DRP concentrations at this monitoring location currently reflect the "C" attribute state (required by the NPS-FM (2020)) for DRP. The "C" attribute state indicates that ecological communities are being impacted by moderate levels of DRP, elevated above natural reference conditions. If other conditions (such as changing levels of total nitrogen and phosphorus, temperature and pH) also favour eutrophication, DRP enrichment may cause increased algal and plant growth, loss of sensitive macroinvertebrate and fish taxa, and high rates of respiration and decay[17]. The overall trend for DRP concentrations at this site is described by LAWA as "very likely degrading". The site at Glen Rd is identified as being within the worst 50% of all sites within New Zealand for this parameter.

5.2 Existing freshwater receiving environment water quality

The sample results collected from freshwater receiving environment over the monitoring period were used to quantify and summarize any trends observed which are outlined in Sections 5.2.1 to 0.

The monitoring period for this investigation was between November 2020 to December 2021 for most parameters measured, apart from *E.coli* which was monitored for a period of nine months (February 2021 – December 2021). This was due an internal review that was undertaken after the first quarter period of monitoring, which recommended that *E.coli* be added to the sampling regime.

Due to the national COVID19 lockdown in August 2021, no sampling was undertaken for any parameters at any of the sampling locations during this time. Sampling resumed in September 2021 and continued through to December 2021.

Original laboratory reports for each sampling event are available on request.

5.2.1 Total Suspended Solids

The TSS maximum concentration results recorded at each sampling location exceeded the 13-month median and ANZ guideline value (80%ile species protection) as shown in Figure 5-2. The highest TSS concentration (160 g/m^3) was recorded at the SW 01 WW sampling site (Figure 5-2).The minimum TSS concentration results across all sampling locations were always below the 13-month medians but were consistently above the ANZ guideline value (80%ile species protection) of 4.6 g/m^3 (Figure 5-2).

TSS concentration results throughout the monitoring period (November 2020 – December 2021) were highest (Figure 5-3) in the summer month of January 2021 at the SW 01 WW (161 g/m^3) and SW 02 Res (137 g/m^3) sampling sites which are located closest to the treatment ponds.

TSS concentration results observed between February 2021 and June 2021 were similar across all sampling locations, apart from a large exceedance (122 g/m^3) observed at the SW 01 WW sampling site in May 2021 (Figure 5-3). There were only two instances (October (100 g/m^3) and November 2021 (103 g/m^3)), where TSS concentration results associated with the SW 03 Hav sampling location exceeded the TSS concentrations of the other two sampling locations (SW 01 WW and SW 02 Res) as shown in Figure 5-3.

All TSS concentration results obtained throughout the monitoring period (Figure 5-3) were consistently above the ANZ guideline value (80%ilespecies protection) of 4.6 g/m^3.

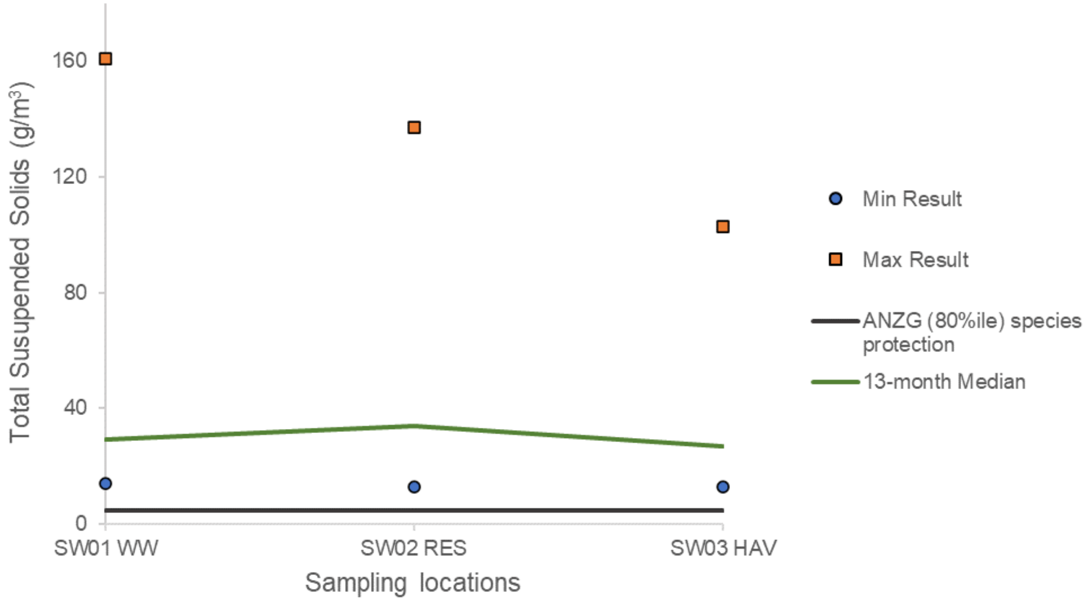

Figure 5-2: TSS concentration results compared to 13-month medians and ANZG (2018) 80%ile species protection guideline value (g/m^3).

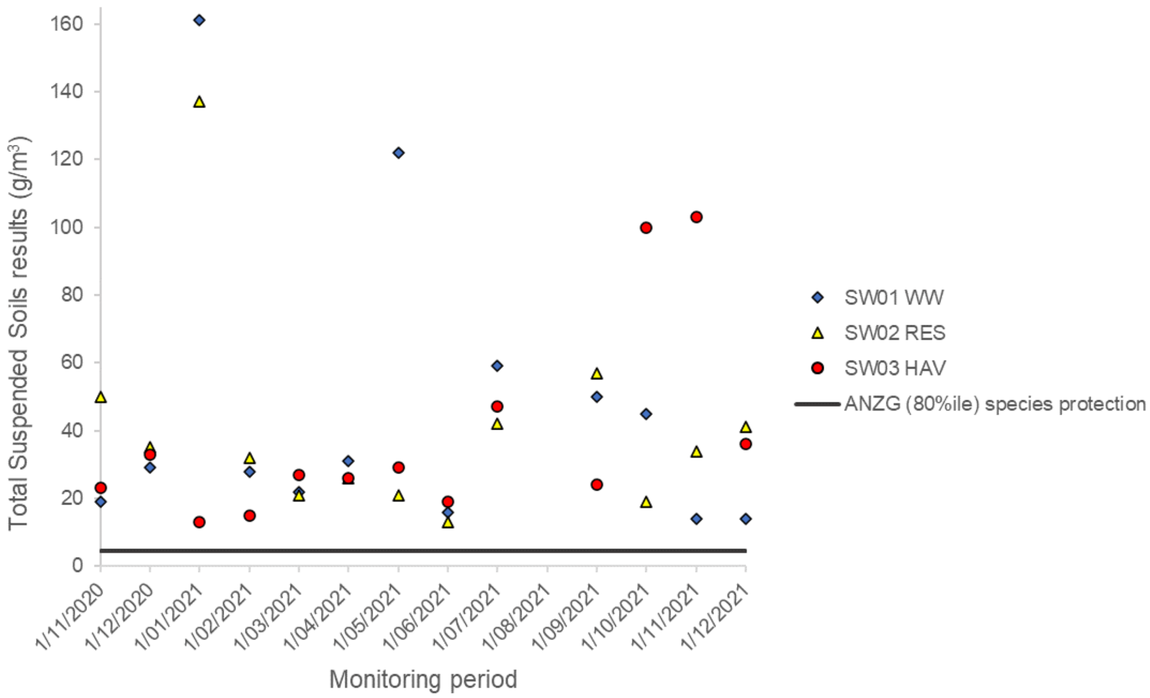

Figure 5-3: TSS concentration results compared to ANZG (2018) 80%ile species protection guideline value (mg/L) throughout monitoring period (November 2020 – December 2021).

5.2.2 Dissolved Reactive Phosphorus

Figure 5-4 shows DRP maximum concentration results recorded at each sampling location exceeded the 13-month median and were all within the "D" attribute band[18] as outlined in the NPS-FM (2020). The highest maximum DRP concentration result (0.72 g/m^3) was recorded at the SW 01 WW sampling site, with the lowest maximum DRP concentration (0.4 g/m^3) observed at the SW 03 Hav sampling site (Figure 5-4). Additionally, all maximum DRP concentration results recorded were above the 13-month medians associated with each sampling site (Figure 5-4). The minimum DRP concentration results observed across each sampling site were consistently below the 13-month medians (Figure 5-4). All sampling sites contained similar minimum DRP concentrations which ranged from 0.025 to 0.04 g/m^3. However, all minimum DRP concentration results for all sampling locations were within the "D" band (NPS-FM (2020)) as outlined in Figure 5-4.

DRP concentrations tended to steadily increase at most sampling locations in the months leading up to summer (December and January) and peaked in February 2021, with the highest DRP concentration (0.72 g/m^3) observed at the SW 01 WW sampling location (Figure 5-5). The lowest DRP concentrations (0.046 g/m^3) out of the three sampling locations during February 2021 were seen at the SW 03 Hav location (Figure 5-5). However, DRP concentrations associated with sampling location SW 01 WW contained large exceedances in March 2021 (0.31 g/m^3), July 2021 (0.30 g/m^3) and November 2021 (0.38 g/m^3), when compared to the concentrations associated with the other two sampling locations during the same months (Figure 5-5).

DRP concentration results from all sampling locations throughout the monitoring period were within the D" band (NPS-FM (2020)) as outlined in Figure 5-5.

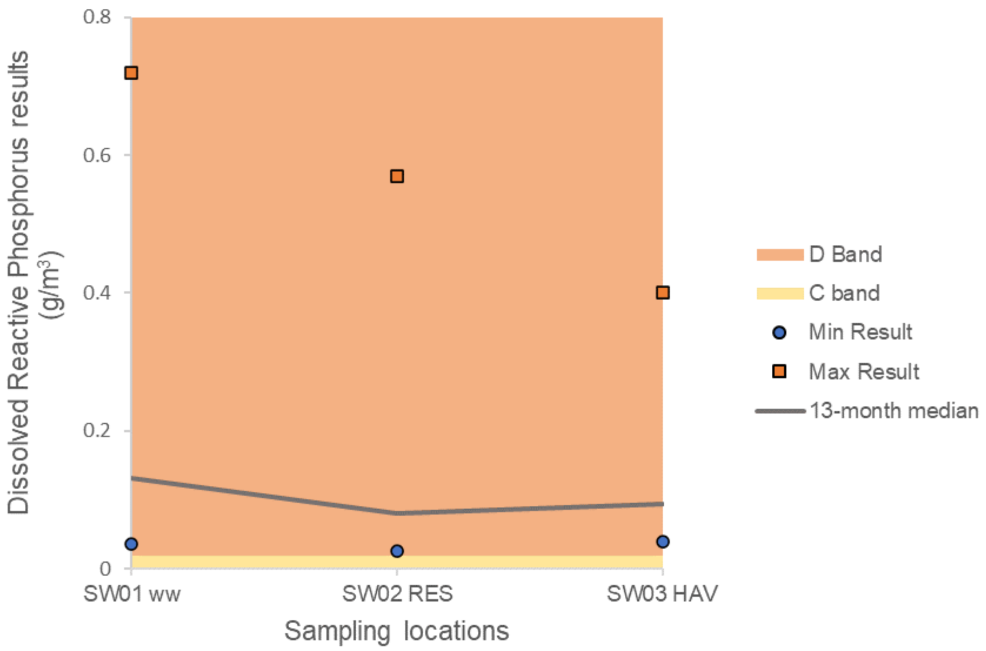

Figure 5-4: DRP results compared to 13-month (November 2021 – December 2021) median results and NPS-FM (2020) attribute bands (mg/L).

[18] "D" band as defined under the NPS-FM (2020); '*Ecological communities impacted by substantial DRP elevation above natural reference conditions. In combination with other conditions favouring eutrophication, DRP enrichment drives excessive primary production and significant changes in macroinvertebrate and fish communities, as taxa sensitive to hypoxia are lost*'.

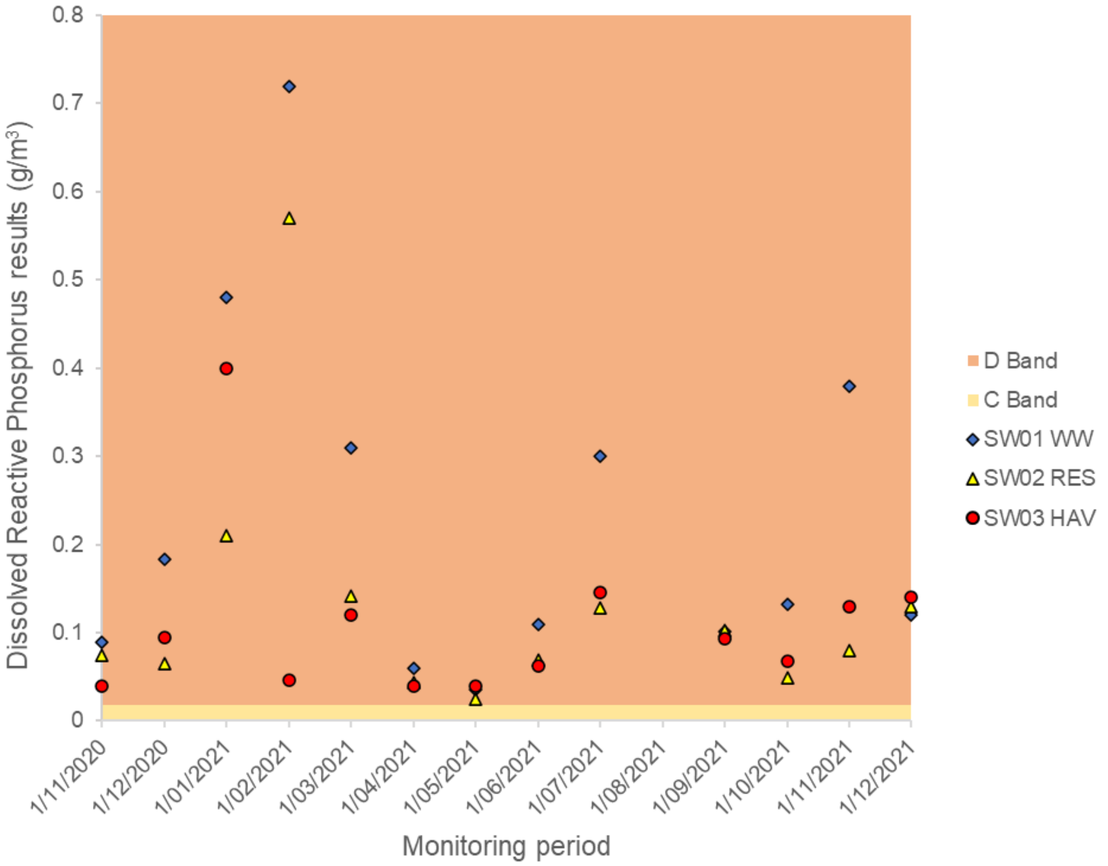

Figure 5-5: DRP results compared to NPS-FM (2020) attribute bands (mg/L) throughout the monitoring period (November 2020 – December 2021).

5.2.3 Total Nitrogen

TN maximum concentration results (Figure 5-6) at each sampling location exceeded the 13-month median at each sampling location. The highest maximum TN concentration result (3.9 g/m^3) was recorded at the SW 02 Res sampling location, with the lowest maximum TN concentration (2.7 g/m^3) observed at the SW 03 Hav sampling location (Figure 5-6). All TN maximum concentration results were above the 13-month medians associated with each sampling location (Figure 5-6). Conversely, all minimum TN concentration results across each sampling location were consistently below the 13-month medians (Figure 5-6).

Sampling sites SW 01 WW (0.42 g/m^3) and SW 02 Res (0.48 g/m^3) contained similar minimum TN concentration results (Figure 5-6) and were above the ANZ guideline value (80%ile species protection) of 0.281 g/m^3. The lowest minimum result (0.13 g/m^3) was recorded at the SW 03 Hav sampling location and was below the 13-month median and the ANZG 80%ile species protection guideline value as shown in Figure 5-6.

TN concentrations showed to increase at most sampling locations from April 2021 and peaked in July 2021, with the highest concentration recorded (3.9 g/m^3) during this month at the SW 02 Res sampling site Figure 5-7. TN concentrations at all sampling locations displayed a decreasing trend from September 2021 to November 2021 (Figure 5-7). Additionally, similar TN concentrations were observed across all sampling sites during these months (Figure 5-7).

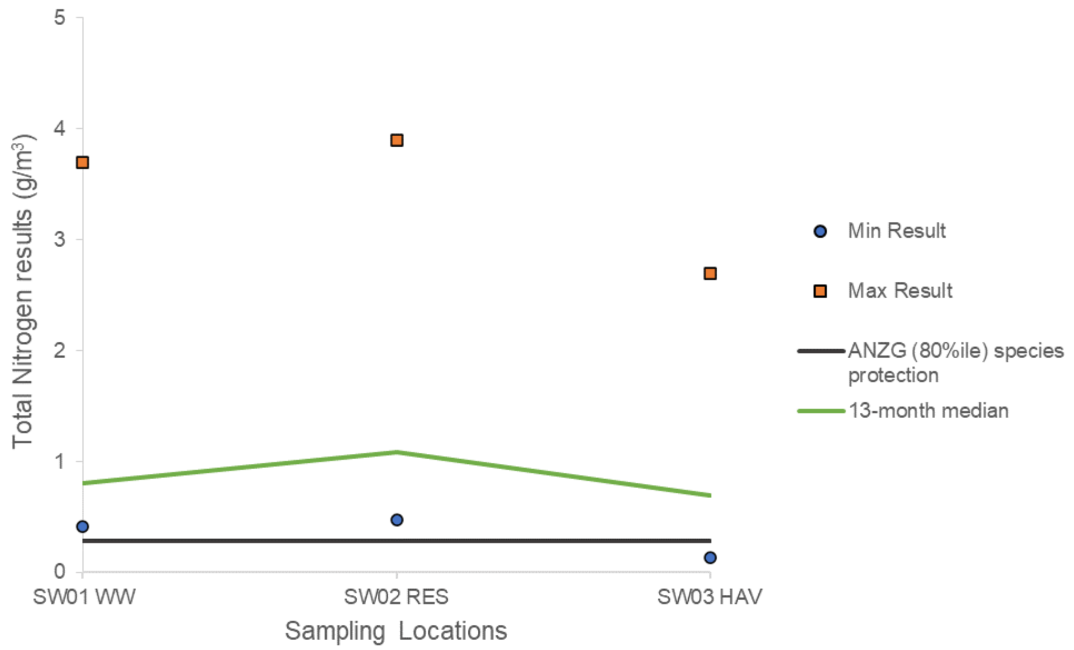

Figure 5-6: Total Nitrogen concentration results compared to 13-month medians and ANZG (2018) 80%ile species protection guideline value (g/m^3).

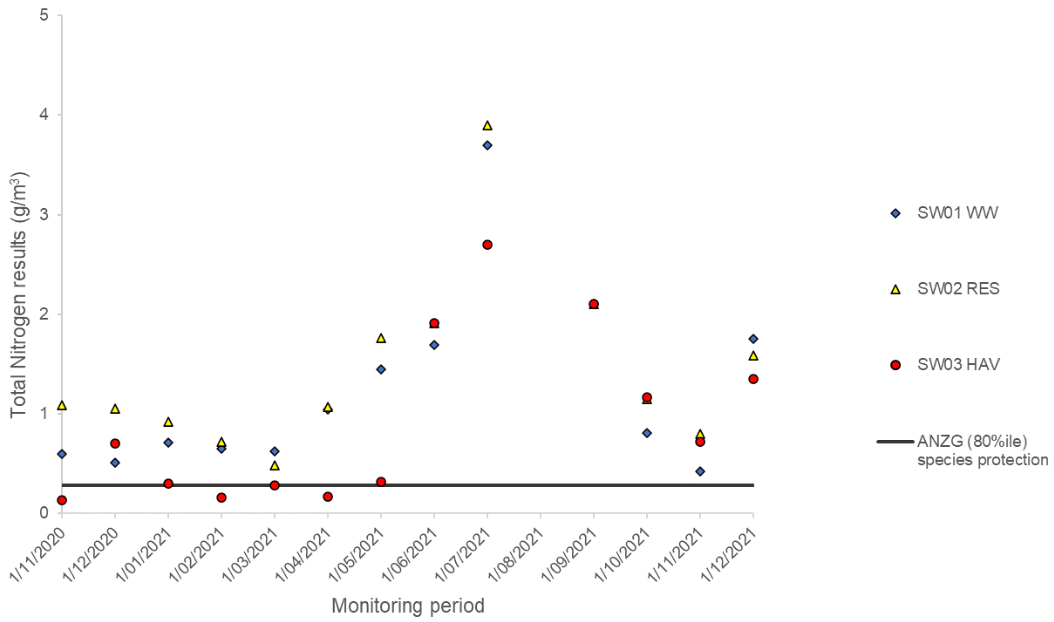

Figure 5-7: Total Nitrogen results compared to ANZG (2018) 80%ile species protection guideline value (0.281 g/m^3) throughout monitoring period (November 2020 – December 2021).

5.2.4 Nitrate-N

Nitrate-N maximum concentrations (Figure 5-8) at each sampling location exceeded the 13-month medians. All sampling sites contained similar maximum Nitrate-N concentrations ranging from 1.45 g/m^3 to 1.51 g/m^3 (Figure 5-8). Maximum Nitrate-N concentrations at each sampling site were within the “B” attribute band[19]. All maximum Nitrate-N concentrations did not exceed the National Bottom Line (2.4 g/m^3 (annual median)) as shown in Figure 5-8.

[19] “B” attribute band as defined under the NPS-FM (2020): *Some growth effect on up to 5% of species*

All sampling sites contained minimum Nitrate-N concentrations below the 13-month medians and National Bottom Line (2.4 g/m^3 (annual median)) as shown in Figure 5-8. Nitrate-N minimum concentration results were similar across all sampling sites and ranged from 0.0024 g/m^3 to 0.055 g/m^3 (Figure 5-8). All sampling sites contained minimum Nitrate-N results within the "A" attribute band[20] (Figure 5-8).

Nitrate-N concentrations across the monitoring period remained relatively consistent from November 2020 to March 2021 across all sampling sites and were all within the "A" attribute band[20] (Figure 5-9). Nitrate-N concentrations appear to increase across most sampling sites from April 2021, with concentrations peaking in July 2021 (Figure 5-9). Nitrate-N concentrations appear to decrease from September 2021 to November 2021, before increasing again at all sites in December 2021 (Figure 5-9).

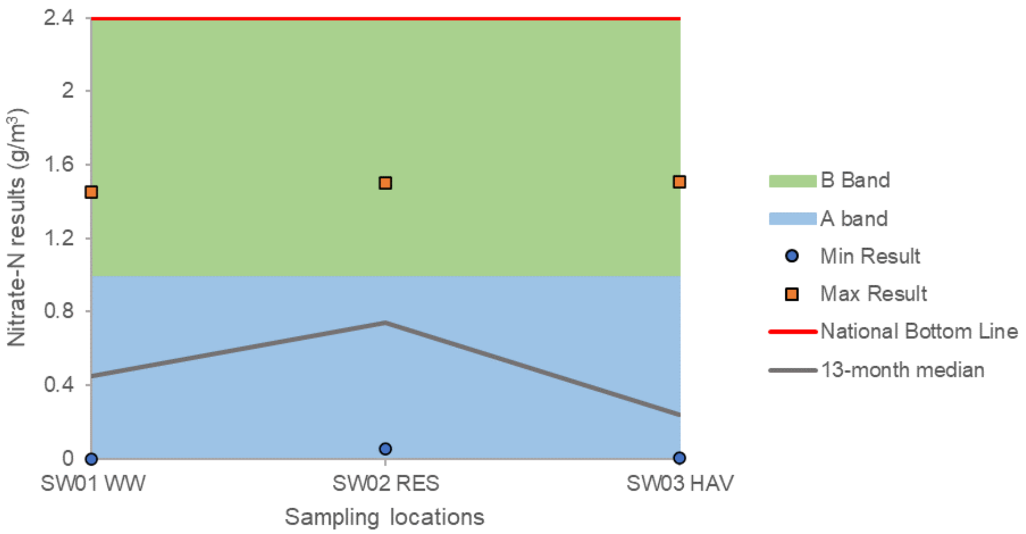

Figure 5-8: Nitrate-N concentration results compared to 13-month medians, NPS-FM 2020 attribute band guideline values and the National Bottom Line.

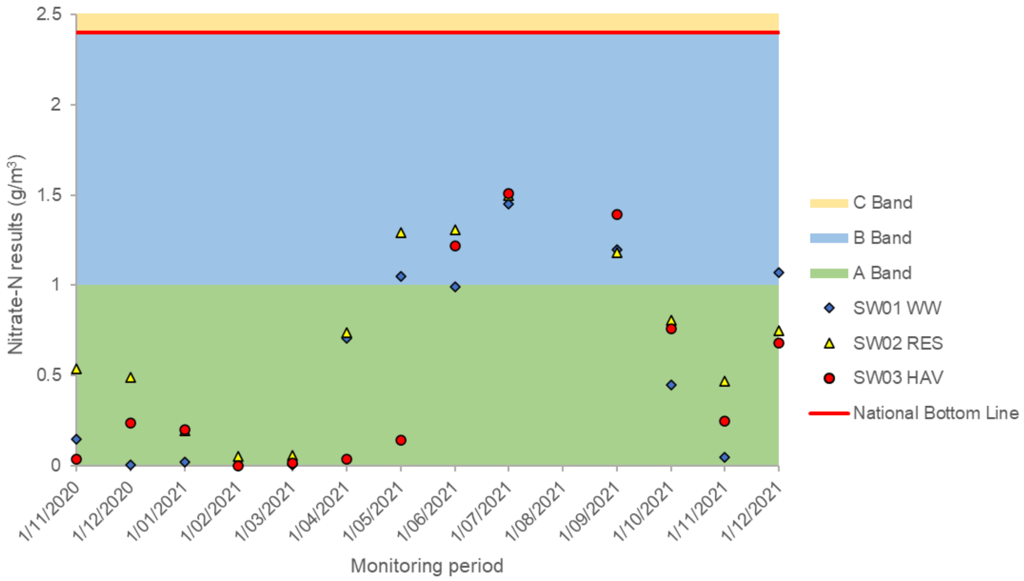

Figure 5-9: Nitrate-N concentration results compared to NPS-FM (2020) attribute bands and National Bottom Line throughout the monitoring period (November 2020-December 2021).

[20] "A" attribute band as defined under the NPS-FM (2020): *High conservation value system. Unlikely to be effects even on sensitive species.*

5.2.5 Total Ammoniacal-N

Total ammoniacal-N maximum concentration results (Figure 5-10) at each sampling location exceeded the 13-month medians. The highest maximum total ammoniacal-N concentration result was recorded at the SW 03 Hav sampling site (1.0 g/m^3), whilst the lowest maximum concentration (0.194 g/m^3) was observed at the SW 02 Res sampling site (Figure 5-10).

Maximum concentrations recorded at the SW 01 WW and SW 03 Hav sampling sites were within the "C" attribute band[21] and exceeded the National Bottom Line, whilst the maximum concentrations recorded at the SW 02 Res sampling site were within the "B" attribute band[22] and did not exceed the National Bottom Line (Figure 5-10). Sampling sites SW 02 Res and SW 03 Hav contained minimum total ammoniacal-N concentrations that were within the "B" attribute band[22], whilst sampling location SW 01 WW's minimum concentration was within the "A" attribute band[23] and contained the lowest minimum concentration recorded (0.01 g/m^3) as outlined by Figure 5-10. All minimum total ammoniacal-N concentration results across all sampling sites were below the National Bottom Line (Figure 5-10).

Total ammoniacal-N results across the monitoring period remained relatively consistent at each sampling location and for the majority of the sampling period concentrations remained within the "A"[23] or "B"[22] attribute bands, as well as below the National Bottom Line (Figure 5-11). Total ammoniacal-N concentrations during January 2021 peaked at sampling locations SW 03 Hav (1.0 g/m^3) and SW 01 WW (0.74 g/m^3) as shown in Figure 5-11. During the January (summer) 2021 peak, the concentrations observed at these two sampling sites were within the "C" attribute band and well above the National Bottom Line (Figure 5-11).

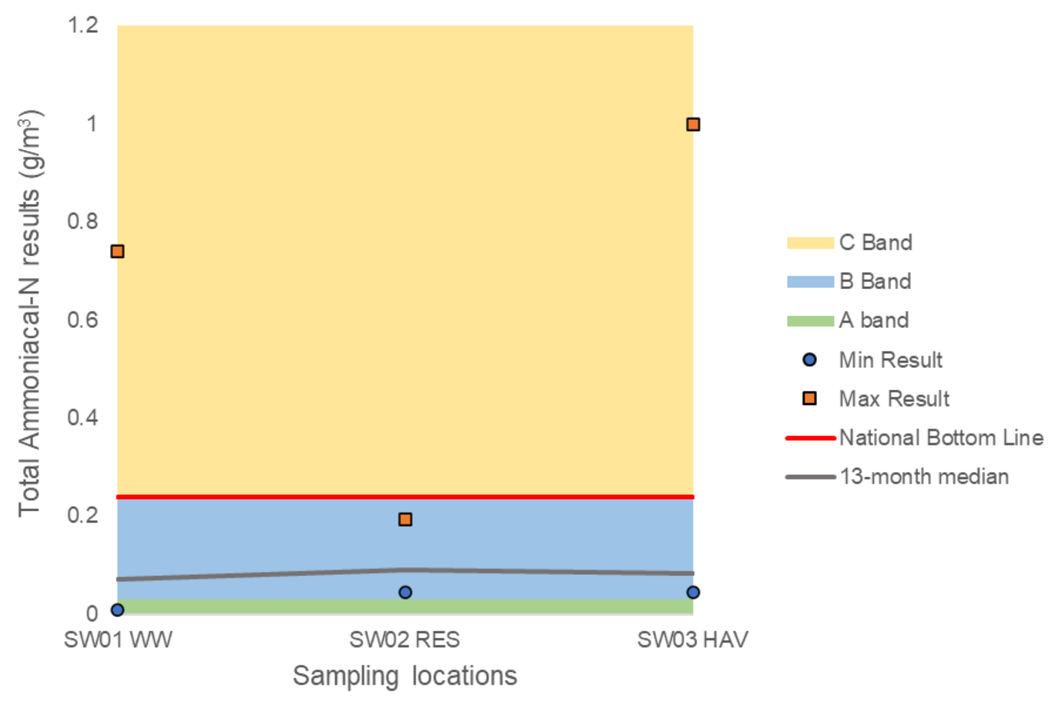

Figure 5-10: 2020-2021 Total ammoniacal-N results compared to 13-month medians, NPS-FM 2020 attribute band guideline values (mg NH_4-N/L) and the National Bottom Line (annual median 0.24 mg NH_4-N/L).

[21] "C" attribute band as defined under the NPS-FM (2020); *80% species protection level: Starts impacting regularly on the 20% most sensitive species (reduced survival of most sensitive species).*
[22] "B" attribute band as defined under the NPS-FM (2020); *95% species protection level: Starts impacting occasionally on the 5% most sensitive species.*
[23] "A" attribute band as defined under the NPA-FM (2020); *00% of species protection level: No observed effect on any species tested.*

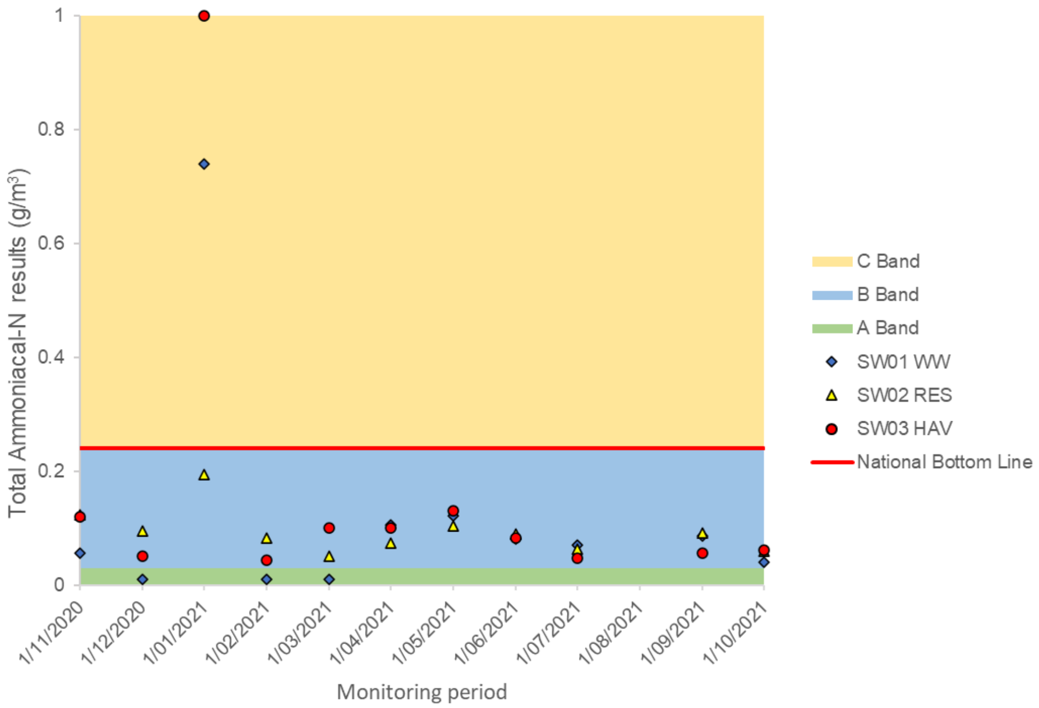

Figure 5-11: Total ammoniacal-N compared to NPS-FM (2020) attribute bands (mg NH_4-N/L) and National Bottom Line (annual median 0.24 mg NH_4-N/L), throughout the monitoring period (November 2020-December 2021).

5.2.6 Total Kjeldahl Nitrogen

TKN maximum concentration results (Figure 5-12) at each sampling location exceeded the 13-month medians. The highest maximum TKN concentration (2.3 g/m^3) was observed at the SW 02 Res sampling site, whilst the lowest maximum concentration (1.21 g/m^3) was associated with the SW 03 Hav sampling site (Figure 5-12). All minimum TKN concentrations across all sites were below the 13-month medians (Figure 5-12) and ranged from 0.1 g/m^3 (SW 03 Hav) to 0.31 g/m^3 (SW 01 WW and SW 02 Res).

TKN concentrations were relatively stable from November 2020 to May 2021 at most of the sampling sites (Figure 5-13). However, TKN concentrations peaked at all sampling sites during July 2021, with concentrations ranging from 2.3 g/m^3 (SW 02 Res) to 1.21 g/m^3 (SW 03 Hav) as outlined in Figure 5-13. Decreasing TKN concentrations were observed from September 2021 till November 2021 at all sampling sites. However, TKN concentrations began to increase again during December 2021 across all sites (Figure 5-13).

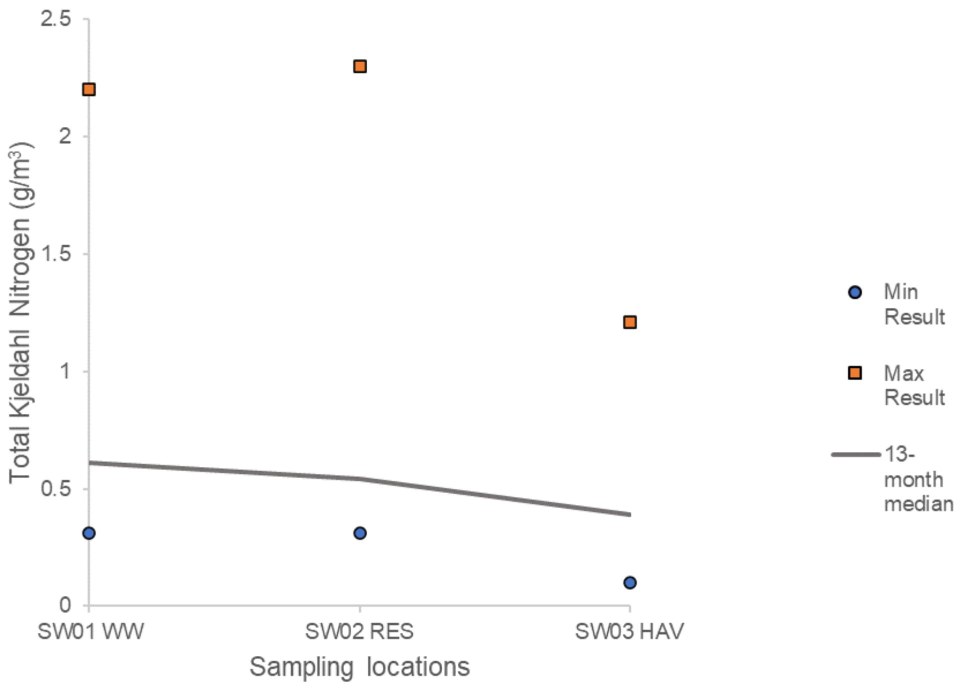

Figure 5-12: TKN concentrations compared to 13-month medians.

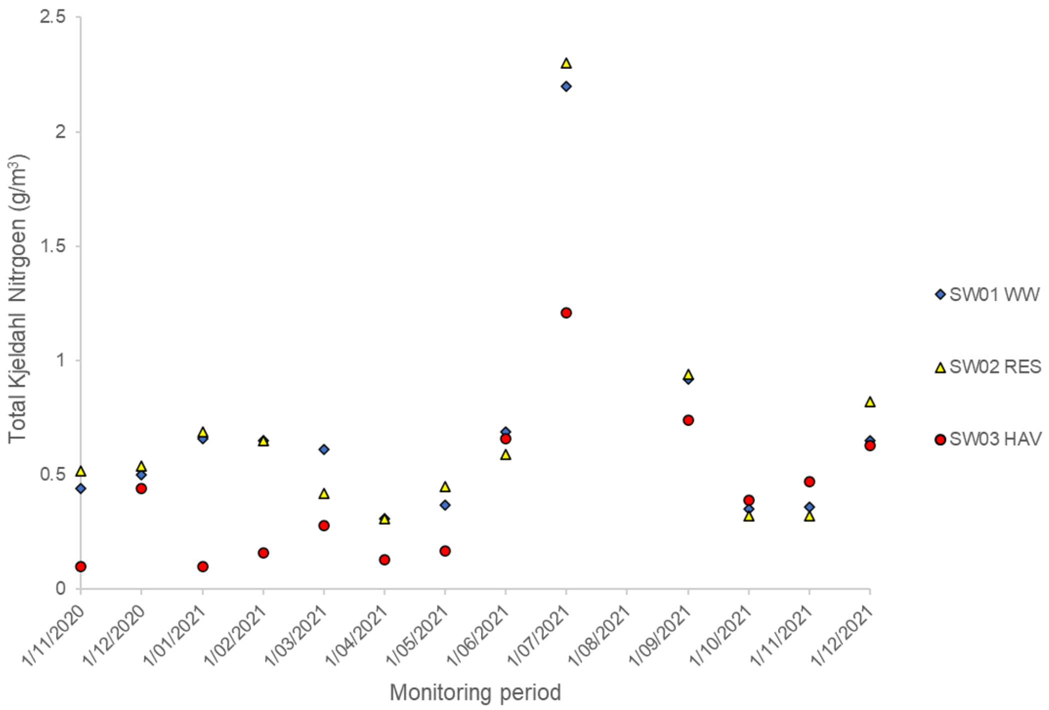

Figure 5-13: TKN concentrations throughout monitoring period (November 2020 to December 2021).

5.2.7 *E. coli*

Maximum *E.coli* concentrations exceeded the 9-month medians and National Bottom Line (as required by the NPS-FM (2020)) at all sampling locations (Figure 5-14). The highest maximum *E.coli* concentration was recorded at the SW 03 Hav sampling site (1800 cfu/100 mL). All maximum *E.coli* concentration results were within the "Poor" attribute band[24]. Minimum *E.coli* concentrations were varied across all sampling locations, with the lowest minimum concentration observed at the SW 03 Hav sampling site (40 cfu/100 mL) which was also within the "Excellent" attribute band[25] and below the NPS-FM (2020) National Bottom Line (Figure 5-14). The minimum *E.coli* concentrations observed at the SW 01 WW sampling site were below the 9-month median, NPS-FM National bottom line and was within the "Fair" attribute band[26].

For the majority of the 2021 monitoring period, *E.coli* concentrations across most sampling locations exceeded the NPS-FM (2020) National Bottom Line of 540 cfu/100mL (Figure 5-15). *E.coli* concentrations peaked in September 2021 at all sampling locations and ranged from 18000 cfu/100mL (SW 03 Hav) to 14000 (SW 01 WW) as outlined in Figure 5-15. The majority of *E.coli* concentrations observed throughout the 2021 monitoring period were within the "Poor" attribute band[24]. The SW 03 Hav sampling site contained *E.coli* concentrations within the "Excellent" attribute band[25] (and did not exceed the National Bottom Line) during February and May 2021 (Figure 5-15). Similarly, during November 2021 *E.coli* concentrations at the SW 01 WW sampling site were within the "Fair" attribute band[26] and also did not exceed the National Bottom Line.

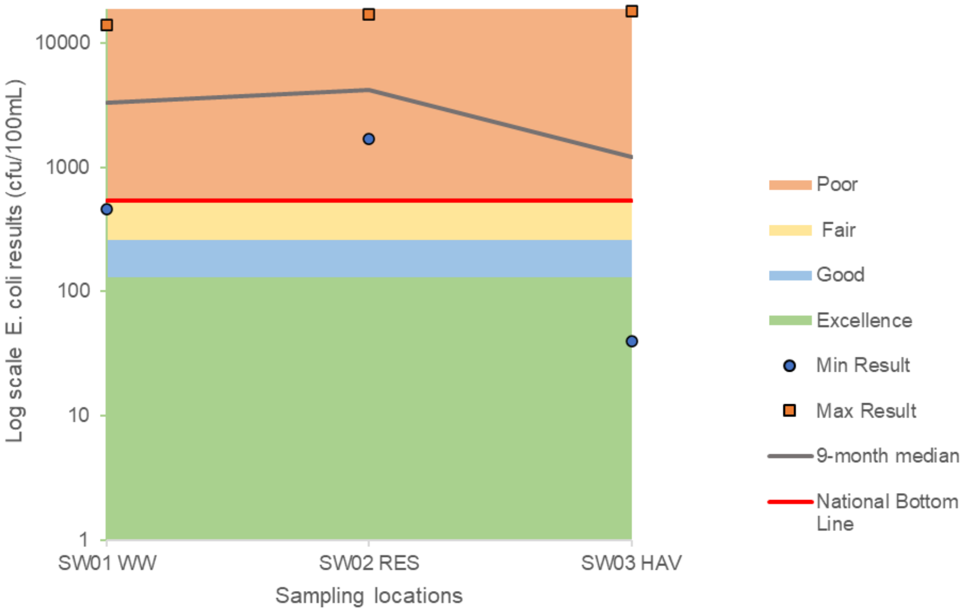

Figure 5-14: Log scale *E coli.* results compared to 9-month (February 2021 – December 2021) medians and the NPS-FM (2020) 95th percentile attribute guidelines (*E coli* / 100mL).

[24] "Poor" attribute band as defined under the NPS-FM (2020); *Estimated risk of Campylobacter infection has a 1-5% occurrence, at least 5% of the time.*
[25] "Excellent" attribute band as defined under the NPS-FM (2020); *Estimated risk of Campylobacter infection has a <0.1% occurrence, 95% of the time.*
[26] "Fair" attribute band as defined under the NPS-FM (2020); *Estimated risk of Campylobacter infection has a 1 – 5% occurrence, 95% of the time.*

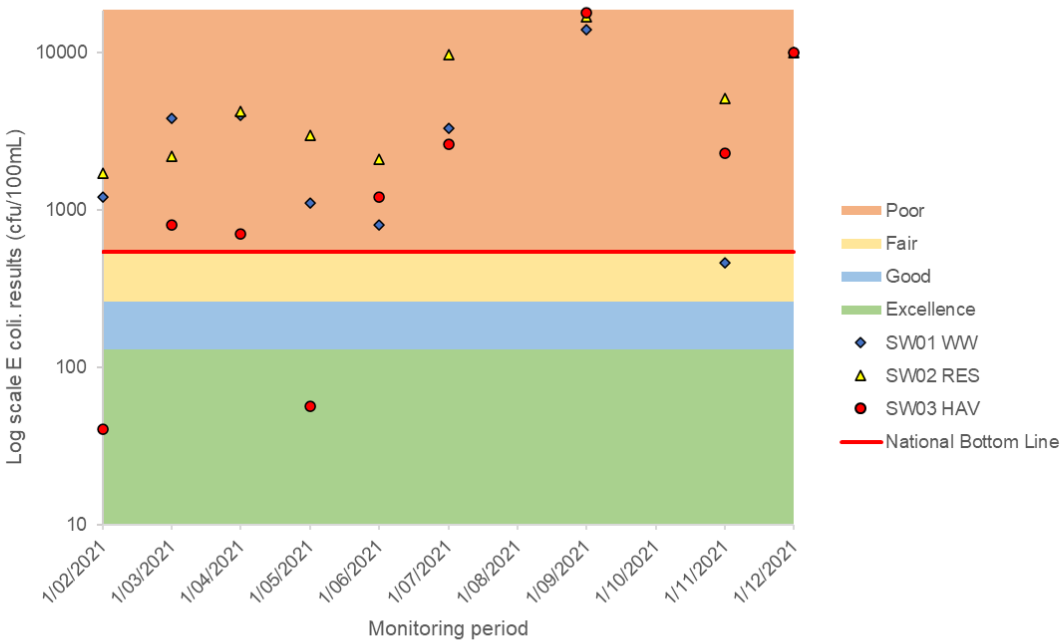

Figure 5-15: Log scale *E coli.* results against NPS-FM 2020 95th percentile attribute band guideline values throughout monitoring period (February 2021 – December 2021).

5.2.8 Chemical Oxygen Demand

The range of results obtained for Chemical Oxygen Demand (COD) at sampling sites SW 01 WW and SW 02 Res is shown in Figure 5-16. It was considered that these two sampling sites are more representative of the potential interaction between surface water and the adjacent NWWTP. The SW 03 Hav sampling site was not included in Figure 5-16 as there is information lacking between the behaviour and potential interaction between this sampling site and the NWWTP to make any accurate conclusions or assessment on COD results observed at this site.

Both sampling sites contained the same maximum COD results (60 gO_2/m^3) which were both above the 13-month medians (Figure 5-16). Results across the monitoring period showed that the SW 03 Hav sampling site had the highest COD results, however there was no discernable pattern to result peaks (Figure 5-17). COD was fairly consistent at SW 01 WW and SW 02 Res throughout the entire monitoring period (Figure 5-17). It is possible that higher concentrations of chloride observed at SW03 Hav (see Section 5.2.9), ionic composition of water, and tidal inputs could have influenced COD (if measures were not taken to eliminate the influence of chloride, which we have not been able to confirm at time of writing), making these results difficult to rely upon.

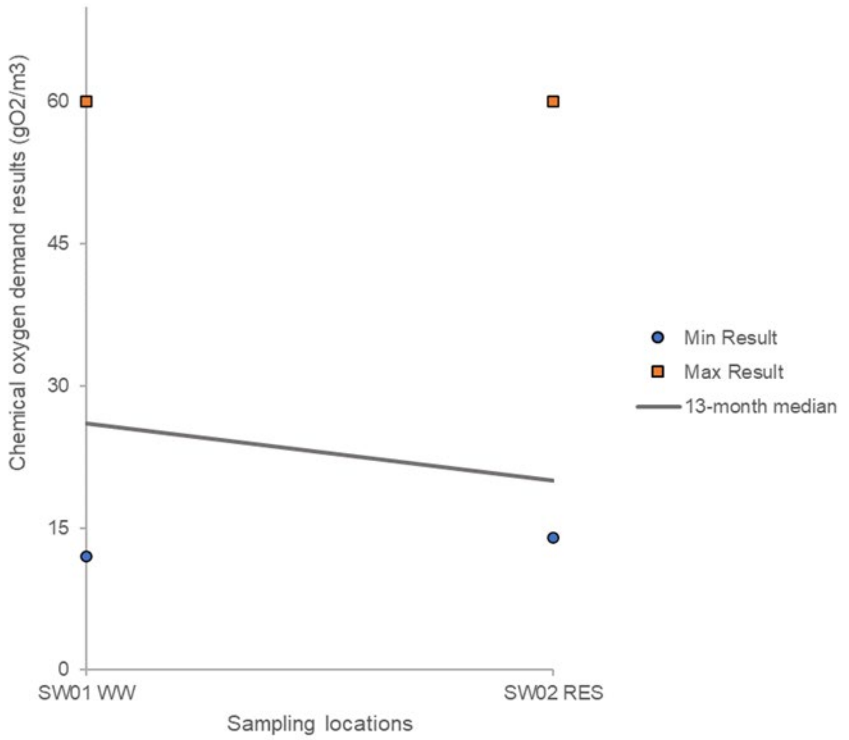

Figure 5-16: COD maximum and minimum results compared to 13-month medians for SW 01 WW and SW 02 Res sampling sites.

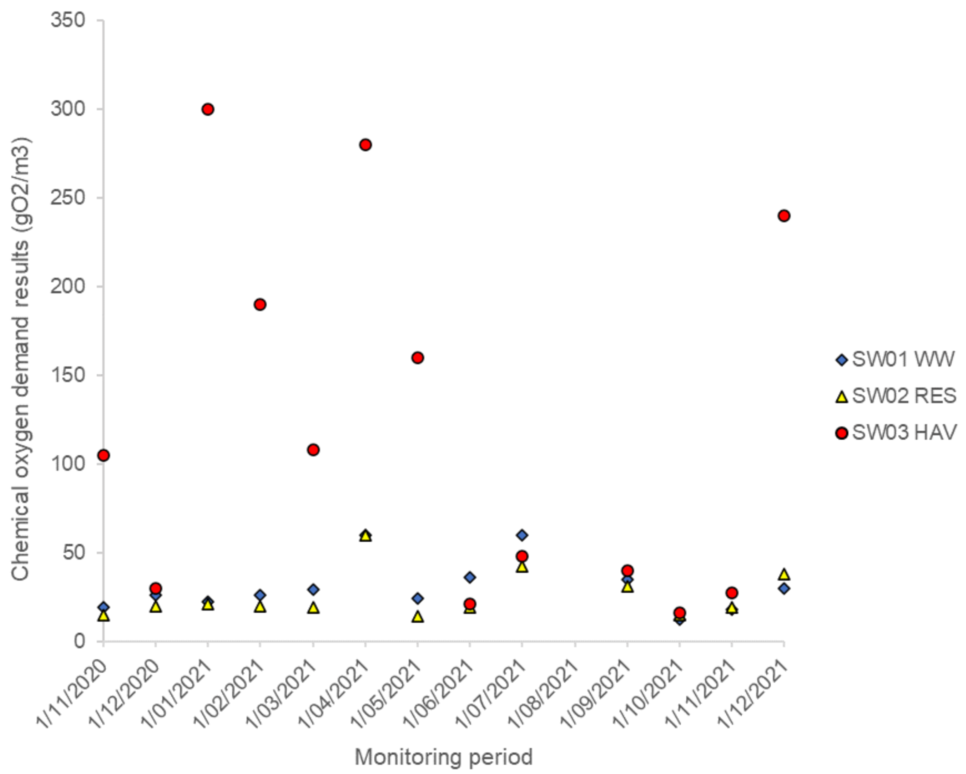

Figure 5-17: COD results throughout monitoring period (November 2020 to December 2021) at each sampling site.

5.2.9 Chloride

Maximum chloride concentration results for the SW 01 WW and SW 02 Res sampling sites were observed to be above the 13-month medians for both sites, with SW 01 WW containing the highest maximum chloride result of 880 g/m^3 (Figure 5-18). Both sites contained similar minimum chloride concentrations which ranged between 31 g/m^3 (SW 02 Res) and 55 g/m^3 (SW 01 WW) as shown in Figure 5-18.

For similar reasons as outlined in the previous section (5.2.8), the range of results associated with the SW 03 Hav sampling site were not included in Figure 5-18.

Results across the monitoring period showed that the SW 03 Hav sampling site had the highest chloride concentrations (>10,000 g/m^3) as shown in Figure 5-19. Chloride concentrations associated with the SW 01 WW and SW 02 Res sampling sites were largely consistent with each other and were typically between 30 g/m^3 and 1,000 g/m^3 (Figure 5-19). It is considered that the results associated with the SW 01 WW sampling location are more representative of any interaction that may potentially be occurring due to its close proximity to the NWWTP.

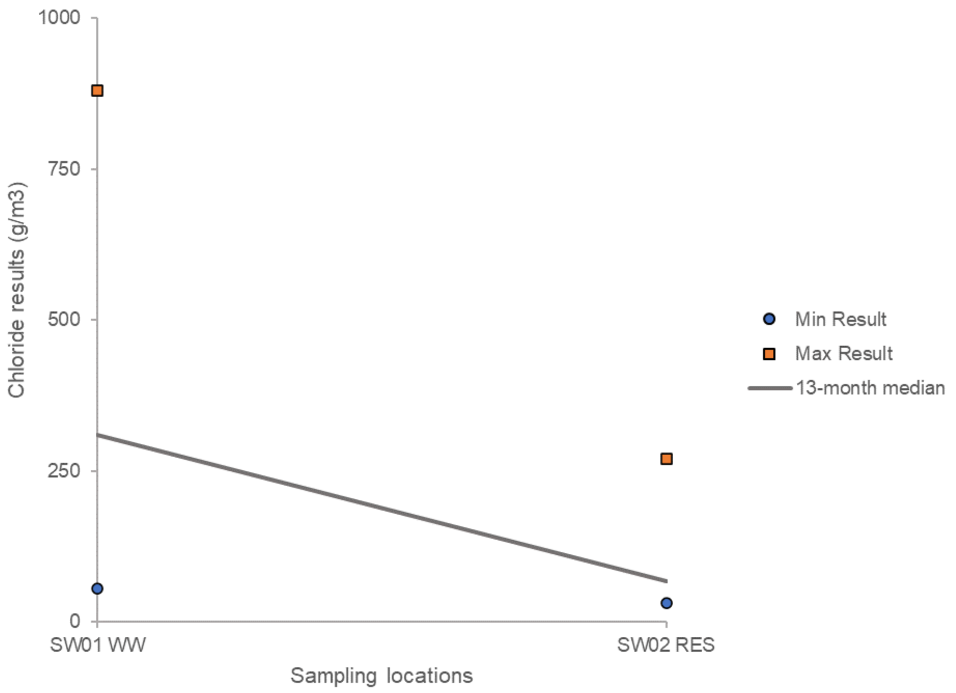

Figure 5-18: Chloride maximum and minimum results compared to 13-month medians for SW 01 WW and SW 02 Res sampling sites.

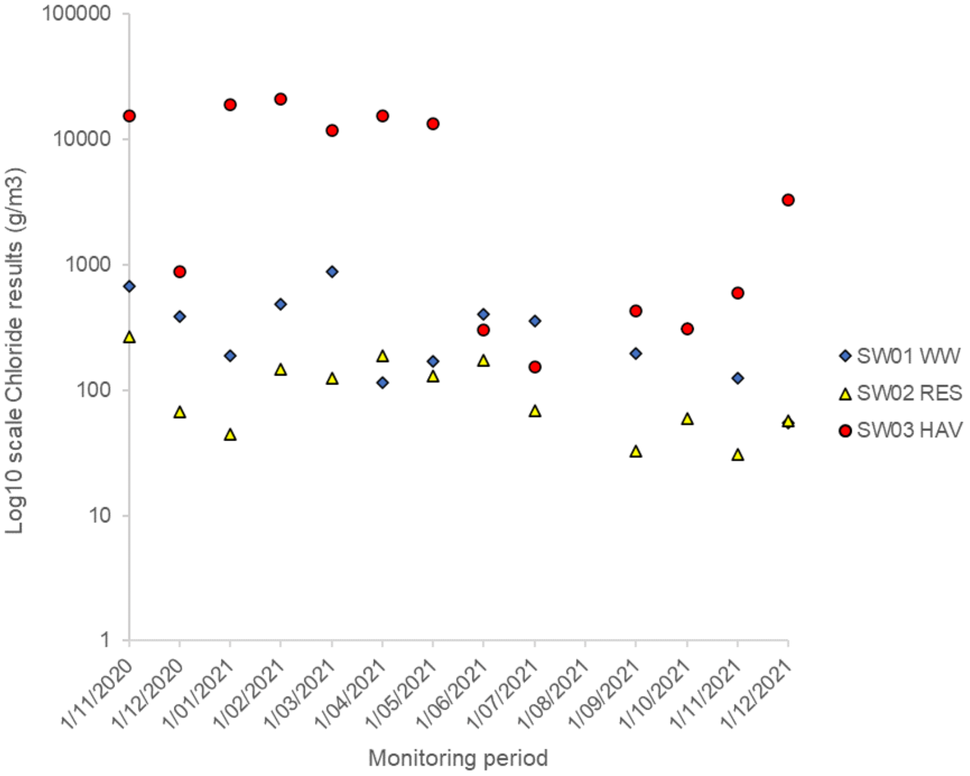

Figure 5-19: Chloride results throughout monitoring period (November 2020 to December 2021) at each sampling site.

5.2.10 pH (in-situ)

The maximum pH reading collected from the SW 03 Hav sampling site (11.61) exceeded the ANZ80%ile species protection guideline value of 7.8 as well as the 13-month median (Figure 5-20). Maximum pH values observed at the SW 01 WW and SW 02 Res sampling sites were 7.9 and only marginally exceeded the ANZG 80%ile species protection guideline value of 7.8. All minimum pH values recorded at all sampling sites were below the 13-month medians and ANZG value (80%ilespecies protection) of 7.8, as shown in Figure 5-20.

The most alkaline pH result (11.61) was observed at the SW 03 Hav sampling site during January 2021 and also exceeded the ANZ guideline value (80%ile species protection) of 7.8 as shown in Figure 5-21. In contrast to this, (during January 2021) pH results recorded at sampling location SW 01 WW (3.09) were on the more acidic end of the scale and were below the ANZ guideline value (80%ile species protection) as shown in Figure 5-21. Whilst sampling location SW 02 Res contained a more neutral pH reading of 6.77 and did not exceed the ANZ guideline value (80%ilespecies protection) , as outlined in Figure 5-21. From February 2021 to July 2021, pH results were relatively stable and remained around the 8.0 range (Figure 5-21). PH results from September 2021, at most of the sampling sites begin to fall toward the more acidic end of the scale (Figure 5-21), until December 2021 where pH results from all sampling sites are seen to be around the 8.0, more neutral end of the scale (Figure 5-21).

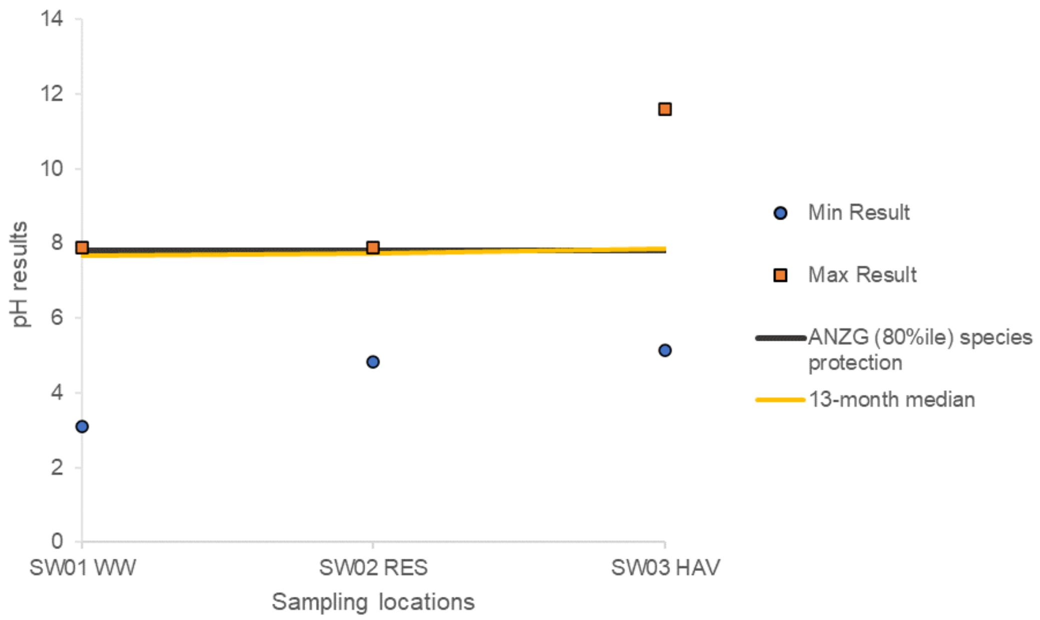

Figure 5-20: pH results compared to the 13-month median and ANZG 2018 80%ile species protection guideline values.

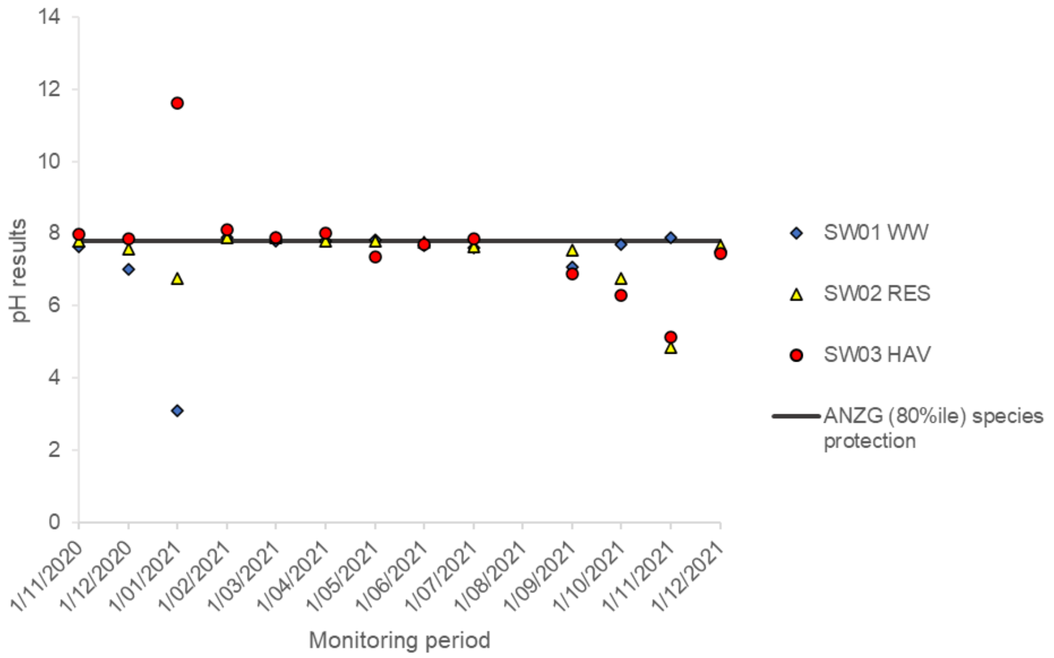

Figure 5-21: pH results compared to ANZG (2018) 80%ile species protection guideline value (7.8) throughout monitoring period (November 2020 – December 2021).

5.2.11 Electrical Conductivity (in-situ)

Maximum electrical conductivity results exceeded both the 13-month median and ANZ guideline value (80%ilespecies protection) of 86 µS/cm across all sampling locations (Figure 5-22). Sampling locations SW 01 WW and SW 03 Hav contained minimum electrical conductivity results that did not exceed the 13-month median and ANZ guideline value (80%ilespecies protection) of 86 µS/cm. Sampling location SW 02 Res contained minimum electrical conductivity results above the ANZ guideline value (80%ilespecies protection), but did not exceed the 13-month median value of 749 µS/cm.

The electrical conductivity results measured across the monitoring period displayed no discernible trend across any of the sampling locations (Figure 5-23). Sampling locations SW 01 WW (2,589 µS/cm) and SW 03 Hav (2,541 µS/cm) contained the two highest electrical conductivity readings which also exceeded the ANZ guideline value (80%ilespecies protection) as shown in Figure 5-23. Sampling location SW 03 Hav contained electrical conductivity readings below the ANZ guideline value (80%ilespecies protection) on three occasions during December 2020, January 2021 and December 2021 (Figure 5-23). Similarly, on two instances throughout the monitoring period (February and March 2021), sampling location SW 01 WW contained electrical conductivity results below the ANZ guideline value (80%ilespecies protection), as shown in Figure 5-23.

The ANZG guidelines referenced above are for a freshwater environment (warm, dry, low-elevation stream). Given that a degree of tidal influence is likely causing increased EC upstream of the Nelson Haven, it is not surprising that these guidelines were regularly exceeded (and as such, are probably not appropriate to apply in future).

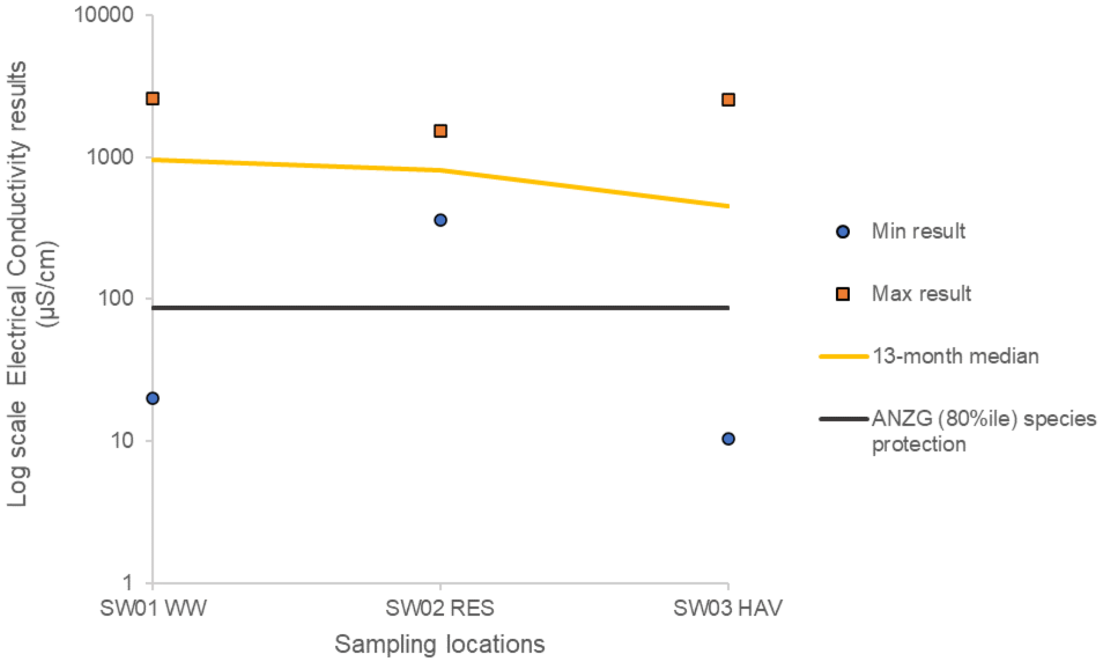

Figure 5-22: 2020-2021 Electrical Conductivity results compared to 13-month median results and ANZG (2018) 80%ile species protection guideline value (86 µS/cm).

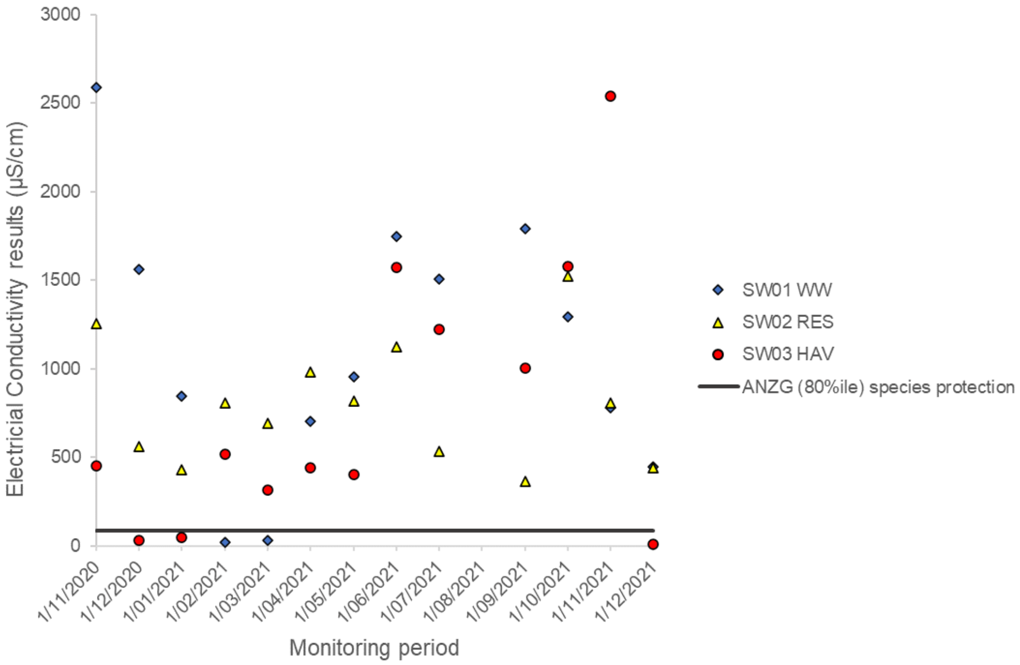

Figure 5-23: Electrical Conductivity compared to ANZG (2018) 80%ile species protection guideline value (86 µS/cm) throughout the monitoring period (November 2020 – December 2021).

5.2.12 Dissolved Oxygen (in-situ)

Maximum DO results recorded at each sampling location were above the 9-month median and National Bottom Line (as required by the NPS-FM (2020)) and were all within the "A" attribute band[27] (Figure 5-24). Minimum DO results recorded at the SW 01 WW and SW 03 Hav sampling sites were below the 9-month median, did not exceed the National Bottom Line and were within the "B" attribute band[28] (Figure 5-24). Minimum DO results observed at the SW 02 Res sampling site were the lowest (3.74 mg/L) of the three sampling sites and was within the "D" attribute band[29].

DO results across most sampling sites were within the "A"[27] or "B"[28] bands and did not exceed the National Bottom Line (required by the NPS-FM (2020)), as outlined in Figure 5-25. The only exception to this trend were the results associated with sampling location SW 02 Res during January (3.74 mg/L) and February (3.86 mg/L) 2021 and were also within the "D"[29] attribute band during these months (Figure 5-25). Sampling location SW 01 WW's DO concentrations peaked during November 2020 (8.34 mg/L) whilst DO concentrations at sampling location SW 02 Res peaked (8.94 mg/L) during May 2021 and lastly SW 03 Hav contained its highest DO concentration (8.79 mg/L) during April 2021 as shown in Figure 5-25.

[27] "A" attribute band as defined by the NPS-FM (2020); *No Stress caused by low dissolved oxygen on any aquatic organisms that are present at matched reference (near-pristine) sites.*
[28] "B" attribute band as defined by the NPS-FM (2020); *Occasional minor stress on sensitive organisms caused by short periods (a few hours each day) of lower dissolved oxygen. Risk of reduced abundance of sensitive fish and macroinvertebrate species.*
[29] "D" attribute band as defined by the NPS-FM (2020); *Significant, persistent stress on a range of aquatic organisms caused by dissolved oxygen exceeding tolerance levels. Likelihood of local extinctions of keystone species and loss of ecological integrity.*

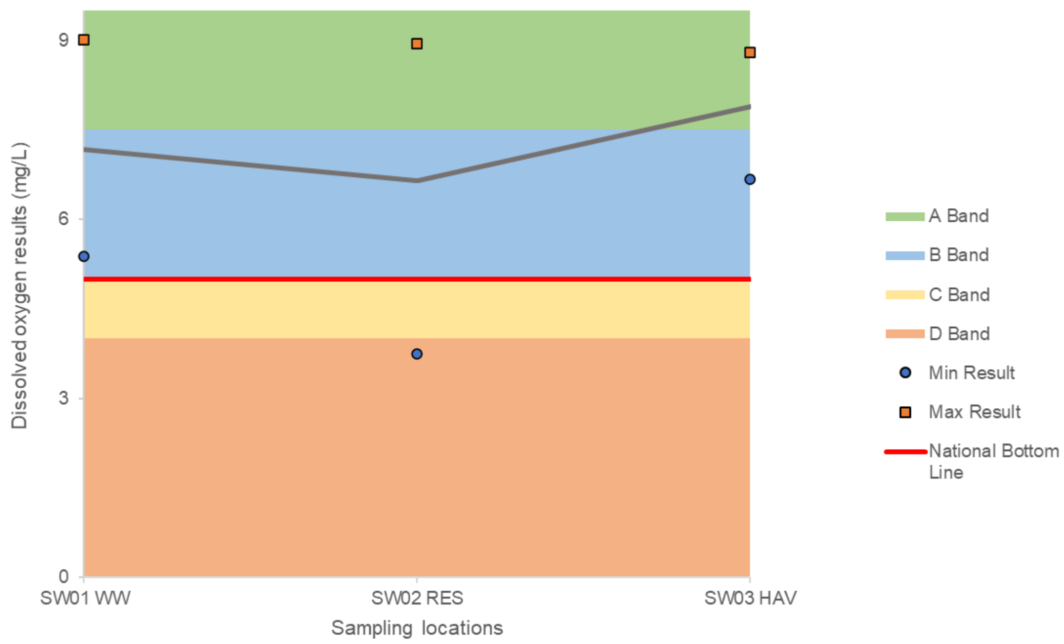

Figure 5-24: 2020-2021 Dissolved Oxygen results against the 9-month median and NPS-FM 2020 1-day minimum attribute band guideline values (mg/L).

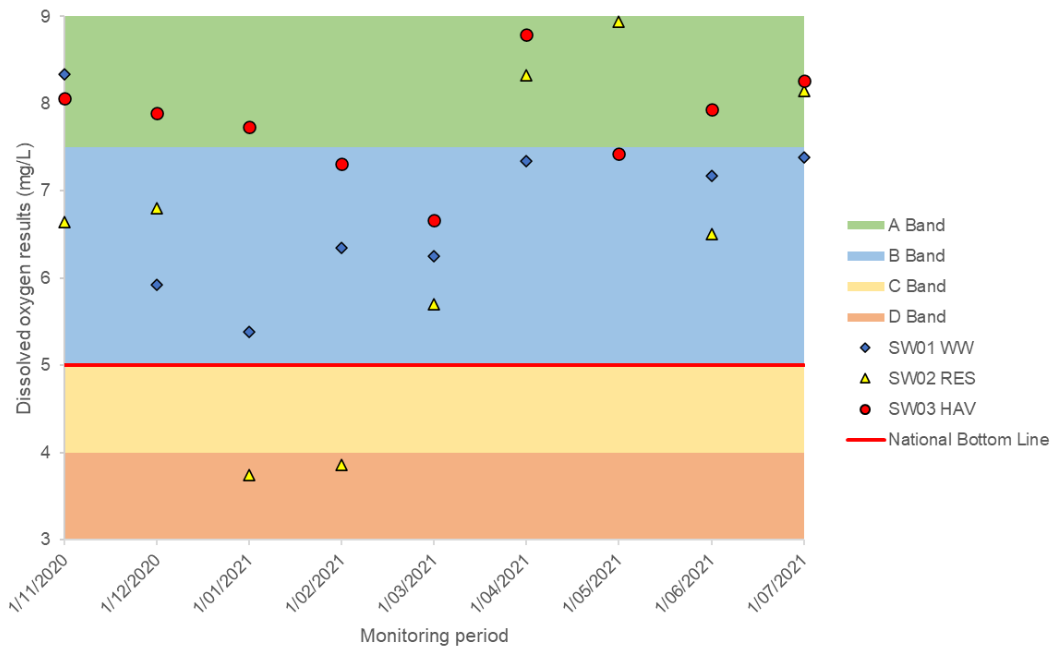

Figure 5-25: 2020-2021 Dissolved Oxygen compared to NPS-FM (2020) 1-day minimum attribute band guideline values (mg/L) throughout monitoring period (November 2020 – December 2021).

5.2.13 Ambient water temperature (in-situ)

Maximum temperature results exceeded the 13-month medians at each of the sampling locations (Figure 5-26). All sampling locations contained similar maximum temperatures of 21˚C (Figure 5-26). Minimum temperature results remained consistent across all three sampling sites and ranged from 7.8°C (SW 02 Res) to 11.5°C (SW 03 Hav), with all minimum results not exceeding the 13-month medians (Figure 5-26).

Temperature fluctuations throughout the monitoring period (November 2020 – December 2021) can be associated with seasonal changes, with higher temperatures measured at all sampling locations during the months leading up to and including the summer months (November 2020 – March 2021) as shown in Figure 5-27. Similarly, lower temperatures occurred during the months leading up to and including the winter season (April 2021 – September 2021), with little variation in temperature between sampling sites (Figure 5-27).

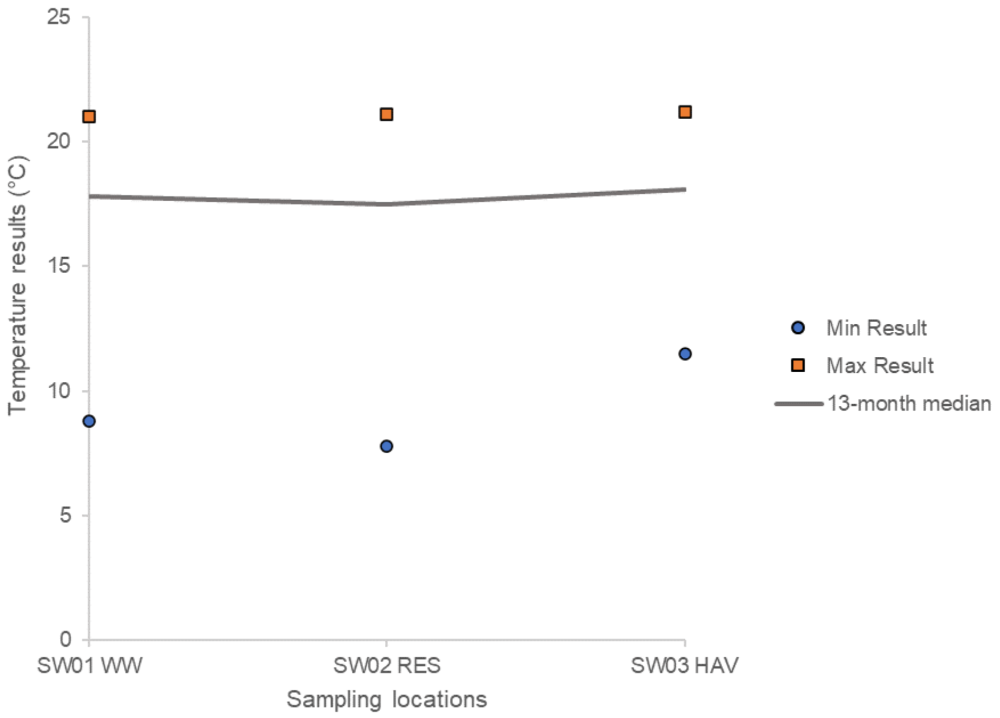

Figure 5-26: Temperature results compared to 13-month median values.

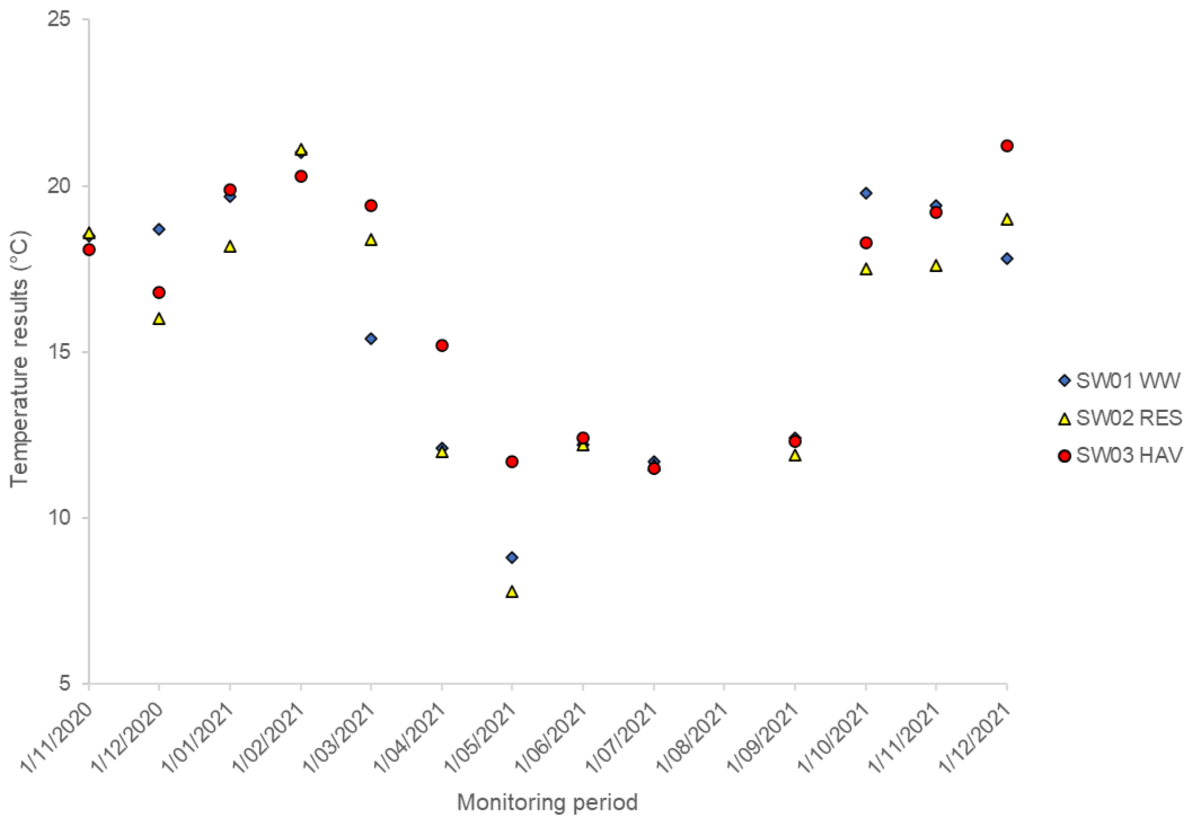

Figure 5-27: Temperature results throughout monitoring period (November 2020 – December 2021).

5.3 Summary of additional parameters

Summary statistics of additional parameters that have not already been assessed in Sections 5.2 and Section 5.3 are provided in Table 5-1.

The Enterococci results observed at the SW 02 Res sampling site contained the highest maximum concentrations compared to the SW 01 WW sampling site which contained the lowest maximum result (Table 5-1).

Sampling location SW 01 WW contained the highest 13-month median for Nitrite-N concentrations compared to the other two sampling sites (Table 5-1).

SW 03 Hav contained the highest salinity median, whilst the SW 02 Res sampling site contained the lowest salinity median reading (Table 5-1). The maximum salinity recording observed at the SW 03 Hav sampling site was 33.96 psu, which is indicative of the average salinity of surface waters which can range between 30 and 38 psu (depending on freshwater flows)[30].

Table 5-1: Summary Statistics of Additional Parameters

Parameter	Median (minimum-maximum)		
	SW 01 WW	SW 02 Res	SW 03 Hav
Enterococci* (MPN/100mL)	1,100 (85-7,700)	1,250 (200-14,000)	320 (10-9,800)
Nitrate-N+Nitrite-N (g/m^3)	0.47 (0.002-1.47)	0.76 (0.066-1.52)	0.25 (0.0031-1.52)
Nitrite-N (g/m^3)	0.13 (0.002-0.032)	0.018 (0.006-0.03)	0.02 (0.001-0.2)
Total phosphorus (g/m^3)	0.24 (0.123-0.98)	0.162 (0.068-0.76)	0.142 (0.025-0.32)
Salinity (psu)	0.813 (0.262-1.631)	0.431 (0.219-0.806)	5.926 (0.534-33.96)

* Note: *The raw data for this parameter contained two sets of results collected at the start of each month which were measured in cfu/100 mL, whilst the remainder of the samples for that monitoring period were measured in MPN/100 mL. Despite this difference in measurement units, it is still considered that the results present in Table 5-1 are representative of overall Enteroccoci concentrations.*

5.4 Assessment of results against NRMP

As outlined in Section 4.1.1 previously, the NRMP contains water quality standards which are listed in AP28.5 of the plan. The Hillwood Stream was assessed as being ‘Class D’ in 2007 (AP28.5 of the NRMP),Table 5-2 and Table 5-3 assess the water quality results against both Class D and Class C criteria. This is due to the requirement for Council to improve any Class D or E water bodies to at least a Class C (outlined in DO19.1.5.vi of the NRMP). However, the majority of the water quality criteria outlined in Table 5-2 and Table 5-3 were unable to be assessed against the water quality results collected as part of this investigation due to differing sampling methodologies.

[30] https://oceansconnectes.org/en/category/chiffres-cles/

Table 5-2 Water Quality Criteria for 'Class D' Degraded Waterbodies

Water Quality Criteria (AP28.5 of the NRMP)		Assessment of water quality results collected from this investigation against Class D water quality criteria
Waterborne Pathogens	No criteria	N/A.
Toxic algae	No criteria	N/A.
Dissolved Oxygen	Rivers and streams: minimum dissolved oxygen measured under low flow conditions over 24 consecutive hours is not less than 80% saturation. Lakes and reservoirs; no measurable decrease from natural conditions.	N/A; Unable to assess results against Class D criteria, due to differing sampling methodology used in this investigation.
Turbidity	Turbidity (mean or median) in rivers and streams does not exceed 5.0 NTU.	N/A; Turbidity was not a parameter measured as part of this investigation.
Clarity	Clarity: natural visual clarity is not reduced by more than 33%. Alternatively, clarity (median) of rivers and streams (black disc) is not less than 0.6m. Lakes and reservoirs (secchi disc) is not less than 3m.	N/A; Clarity was not a parameter measured as part of this investigation.
Colour	Colour: hue is not changed by more than 10 points on the Munsell scale.	N/A; Colour was not measured as part of this investigation.
Temperature	Temperature in rivers and streams does not exceed a daily mean of 25^{0}C or a daily maximum of 30^{0}C due to human activities.	N/A; Unable to assess results against Class D criteria, due to differing sampling methodology used in this investigation.
pH	pH is within the range of 6.5 and 9.0.	pH results from this investigation did not meet the Class D criteria; results ranged between 3 and 11 (pH units) respectively.
Periphyton	No criteria	N/A
Nutrients	Phosphorus and nitrogen. Rivers and streams; mean monthly concentrations of soluble inorganic phosphorus (SIP) and soluble inorganic nitrogen (SIN) measured under low flow conditions should be less than 30 and 350ug/l respectively. Lakes and reservoirs: mean monthly concentrations of total phosphorus (TP) and total nitrogen (TN) are less than 20 and 337ug/l respectively	N/A; Unable to assess results against Class D criteria, due to differing sampling methodology used in this investigation.
Toxicants	Toxicants – toxic, radioactive or deleterious material concentrations are below those which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon these waters and bed sediments, or adversely affect public health, as determined by the 90% level of protection for toxicants in water (AP28.6.i in Appendix 28) and the ISQG-Low Trigger Value for toxicants in sediments (AP28.6.ii in Appendix 28).	N/A; Sediment samples were not taken as part of this investigation.
Objectionable material	Not applicable	N/A
Aesthetic	Aesthetic values are not interfered with by the presence of obnoxious wastes, slimes, aquatic growths, or materials which taint the flesh of edible species.	During the sampling period, no obnoxious wastes, slimes, aquatic growths or suspicious materials were observed.
Macroinvertebrates (rivers and streams)	No criteria	N/A
Aquatic habitat	No criteria	N/A

Table 5-3 Water Quality Criteria for 'Class C' Moderate Waterbodies

Water Quality Criteria (AP28.5 of the NRMP)		Assessment of Water Quality Results Collected from this Investigation against Class D Water Quality Criteria
Waterborne Pathogens	E.coli. running median (estimated monthly): less than 500/100ml. Faecal coliforms (estimated monthly): no greater than 20% of samples exceed 400/100ml.	N/A; Unable to assess results against Class C criteria, due to differing sampling methodology used in this investigation.
Toxic algae	No criteria.	N/A.
Dissolved Oxygen	Rivers and streams: minimum dissolved oxygen measured under low flow conditions over 24 consecutive hours is not less than 90% saturation. Lakes and reservoirs: dissolved oxygen is in the range of 90-110% saturation.	N/A; Unable to assess results against Class C criteria, due to differing sampling methodology used in this investigation.
Turbidity	Turbidity (mean or median) in rivers and streams does not exceed 3.0 NTU.	N/A; Turbidity was not a parameter measured as part of this investigation.
Clarity	Clarity - Natural visual clarity not reduced by more than 33%. Or Clarity (median) - rivers and streams (black disc) shall not be less than 2.5m. Lakes and reservoirs (secchi disc) shall not be less than 4m.	N/A; Clarity was not a parameter measured as part of this investigation.
Colour	Colour – hue is not changed by more than 10 points on the Munsell scale.	N/A; Colour was not measured as part of this investigation.
Temperature	Temperature in rivers and streams, does not exceed a daily mean of 22^{0}C or a daily maximum of 27^{0}C due to human activities.	N/A; Unable to assess results against Class C criteria, due to differing sampling methodology used in this investigation.
pH	pH is within the range of 6.5 and 8.5.	pH results from this investigation did not meet the Class C criteria; results ranged between 3 and 11 (pH units) respectively.
Periphyton	Maximum cover of diatoms and cyanobacteria: more than 0.3cm thick in gravel/cobble bed streams does not exceed 60% cover and filamentous algae more 2cm long does not exceed 30% cover unless there have been no significant freshes (more than 6x baseflow) for a period longer than 20 days.	N/A; Periphyton was not a parameter measured as part of this investigation.
Nutrients	Phosphorus and nitrogen. Rivers and streams: mean monthly concentrations of soluble inorganic phosphorus (SIP) and soluble inorganic nitrogen (SIN) measured under low flow conditions are less than 26 and 295ug/l respectively. Lakes and reservoirs: mean monthly concentrations of total phosphorus (TP) and total nitrogen (TN) are less than 20 and 250ug/l respectively.	N/A; Unable to assess results against Class C criteria, due to differing sampling methodology used in this investigation.
Toxicants	Toxicants – toxic, radioactive or deleterious material concentrations are below those which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon these waters and bed sediments, or adversely affect public health, as determined by the 95% level of protection for toxicants in water (AP28.6.i in Appendix 28) and the ISQG-Low Trigger Value for toxicants in sediments (AP28.6.ii in Appendix 28).	N/A; Sediment samples were not taken as part of this investigation.
Objectionable material	Waters are free from: floating debris, oil, grease and other objectionable material, excluding those of natural origin.	During the sampling period, no floating debris, oil, grease and other objectionable material were observed.
Aesthetic	Aesthetic values are not reduced by dissolved, suspended, floating, or submerged matter not attributed to natural causes, so as to affect water use or taint the flesh of edible species.	During the sampling period, no obnoxious wastes, slimes, aquatic growths or suspicious materials were observed.
Macroinvertebrates (rivers and streams)	Species richness of the predominant invertebrate assemblages in gravel/cobble bed rivers and streams, as measured by the	LAWA data for Hillwood Stream indicated that these criteria would likely be met, however due to limited availability of data it

Water Quality Criteria (AP28.5 of the NRMP)		Assessment of Water Quality Results Collected from this Investigation against Class D Water Quality Criteria
	macroinvertebrate community index (MCI), are not less than 80, and/or the semi-quantitative MCI (SQMCI) is not less than 4.00.	is not possible to verify this. Freshwater macroinvertebrate community analyses are not entirely relevant for Hillwood Stream (downstream of the WWTP) due to the saline influence on aquatic ecology. Refer to Ecological Impact Assessment Report (Stantec 2023) for further discussion.
Aquatic habitat	No criteria.	N/A

6 Influence of Groundwater

A detailed description of the influence of groundwater on the receiving freshwater environments is provided in the Stantec 2023 NNWTP Assessment of Effects on Groundwater[31] undertaken by Stantec (2023). The findings of the report[31] indicate that the freshwater receiving bodies including the Nelson Haven and Tasman Sea are hydraulically connected to the wastewater discharge through groundwater flow. Modelling undertaken as part of the report[31] indicates groundwater discharges into these features are 'at very low volumes'.

A summary on the influence of groundwater on each freshwater receiving body is provided in Sections 6.1.1 and 6.1.2.

6.1.1 Hillwood Stream North

Modelling undertaken in groundwater report[31] indicates that it is unlikely any contaminants have reached the Hillwood Stream North from the oxidation pond or treatment wetlands. The report[31] determined that it would take a travel time of more than 100 years for the contaminant plume to reach this freshwater receiving body. It was concluded[31] that irrespective of the period taken for contaminant travel, the daily volumes of potentially contaminated groundwater are low (≈2.1 m^3/day) and that after mixing within this stream, it is unlikely that these volumes will reduce the overall water quality

6.1.2 Hillwood Stream

Modelling has indicated that contaminants may have reached the Hillwood Stream from the oxidation ponds or wetlands, based on a conservatively estimated travel time of seven years for the plume reach this stream[31]. Daily volumes of contaminated groundwater discharging to this receiving freshwater environment were determined to be 'low' and in the order of of ≈1.6 m^3/day[31]. It was concluded that after mixing within the stream, it would be unlikely that this conservatively estimated volume would reduce overall water quality within this freshwater receiving environment[31].

[31] Nelson Wastewater Treatment Plant Assessment of Effects on Groundwater, Stantec (2023)

7 Assessment of Potential Effects on Surface Water Quality

The potential effects associated with the proposed overflow discharges discussed in this report have been assessed with regards to the results and additional information presented in Sections 2,3 and 5, using the methodology outlined in Section 4.5. While this assessment is aligned with other components of work undertaken to inform the consent application, it does not seek to encompass them. Detailed assessments of effects on ecological values, marine water quality and public health are provided separately within the main NWWTP consent application.

Table 7-1 outlines the aspects considered to be most relevant in relation to water quality within the freshwater receiving environment for discharges from the NWWTP treatment ponds, including the potential changes which may occur as a result of the proposed discharges and associated effects of these.

Effects shaded in orange in Table 7-1 are assessed as part of separate reports as discussed in Section 1.2.1, and therefore are not featured in the detailed water quality assessment presented in Table 7-2.

Table 7-1: Potential Effects On Water Quality that could Result from Proposed Discharges

	Potential Changes as a Result of Proposed Discharges						
Effect	Microbiological contaminants	Nutrient enrichment or depletion; mass balance	Acidity (low pH)	Water temperature	Water clarity / suspended solids	Amenity (colour, odour, water level)	Elevated BOD / COD; reduced dissolved oxygen
Risk to health of people engaging in contact recreation; decreased opportunity for recreation	✸				✸	✸	
Contamination of shellfish	✸						
Contamination of fin fish	✸						
Migration of waterborne contaminants from surface water to groundwater	✸	✸	✸	✸		✸	
Diminishing cultural values*	✸	✸	✸	✸	✸	✸	
Change in suitability of physical habitat		✸	✸	✸	✸		
Change in availability of food for aquatic life	✸	✸	✸	✸	✸		
Toxic effects on aquatic life		✸	✸	✸	✸		✸
Changes to physical condition of water (nutrient-related, e.g. toxic algal bloom)		✸	✸	✸	✸	✸	
Changes to physical condition of water (physico-chemical)			✸	✸	✸	✸	✸

Note:
**Effects on cultural values are to be assessed in consultation with iwi. It is expected that this water quality effects assessment will help to inform that process*

Table 7-2: Assessment of Potential Effects On Surface Water Quality within the Freshwater Receiving Environment, as a Result of Proposed Discharges

Receiving Environment Location / Feature	Potential Effect	Values Associated with Water Quality at Location	Magnitude of Effect	Potential Level of Effect	Justification / Further Comment
Hillwood Stream (vicinity of SW02) prior to confluence with Hillwood Stream North	Change in suitability of physical habitat	Low	Negligible	Very low	This portion of Hillwood Stream is modified but still retains some resemblance of natural meanders. Water quality has historically been slightly improved in this location compared with the LAWA site at Glen Road, but overall water quality is still considered to be poor. This location is hydrologically upstream of discharges from the treatment ponds, so direct discharges to surface water are highly unlikely. Such discharges may be possible following extreme heavy rainfall events or an emergency situation such as collapse of treatment pond walls (which would be very rare, but not impossible). Discharges may also reach this location via groundwater recharge, but inputs are considered very minimal due to extremely slow moving groundwater (i.e. 100 years or more for groundwater to migrate from beneath the treatment ponds to this portion of Hillwood Stream)(Stantec 2023 NWWTP Assessment of Effects on Groundwater).
	Change in availability of food for aquatic life		Negligible	Very low	
	Toxic effects on aquatic life		Negligible	Very low	
	Changes to physical condition of water (nutrient-related, e.g. toxic algal bloom)		Negligible	Very low	
	Changes to physical condition of water (physico-chemical)		Negligible	Very low	
Hillwood Stream North adjacent to treatment pond (vicinity of SW01 WW)	Change in suitability of physical habitat	Low	Low	Very low	Hillwood Stream North has been straightened in this location and as such is highly modified. Magnitude of effect is slightly higher for changes in physical condition due to historic evidence of increased TSS in this location (due to discharges from treatment ponds). TSS has been targeted as a contaminant to actively manage in past operations of NWWTP. 'Moderate' magnitude is considered an appropriate classification because effects from TSS / nutrient inputs attributable to the WWTP can be reversed and are likely to be temporary, e.g. seasonal or related to a specific event.
	Change in availability of food for aquatic life		Low	Very low	
	Toxic effects on aquatic life		Low	Very low	
	Changes to physical condition of water (nutrient-related, e.g. toxic algal bloom)		Moderate	Low	
	Changes to physical condition of water (physico-chemical)		Moderate	Low	
Other downstream reaches of Hillwood Stream between SW01 WW and the Nelson Haven (including vicinity of SW03 Hav)	Change in suitability of physical habitat	Low	Negligible	Very low	Hillwood Stream has been straightened throughout a significant portion of its length. Riparian margins are generally not intact (i.e. banks and floodplains are grassed, very few remnants of mature natural riparian vegetation such as shrubs or trees). TSS has historically been elevated downstream of the WWTP, along with nutrients including DRP and Ammoniacal-nitrogen, to the extent that algal blooms have been present in warmer months. However, given the degree of agricultural land use upstream in the Hillwood Stream catchment, the TSS and nutrient inputs cannot be entirely attributed to the treatment pond discharges; it is highly likely that a significant portion of TSS and nutrient load is sourced from dairying activities. Chloride concentrations are high in the vicinity of SW03 (which has also been observed in groundwater results, see Stantec 2023 report), along with COD. These parameters are elevated at levels much higher than those observed upstream at SW01 indicating additional inputs (separate to WWTP discharges) from across the wider catchment contributing to poor water quality in this reach.
	Change in availability of food for aquatic life		Negligible	Very low	
	Toxic effects on aquatic life		Negligible	Very low	
	Changes to physical condition of water (nutrient-related, e.g. toxic algal bloom)		Moderate	Low	
	Changes to physical condition of water (physico-chemical)		Moderate	Low	

8 Conclusions

This report summarises existing water quality within the freshwater receiving environment, utilising data collected between November 2020 and December 2021 at the NWWTP site.

Results from the supporting Stantec 2023 NWWTP Assessment of Effects on Groundwater and model, indicate that there is minimal seepage occurring between the treatment ponds and the freshwater receiving environment[31] Therefore, it is likely that the water quality of the freshwater receiving environments is primarily being influenced by the land use activities occurring upstream, which include a large dairy farm (outlined in Section 3.2).

In summary, the results obtained as part of this investigation indicate that:

- Faecal contamination (indicated by *E.coli)* has historically been an issue for the Hillwood Stream, with the overall trend described as 'very likely degrading'. Results obtained as part of this study indicate that for the majority of the 9-month monitoring period, *E.coli* counts at all sampling locations exceeded the NPS-FM (2020) National Bottom Line.
- Total nitrogen concentrations observed as part of this study indicate typically exceeded the ANG (2018) 80%ile species protection guideline value and peaked in July 2021 which coincided with a large rainfall event. This large rainfall event (Table 4-3) likely produced significant runoff from the surrounding dairy farm which would have spiked overall nitrogen concentrations within the Hillwood Stream. The same trend was also observed in TKN concentrations, which also spiked / peaked in July 2021.
- TSS concentrations and water temperatures of the Hillwood stream peaked in the summer months, whilst the DO concentrations dropped during these same months, indicating a more anoxic environment which can be harmful to ecological receptors.
- Seasonal variations were also observed in Total Ammoniacal-N concentrations, which peaked during January 2021 (summer). DRP concentrations within the Hillwood Stream also peaked during the summer months. These results indicated that there could have been an algal bloom occurring during this time, as a combination of elevated nitrogen and phosphorus was observed. Excessive algal growth in waterbodies can be harmful to the ecology of a stream as this can reduce overall oxygen concentrations which is a huge stressor for the streams' inhabitants. Historical DRP concentrations for the Hillwood Stream are currently sitting within the "C" attribute band (as outlined by the NPS-FM (2020)) but the overall trend is described as 'very likely degrading'. Whilst historical Ammoniacal-N concentrations currently sit within the "B" attribute band (as outlined by the NPS-FM (2020)), but the overall trend is described as 'very likely degrading'.

An assessment of effects was undertaken based on the information available regarding existing water quality within the freshwater receiving environment (including monitoring of discharges under the current consent, and background water quality) and likely changes that may occur as a result of continued discharges under the proposed new consent. The assessment found that the following effects could be expected to occur only at a **low** or **very low** level:

- Change in suitability of physical habitat
- Change in availability of food for aquatic life
- Toxic effects on aquatic life
- **Changes to physical condition of water (nutrient-related, e.g. toxic algal bloom)**
- **Changes to physical condition of water (physico-chemical)**

The effects in bold text would potentially occur at a **low** level (i.e. to a slightly greater extent) at locations closest to the NWWTP treatment ponds, such as in the vicinity of SW01 WW monitoring site, and between that site and the Nelson Haven. This is namely due to a higher magnitude of effect, based on historic issues with contaminants such as TSS and nutrients downstream of the discharge point.

The assessment found that **none** of the identified potential effects would occur at **moderate** or higher levels.
In general, the Hillwood Stream catchment is highly modified due to historic activities not related to the NWWTP, and as such has limited water quality values (i.e. historically poor water quality, and highly disturbed aquatic habitats including riparian margins). This has contributed to a lower level of effect potentially arising from the proposed discharges.

9 Recommendations

The following items are recommended for consideration by the consent holder and have been identified on the basis of this assessment. If practical to do so, these items could be incorporated directly into consent conditions or integrated into management plans or procedures required by the new consent.

1. Water quality monitoring should ideally be undertaken during consistent tidal cycles / times of day in future and target the low tide phase to minimise potential tidal influence in results. However, monitoring only during low tide would also present a 'worst case' scenario for mixing of the discharge in the stream, as water levels will likely be lower (therefore less dilution can occur).

2. While monitoring was undertaken on a monthly basis during 2020/21 to enable this assessment, given the overall low level of potential effects on water quality as a result of the proposed discharges it is considered appropriate that a monitoring regime similar to that in the existing consent would be appropriate. For clarity, the existing consent initially required that coastal receiving waters (at 250m, 500m, and 1000m from the ocean outfall) were monitored every three months. The consent then allowed for this requirement to lapse after two years at the discretion of the regulatory authority. This approach should be matched (at minimum) for the freshwater receiving environments discussed in this assessment.

3. In-situ and laboratory analysis of water quality parameters for ongoing routine receiving environment monitoring under the new consent should include at minimum:

   Laboratory analysis:

   - TSS (mg/L or g/m^3)
   - Nitrate-N (mg/L)
   - Total ammoniacal-nitrogen (mg/L)
   - Total nitrogen (mg/L)
   - Total phosphorus (mg/L)
   - DRP (mg/L)
   - COD (mg/L)
   - 5-day Biochemical Oxygen Demand (BOD_5) (mg/L)
   - Chloride (mg/L)
   - Faecal coliforms (MPN/100mL).

   In-situ measurements:

   - Dissolved oxygen (mg/L), (DO)
   - Electrical conductivity (μS/cm), (EC)
   - Ambient water temperature (°C)
   - pH (pH units)
   - Turbidity (NTU) OR visual clarity (metres; black disc).

4. Routine monitoring records should include the recording of visual and contextual observations for each sampling event, including (but not limited to):

   - Colour of water.
   - Presence of any conspicuous oil or grease films, scums or foams, growths, or floatable or suspended materials on the water surface (and a description of what is observed, if any).
   - Presence of any solid debris within the water body such as construction waste, large woody debris, litter, etc.
   - Discernible and objectionable odour.
   - Weather conditions at time of sampling.
   - Tidal level at time of sampling.

   Such observations should be included on field proformas where in-situ monitoring data are also recorded.

5. Consider revising the requirements for routine monitoring of the receiving environment to better align sampling methodologies with those outlined in the NPS-FM and the NRMP. For example:

   - Use continuous monitoring techniques (such as a fixed sensor) to capture dissolved oxygen over a 24 hour period, once a month, to enable comparison with NRMP criteria (see Section 5.4 above).
   - Include in-situ monitoring of turbidity and/or water clarity within Hillwood Stream (at all monitoring locations).
   - Include laboratory analysis of soluble inorganic nitrogen (SIN) as part of routine monitoring. It is not anticipated that this addition will greatly improve understanding of the condition of this particular receiving environment beyond what is already known, however if the consent holder wishes to complete full assessment against NRMP criteria, it is necessary to include it.

Appendices

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Appendix A Raw Monitoring Data