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# *memorandum*

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|---|---|---|---|
| TO | Martell Letica | FROM | Phil Hook, Linda Shamrock, Daryl Irvine, Simon Greening |
| | Far North District Council | DATE | 7 February 2024 |
| RE | Kaitāia WWTP – Instream Limits and Effluent Quality Requirements | | |

## 1.0 Introduction

Far North District Council (FNDC) owns and operates the Kaitāia Wastewater Treatment Plant (K-WWTP), which discharges treated effluent to the Awanui River. FNDC holds Resource Consent AUT.00093 issued by Northland Regional Council (NRC) that authorises the following activities:

- AUT.000932.01.03: To discharge treated wastewater to the Awanui River.
- To discharge contaminants (primarily odour) to air from a wastewater treatment system.
- To discharge contaminants to ground via seepage from a wastewater treatment system.

This Resource Consent AUT.00093 expired on 30 November 2021. Pattle Delamore Partners Ltd (PDP) has been commissioned by FNDC to assist with reconsenting.

As part of the reconsenting works, PDP has identified that the calculations used to determine the K-WWTP upgrades are based on using mean flows in the Awanui River which will not represent worst case conditions i.e. Mean Annual Low Flow (MALF). NRC will expect this assessment to consider effects of the Awanui under these worst case conditions.

FNDC has therefore requested that PDP;

- determine the MALF at the discharge site; and
- determine effluent concentration limits in order to meet Proposed Regional Plan for Northland – Appeals Version August 2022 (pRPN) limits; and
- review the Harrison Grierson report entitled '*Kaitaia and Kaikohe WWTP Options Assessment*' (HG Report) dated November 2020 to determine whether the design elements will achieve compliance with the pRPN limits. These design elements will be key evidence to present as part of the consenting and/or hearing process. It will also minimise risk to FNDC by ensuring the K-WWTP design basis is correct for future, more detailed design.

## 2.0 Water Quality Guidelines and Policy

The following assessment only considers water quality parameters that haven't already been included in the proposed draft conditions.

### 2.1 National Policy Statement for Freshwater Management 2020

The K-WWTP discharges into freshwater. Accordingly, the NPSFM applies. Appendix 2A (Attributes requiring limits on resource use) sets out the water quality standards that apply to all freshwater systems, which are applicable to this consent application. The Awanui River being approximately 14 m wide at the at the confluence of the Waihou Channel[1] (also known as the Waihoe Channel), would not meet the following 'wadeable' definition to which certain NPSFM attributes apply: '*Wadeable for the purpose of these protocols is defined as sites where 90% of the reach being sampled is 0.6 m deep or less and has an average wetted width of 12 m or less*.[2]' Furthermore, the Awanui River is not identified as a 'primary contact site' (as defined by the NPSFM[3]) as far as PDP is aware, hence the *E.coli* limits for primary contact sites does not apply.

PDP considers that the parameters listed in Appendix 2A of the NPSFM should form the basis of the water quality limits. Relevant Appendix 2A (NPSFM) attributes tables are presented in Appendix A.

In considering appropriate limits, PDP has turned to Policy 5 of the NPSFM as follows:

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

The NPSFM helpfully provides a definition for the 'degraded' which is as follows:

***degraded**, in relation to an FMU or part of an FMU, means that as a result of something other than a naturally occurring process:*

- *a. a site or sites in the FMU or part of the FMU to which a target attribute state applies:*
  - *i. is below a national bottom line; or*
  - *ii. is not achieving or is not likely to achieve a target attribute state; or*
- *b. N/A*
- *c. the FMU or part of the FMU is less able (when compared to 7 September 2017) to provide for any value described in Appendix 1A or any other value identified for it under the NOF*

In respect of water quality parameters, the focus generally falls to limb (a) above for attributes below a national bottom line. In other cases where there is no bottom line and contaminant levels fall in lower level bands, there is no driver for improvement, but best practice would dictate that minimisation of contaminant concentrations be pursued.

[1] Tangata Whenua have advised that Waihou is the correct name of this channel.
[2] *New Zealand Freshwater Fish Sampling Protocols (Part 1): Wadeable rivers and streams. Massey University: Palmerston North, New Zealand.*
[3] primary contact site means a site identified by a regional council that it considers is regularly used, or would be regularly used but for existing freshwater quality, for recreational activities such as swimming, paddling, boating, or watersports, and particularly for activities where there is a high likelihood of water or water vapour being ingested or inhaled

## 2.2 Proposed Regional Plan for Northland Limits

The K-WWTP is located within the 'small river' overlay of the pRPN. It is also not an 'outstanding river', and therefore is classified as 'other rivers' under the pRPN. Accordingly, the freshwater provisions of the pRPN apply. Policy H.3.1 sets out the water quality standards for continually or intermittently flowing rivers in Northland, which are applicable to this consent application. PDP consider that the parameters listed in Table 22 of the pRPN should form the basis of the water quality limits. Table 22 and 23 are presented in Table 10 of Appendix B.

In considering appropriate limits, PDP has turned to Policy D.4.1 of the pRPN as follows:

*When considering an application for a resource consent to discharge a contaminant into water or onto or into land where it may enter water or onto land where it may enter water:*

1) *ensure that the quality of fresh and coastal water is at least maintained, and*
2) *where a water quality standard in Appendix H.3 is currently met:*
    a. *ensure that the quality of water in a river, lake or the coastal marine area will continue to meet the standards in Appendix H.3; and*
    b. *consider whether any improvements to water quality are required in order to achieve Objective F.1.2*
3) *N/A*
4) *where a water quality standard in Appendix H.3 is currently exceeded and the exceedance of the water quality standard is caused or contributed to by an existing activity for which a replacement resource consent is being considered, ensure any replacement resource consent granted for the existing discharge includes a condition(s) that:*
    a. *requires the quality of the discharge to be improved over the term of the consent to reduce the contribution of the discharge to the exceedance of the water quality standard in Appendix H.3; and*
    b. *sets out a series of time bound steps, demonstrating how the activity will be managed to achieve the water quality improvements required by (4) (a).*
5) *ensure that the discharge will not cause an acute toxic adverse effect within the zone of reasonable mixing*

In this respect, water quality is sought to either be maintained or improved (applicable to *E. Coli* only) where a water quality standard in Appendix H.3 is currently exceeded.

Regarding the zone of reasonable mixing, is defined in the pRPN as:

*For the purpose of a discharge of a contaminant permitted by a rule in this Plan:*

1) *in relation to flowing surface water bodies, a distance downstream of the point of discharge that is the lesser of:*
    a) *200 metres if the bed width of the surface water body is greater than 30 metres at the point of discharge, or*
    b) *a distance equal to seven times the bed width of the surface water body, but which must not be less than 50 metres from the point of discharge, or*
2) *N/A*

*For the purpose of activities that require resource consent, the zone of reasonable mixing will be determined consistent with 1) or 2) above unless the nature or scale of the discharge requires that a case-by-case basis determination is more appropriate, in which case the extent of departure from the zone defined under 1) or 2) above will be determined in accordance with Policy D.4.4 Zone of reasonable mixing.*

In this case, the zone can be determined in accordance with point 1). The width of the bed at the discharge location appears to be approximately 14 m which discounts 1)a) and would equate to a 98 m mixing zone under 1)a). This puts the edge of the mixing zone immediately above the confluence with the Waihou / Waihoe Channel (i.e. approximately where NRC monitoring site 100370 would be located).

This location has been used to determine where reasonable mixing will have occurred and limits should be set.

## 2.3 Data Sources

The following data sources are available and have been relied on for this assessment.

**Table 1: K-WWTP Monitoring**

| Sample Location | Consent Conditions - Effluent | Consent Conditions - Instream | Land, Air, Water Aotearoa (LAWA) | PDP Ecology Report[1] |
|---|---|---|---|---|
| pH | Y | Y | | Y |
| Temperature | Y | Y | | Y |
| DO concentration and percentage saturation | Y | Y | | Y |
| Electrical Conductivity (EC) | | | | Y |
| Turbidity | | | | Y |
| 5 Day BOD | Y | | | Y |
| TSS | Y | | | Y |
| Visual Clarity | | | | Y |
| TN | | | | Y |
| TAN | Y | Y | Y | Y |
| Nitrate-N | | | Y | Y |
| Total Kjeldahl Nitrogen | | | | Y |
| Nitrite-N | | | | Y |
| TP | Y (to 2015) | | | Y |
| DRP | Y (to 2015) | Y (to 2015) | Y | Y |
| *E. coli* | Y | Y | | Y |
| Periphyton biomass (chlorophyll a) | | | | |

*Notes:*

[1] *Baseline Ecological Report – Awanui River at Kaitaia Wastewater Treatment Plant*

As described in the '*Baseline Ecological Report – Awanui River at Kaitaia Wastewater Treatment Plant*' also noted that periphyton presence was very high covering 50 to >75% of available substrates.

## 2.4 Recommended Approach

### 2.4.1 Limits

It is recommended that the following parameters form limits as part of the draft conditions. The 'instream limits' are as read within this section, however the numeric limits for effluent controlled contaminants are detailed in section 4.4:

*Instream Limits (after reasonable mixing):*

- pH - Annual minimum and annual maximum pH to be between 6.0 and 9.0.
- Dissolved oxygen (DO) – The concentration of DO to not change by more than 20% and to remain with a 7-day mean minimum of 5.0 mg/L and a 1-day minimum of 4.0 mg/L in accordance with Table 7 of the NPSFM.
- Temperature – The temperature to not result in a temperature change of ≤3°C in accordance with Table 22 of the pRPN for the summer period measurement of the Cox-Rutherford Index averaged over five (5) hottest days.
- Turbidity / Clarity – The clarity to not change by more than 30% in accordance with Table 22 of the pRPN.

*Effluent Limits (refer to section* 5.0 *for numeric limits):*

- Ammonia (toxicity) - The concentration of pH adjusted total ammoniacal nitrogen [($NH_3$ + $NH_4$)-N] (ammoniacal -N) to not result in a reduction from Attribute State B in accordance with Table 5 of the NPSFM;
- Nitrate (toxicity) – The concentration of nitrate-nitrogen [($NO_3$)-N] (Nitrate -N) to not result in a reduction from Attribute State A in accordance with Table 6 of the NPSFM;
- DRP - The concentration of DRP to not result in a reduction from Attribute State C in accordance with Table 20 of the NPSFM
- *E. Coli* - The concentration of *E. coli* to not result in an increase in concentration from its current concentrations (currently in Attribute E Band) with respect to median and 95$^{th}$ percentile in accordance with Table 9 of the NPSFM (based on analysis of upstream Awanui River *E.coli* data for the period January 2010 to July 2022).

*Other Limits:*

PDP note that Cyanobacteria is already addressed within the draft conditions and is not included here.

### 2.4.2 Monitoring

PDP recommend that the following contaminants be monitored to ensure compliance with the parameters listed above and corresponding limits proposed in section 5.0.

**Table 2: K-WWTP Monitoring**

| Sample Location | Frequency | Method | Parameters |
|---|---|---|---|
| Effluent Discharge (NRC #100373) | Monthly | Grab sample as per NEMS.<br>Temperature, DO, EC and pH are to be measured at sampling sites using a hand-held meter, and in accordance with standard procedures | ⁘ pH<br>⁘ Temperature (°C)<br>⁘ DO (mg/L)<br>⁘ EC (mS/m)<br>⁘ $cBOD_5$ (mg/L)<br>⁘ TSS (mg/L)[1]<br>⁘ Total Nitrogen (mg/L)[2]<br>⁘ Ammoniacal-N (mg/L)<br>⁘ Nitrate-N (mg/L)<br>⁘ TP (mg/L)[2]<br>⁘ DRP (mg/L)<br>⁘ *E. coli* (#/100 mL)<br>⁘ Faecal coliforms (cfu/100 mL)<br>⁘ In effluent only:<br>⁘ TKN (mg/L)<br>⁘ In Awanui River only:<br>⁘ Visual Clarity (m)<br>⁘ Periphyton biomass (chlorophyll a) (mg chl-a/ $m^3$) (in Awanui River only)[3] |
| Awanui River Upstream (NRC #100369) | Monthly | | |
| Awanui River Downstream of Discharge but Upstream of Waihou / Waihoe Channel (NRC #100370) | Monthly | | |

*Notes:*

1. *TSS is currently monitored in the effluent but not within the Awanui River. In order to assess the effect of TSS on the Awanui River it is recommended that TSS is monitored upstream and downstream of the K-WWTP;*
2. *There are no national guidelines for TN or TP in rivers, but it is recommended that it is monitored for total load tracking purposes as well as can be used compared to the State of the Environment monitoring undertaken by NRC; and*
3. *Monitor monthly with a requirement to assess after 3 years.*

## 3.0 MALF for the Awanui River

In the HG report the mean flow was used to determine what K-WWTP upgrades would be required. This however does not represent a worst case scenario, in which the actual and/or potential effect of the discharge from the K-WWTP on the Awanui River at the MALF would be more appropriate

NRC currently maintain and operate two flow sites within the Kaitāia township on the Awanui River.

The two sites are:

- Awanui River at School Cut; and,
- Awanui River at Waikuruki.

The Awanui River at Waikuruki is the closest to the discharge from the K-WWTP into the Awanui River, so this site was used to determine the 7-day MALF estimate used in the subsequent analysis.

PDP contacted NRC to acquire their estimate for the MALF at the current Waikuruki flow site. NRC undertook the analysis using data extending back to 2016 for the site. NRC informed PDP that the 7-Day MALF estimate for the Waikuruki site is 0.505 $m^3/s$.

As the Waikuruki site is located approximately 5 km upstream of the discharge point, the 7-day MALF estimate was adjusted using catchment area to estimate any additional flow from groundwater and other potential flow sources. Using the Ministry of the Environment River Environment Classification database, the catchment area at the discharge location was found to be 1.02x larger than the Awanui River at Waikuruki site. Therefore, the 7-Day MALF of 0.505 $m^3/s$ was then multiplied by 1.02 for an estimated 7-Day MALF at the discharge location of 0.515 $m^3/s$.

## 4.0 Effluent concentration requirements to meet pRPN limits

Using the MALF upstream of the K-WWTP, the effluent concentrations which could be discharged to the Awanui River from the K-WWTP was determined in order to meet pRPN limits (illustrated in section 2.4.1). This represents worst case conditions.

### 4.1 HG Report Assessment

As per the HG Report, K-WWTP data for pH, Temperature, DO, Nitrate-N, Ammonia, five-day carbonaceous biochemical oxygen demand ($cBOD_5$), TSS and dissolved inorganic nitrogen (DIN) are available. When water quality data was compared to the water quality standards in Table 22 of the pRPN (water quality standards for ecosystem health in rivers) and Table 23 (water quality standards for human contact in rivers), only nitrate, ammonia and *E.coli* were in non-compliance. For *E.coli* the median and 95$^{th}$ percentile values were already above the pRPN standards upstream of the K-WWTP. An increase in *E.coli* numbers however did occur downstream of the K-WWTP which suggests that disinfection at K-WWTP is required.

### 4.2 PDP Methodology

In order to carry out the assessment, data from LAWA at a monitoring point in the Awanui River at FNDC uptake was used. For the annual maximum for ammonia and 95$^{th}$ percentile for nitrate-N, data which was collected for FNDC by PDP in the Awanui River upstream and downstream of the K-WWTP in 2021 to assess the effect of the Juken New Zealand Limited (JNL) trade waste was used. The following assessment was carried out:

- The ammoniacal-N concentration limit determined in the K-WWTP effluent discharged at MALF to the Awanui River which will meet the pRPN annual median of 0.24 mg/L and annual maximum of 0.40 mg/L;
- The nitrate-N concentration limit determined in the K-WWTP effluent discharged at MALF to the Awanui River which will meet the pRPN annual median of 1.0 mg/L and annual 95$^{th}$ percentile of 1.5 mg/L; and
- The DRP concentration limit determined in the K-WWTP effluent discharged at MALF to the Awanui River which will meet the NPSFM Attribute Band State C with a median of > 0.018 mg/L and a 95$^{th}$ percentile of > 0.054 mg/L.
- The *E.coli* in the Awanui River is already in the bottom band for NPSFM (Attribute Band E) with a median >260 *E.coli*/100mL and a 95$^{th}$ percentile of >1,200 *E.coli*/100 mL.

To undertake the above assessments, a simplified mass balance model that determines the mixing and dilution of the contaminant concentrations was developed. The equation used to develop the mass balance model was:

$$Effluent\ Contaminant\ Concentration = \frac{\text{pRPN std} \times V_1 - C_2 \times V_2}{V_3}$$

Where $V_1$ = Downstream Awanui River Flow or $V_2$+$V_3$

$C_2$ = Upstream Awanui River Concentration (annual median, maximum or 95$^{th}$ percentile)

$V_2$ = Flow rate from 'upstream' water.

$V_3$ = K-WWTP effluent future flow.

The inputs used are shown in Table 3. The pRPN water quality standards used are shown in Table 10.

**Table 3: Inputs used in Mass Balance equations**

| Attribute | Unit | Statistical Parameter used | Data used | Source |
|---|---|---|---|---|
| Nitrate (toxicity) ($C_2$) | g $NO_3$-N/$m^3$ | 5 year Annual Median | 0.017 | LAWA – Awanui at FNDC Take |
| | | 95$^{th}$ Percentile | 0.433 | PDP 2021 Awanui River upstream data |
| Ammonia (toxicity) ($C_2$) | g $NH_4$-N/$m^3$ | 5 year Annual Median | 0.007 | LAWA – Awanui at FNDC Take |
| | | Maximum | 0.02 | PDP 2021 Awanui River upstream data |
| Awanui River Upstream Flow ($V_2$) | $m^3/s$ | 7 day MALF | 0.515 | Catchment scaled from NRC @ Waikuruki |
| Effluent Flow rate ($V_3$) | $m^3/s$ | Maximum future K-WWTP effluent flow rate | 0.04 | HG Report |

## 4.3 Results Comparison and Recommended Limits

The K-WWTP effluent concentrations which could be discharged to the Awanui River using the pRPN/NPSFM limits for Ammoniacal-N, Nitrates and DRP are shown in Table 4, Table 5 and Table 6.

### 4.3.1 Ammonical-N

It is possible to maintain compliance with pRPN water quality limits and NPSFM bottom line limits to avoid dropping an NPSFM band (B) between upstream and downstream of the discharge. The K-WWTP effluent concentration required to achieve this is present in Table 4 below.

**Table 4: Ammoniacal-N Results using MALF**

| Scenario | Flow used ($m^3/s$) | Ammoniacal-N concentration Upstream ($g/m^3$) | pRPN/NPSFM Limit (B Band) ($g/m^3$) | K-WWTP Effluent Concentration required ($g/m^3$) |
|---|---|---|---|---|
| HG | 3.7[1] | 0.08[2] | 0.24 | 14 |
| Use MALF and HG Report concentration | 0.515 | 0.08[2] | 0.24 | 2 |
| Use MALF and LAWA 5-year Annual median | 0.515 | 0.007[3] | 0.24 | 3 |
| Use MALF and PDP April 2021 Maximum Data | 0.515 | 0.02[4] | 0.40 | 5 |

*Notes:*

1. *Mean Flow in $m^3/s$*
2. *Annual Median concentration in $g/m^3$.*
3. *LAWA 5 year annual median concentration in $g/m^3$.*
4. *PDP Awanui River 2021 data*

### 4.3.2 Nitrate-N

It is possible to maintain compliance with pRPN water quality limits and NPSFM bottom line limits to avoid dropping an NPSFM band (A) between upstream and downstream of the discharge. The K-WWTP effluent concentration required to achieve this is present in Table 5 below.

**Table 5: Nitrate-N Results using MALF**

| Scenario | Flow used ($m^3/s$) | Ammoniacal-N concentration Upstream ($g/m^3$) | pRPN/NPSFM Limit (A Band) ($g/m^3$) | K-WWTP Effluent Concentration required ($g/m^3$) |
|---|---|---|---|---|
| HG Report | 3.7[1] | 0.052[2] | 1.0 | 82 |
| Use MALF and HG Report concentration | 0.515 | 0.052[2] | 1.0 | 12 |
| Use MALF and LAWA 5-year Annual median | 0.515 | 0.017[3] | 1.0 | 13 |
| Use MALF and PDP April 2021 95$^{th}$ %ile | 0.515 | 0.433[4] | 1.5 | 14 |

*Notes:*

1. *Mean Flow in m3/s*
2. *Annual Median concentration in $g/m^3$.*
3. *LAWA 5 year annual median concentration in $g/m^3$.*
4. *PDP Awanui River 2021 data*

### 4.3.3 DRP

There is no bottom line for DRP in the NPSFM. Based on data collected by K-WWTP between (2010 and 2015) in the Awanui River upstream and downstream of the K-WWTP discharge, it was found that the upstream site is currently in the NPSFM Attribute Band C for the median (0.0175 mg/L) but in the NPSFM Attribute Band D for the 95$^{th}$ percentile (0.056 mg/L). The NPSFM requires that where there are two attribute bands that the conservative approach is adopted and the lower of the bands is used. As such the Awanui River upstream would be classified as in the NPSFM Attribute Band D. The Awanui River downstream of the K-WWTP is in the Attribute D Band for both the median and the 95$^{th}$ percentile DRP concentrations. Refer to Table 4 below.

The K-WWTP is contributing a reasonably high DRP load to the Awanui River. Although the worst Attribute state is considered to be a D, it is recognised that the K-WWTP is contributing DRP load which affects the median DRP concentration in the Awanui River which causes it to fall into a D band downstream. As the upstream median concentration of DRP is already on the cusp of a D band, any contribution of DRP from the K-WWTP is going to cause a change in band from C to D. Therefore, in order to minimise the K-WWTPs contribution of DRP to the Awanui River, the DRP concentration in the effluent discharge will be required to be as low as practical for the K-WWTP operation, rather than seeking an arbitrary reduction.

**Table 6: DRP Results using MALF (referring to upstream and downstream after K-WWTP discharge)**

| Scenario | DRP concentration upstream (g/m$^3$) | K-WWTP Effluent Concentration used (g/m$^3$) | DRP concentration downstream (g/m$^3$) | NPSFM Limit for Attribute D Band (g/m$^3$) | K-WWTP Effluent Concentration required (g/m$^3$) |
|---|---|---|---|---|---|
| LAWA 5 Year Median | 0.0170[1] | 1.846 | 0.04 | >0.018 | Refer to text above and see Table 8. |
| K-WWTP Median | 0.0174[2] | 1.846 | 0.04 | >0.018 | |
| K-WWTP 95$^{th}$ percentile | 0.0557[3] | 1.846 | 0.092 | >0.054 | |

*Notes:*

1. *LAWA 5 year annual median concentration in g/m$^3$.*
2. *Annual Median concentration from K-WWTP (2010 to 2015) in g/m$^3$.*
3. *Annual 95$^{th}$ percentile concentration from K-WWTP (2010 to 2015) in g/m$^3$.*

### *4.3.1 E. Coli*

There is no bottom line for *E.coli* , however, *E.coli* was found to be in the bottom band of the NPSFM (Attribute Band E) with K-WWTP data from Jan 2012 to July 2022 for the median and 95$^{th}$ percentile. Although there is no driver to improve *E. coli* levels to a higher band, from a best practice point of view, a level of disinfection is appropriate to minimise the contribution of *E. coli* to the receiving environment. Accordingly, a limit for *E. Coli* is proposed in Table 8 based on what can be practically achieved with UV disinfection. To achieve a meaningful reduction from the status quo, these levels have been set for the effluent count to be the same as the Band D limit.

**Table 7: *E.coli* Results using MALF (referring to upstream and downstream after K-WWTP discharge)**

| Scenario | *E.coli* upstream (#/100mL)[1] | K-WWTP Effluent *E.coli* (#/100mL)[1] | *E.coli* downstream (#/100mL)[1] | NPSFM Limit for Attribute E Band | K-WWTP Effluent Count required (#/100mL)[1] |
|---|---|---|---|---|---|
| % exceedances over 540/100 mL | 26% | 41% | 25% | >30% | Refer to text above and see Table 8. |
| % exceedances over 260/100 mL | 50% | 59% | 58% | >50% | |
| Median *E.coli*/100 mL | 272 | 368 | 277 | >260 | |
| 95th percentile *E.coli*/100 mL | 3,505 | 6,077 | 3,304 | >1,200 | |

*Notes:*

1. *LAWA 5 year annual median E.coli* per 100 mL.
2. *Annual Median E.coli from K-WWTP (2010 to 2015) in #/mL.*
3. *Annual 95th percentile E.coli from K-WWTP (2010 to 2015) in #/mL.*

## 5.0 Evaluation of K-WWTP basis of design upgrades to meet NPSFM/pRPN limits

Based on the analysis of the NPSFM and pRPN limits assessed under low flow conditions, the contaminant concentrations in the treated wastewater will need to be significantly lower that the concentration targets used in the HG Reports options assessment. Proposed revised treatment targets are summarised in Table 8.

Proposed ammoniacal-N and nitrate-N performance limits are based on maintaining compliance with receiving environment water quality limits during low flow conditions. Proposed DRP limits are based on achieving the lowest practical reduction in phosphorus based on chemical precipitation.

The required chemical dosing rates for DRP removal tend to rapidly increase for targets below 1.0 g DRP/$m^3$. Therefore 1.5 g DRP/$m^3$ as an average performance target is considered by PDP to be a more practical target.

The proposed performance targets for *E. coli* have been based on maintaining an Attribute D quality in the discharge. While the Awanui River may have higher *E. coli* concentrations than this level, achieving these concentrations in the discharge will ensure that the discharge does not result in a further increase of micro-biological counts.

**Table 8: K-WWTP Targets**

| Parameter | Metric | Current K-WWTP Performance[1] | HG Report Performance Targets[2] | PDP Revised Performance Targets |
|---|---|---|---|---|
| Ammoniacal-N (g $m^3$) | Mean | 5.8 | 14 | 3 |
| | 95$^{th}$ Percentile | 23 | | 5 |
| | Maximum | 51 | | - |
| Nitrate-N (g $m^3$) | Mean | Data not provided | 82 | 13 |
| | 95$^{th}$ Percentile | | | 14[5] |
| | Maximum | | | - |
| DRP(g $m^3$) | Mean | 2.2 | | <1.5 |
| | 95$^{th}$ Percentile | 4.4 | | |
| | Maximum | 20 | | |
| *E. coli* (#/100mL) | Median | 201 | | <260 |
| | 95$^{th}$ Percentile | 1,659 | | <1,200 |
| | Maximum | 10,462 | | |

*Notes:*

1. *Based on monitoring data from Dec 2010 to Jan 2022, provided by FNDC.*
2. *Harrison Grierson Ltd 2020, Kaitaia and Kaikohe WWTP Options Assessment, prepared on behalf of Far North District Council.*
3. *Revised treatment performance proposed by PDP.*
4. *Median and Means are based on an annualised calculation.*
5. *Based on 95 %ile concentration upstream occurring at the same time as the 95$^{th}$ %ile occurring in wastewater. If upstream concentration is on average 0.017 g/$m^3$. then 95$^{th}$ %ile in wastewater treatment plant effluent could be 19 g/$m^3$.*

Based on historical monitoring, the existing treatment system is not currently meeting the required concentrations for discharge as assessed against low flow conditions and NPSFM and pRPN limits.

With the proposed amended water quality targets to address NPSFM and pRPN limits during low flow conditions, the option identified by the HG report as the preferred option, being Option 1 (Remove Wetland + Upgrade Septage Receiving + Aerator + Baffle Curtain + Clarifier + Chemical Dosing +UV) is unlikely to consistently meet discharge requirements, particularly nitrate-N and *E. coli* limits.

Based on the targets proposed in the HG report, the Option 1 would likely have the capacity to meet the target requirements for ammoniacal-N, and phosphorus levels as there is provision for additional aeration to support nitrification and chemical dosing for DRP removal. However, UV disinfection is proposed for *E. coli* reduction but there may be times when colour from algae interferes with UV disinfection performance.

In addition, to maintain ammoniacal-N limits, the proposed additional aeration will maintain a predominantly aerobic lagoon which results in consumption of the majority of organic carbon plus conversion of the majority of ammoniacal-N through to nitrate-N. The subsequent K-WWTP does not incorporate a dedicated stage with anoxic conditions that will promote denitrification and therefore, it is expected that the nitrate-N levels will likely exceed the target limits at times.

While the options will need to be re-assessed against other objectives, Option 4 of the HG Report, which incorporates an intermittent decanting aerated lagoon (otherwise commonly referred to as a lagoon based sequencing batch reactor (SBR)) can provide better overall biological nitrogen removal, to meet both the ammoniacal-N and nitrate-N targets, plus limit the algae growth and the associated effects on disinfection performance.

There may be other similar style options worth considering, however, the requirement to maintain low nitrate-N as well as low ammoniacal-N concentrations potentially limits Option 1 of the HG Report and therefore a reassessment of the options is recommended. This can be done following the granting of consent in order to meet limits and timeframes imposed as consent conditions.

As previously discussed with FNDC, it is recommended that as part of the options assessment, iwi are included in the optioneering process as some of the discharge options potentially preferred by iwi, from a cultural perspective, may provide additional nutrient removal also.

## 6.0 Summary

PDP has investigated the effluent and instream concentrations of contaminants required to meet pRPN and NPSFM limits as a result of municipal wastewater treatment discharges from the K-WWTP. These findings have been compared to the HG Report findings in order to guide appropriate draft consent conditions for the discharge permit. The findings of this assessment are as follows:

- The 7-Day MALF estimate for the Waikuruki site is 0.515 $m^3/s$.
- Instream Limits (after reasonable mixing) are recommended for :
  - pH - annual minimum and annual maximum pH to be between 6.0 and 9.0.
  - DO – to not change by more than 20% and to remain with a 7-day mean minimum of 5.0 mg/L and a 1-day minimum of 4.0 mg/L.
  - Temperature – to not exceed 24°C.
  - Turbidity / Clarity – to not change by more than 30%.
- Effluent concentration limits are recommend for:
  - Ammoniacal-N to meet an instream annual median of 0.24 mg/L and annual maximum of 0.40 mg/L;
  - Nitrate-N to meet an instream annual median of 1.0 mg/L and annual 95$^{th}$ percentile of 1.5 mg/L;
  - Recognising there is no bottom line for DRP to be minimised as far as reasonably practical acknowledging that almost any contribution of DRP is going to change median concentrations from Band C to Band D (>0.018 $g/m^3$).
  - *E. coli* to be minimised as far as reasonably practical acknowledging that almost any contribution of *E.coli* is going to keep the Awanui River in the bottom Band E. (Median >260 *E.coli*/100mL and 95$^{th}$ percentile > 1,200 *E.coli*/100mL).

Based on the revised treatment targets, the treatment options will need to be reassessed to confirm the preferred treatment option.

## 7.0 Limitations

This memorandum has been prepared by PDP on the basis of information provided by FNDC and others (not directly contracted by PDP for the work), including Harrison Grierson and LAWA. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the memorandum. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This memorandum has been prepared by PDP on the specific instructions of fndc for the limited purposes described in the memorandum. PDP accepts no liability if the memorandum is used for a different purpose or if it is used or relied on by any other person. Any such use or reliance will be solely at their own risk.

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# Appendix A: NPSFM Attribute States

**Table 9: NPSFM Water Quality Standards used in Assessment**

| Attribute | Table | Unit | Compliance Metric | Attribute Band | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | A | B | Bottom Line | C | Bottom Line | D | E |
| Periphyton (Trophic state) | Table 2 | mg chl-a/$m^2$ (milligrams chlorophyll-a per square metre) | Numeric attribute state (default class) - Exceeded no more than 8% of samples | ≤50 | >50 and ≤120 | | >120 and ≤200 | 200 | >200 | |
| | | | Numeric attribute state (productive class) - Exceeded no more than 17% of samples | ≤50 | >50 and ≤120 | | >120 and ≤200 | 200 | >200 | |
| Ammonia (Toxicity) | Table 5 | mg $NH_4$-N/L (milligrams ammoniacal-nitrogen per litre) | Annual median | ≤0.03 | >0.03 and ≤0.24 | 0.24 | >0.24 and ≤0.40 | | >1.30 | |
| | | | Annual 95th percentile | ≤0.05 | >0.05 and ≤0.40 | 0.40 | >0.24 and ≤2.20 | | >2.20 | |
| Nitrate (Toxicity) | Table 6 | mg $NO_3$ – N/L (milligrams nitrate-N per litre) | Annual median | ≤1.0 | >1.0 and ≤2.4 | 2.4 | >3.5 and ≤9.8 | | >6.9 | |
| | | | Annual 95th percentile | ≤1.5 | >1.5 and ≤3.5 | 3.5 | >2.4 and ≤6.9 | | >9.8 | |
| DP | Table 7 | mg/L (milligrams per litre) | 7-day mean minimum | ≥8.0 | ≥5.0 and <7.5 | | ≥5.0 and <7.0 | 5.0 | <5.0 | |
| | | | 1-day minimum | ≥7.5 | ≥7.0 and <8.0 | | ≥4.0 and <5.0 | 4.0 | <4.0 | |
| Suspended Fine Sediment | Table 8 | Visual clarity (metres) | Median 1 | ≥1.78 | <0.93 and ≥0.76 | | <1.55 and ≥1.34 | 1.34 | <1.34 | |
| | | | Median 2 | ≥0.93 | <0.93 and ≥0.76 | | <0.76 and ≥0.61 | 0.61 | <0.61 | |
| | | | Median 3 | ≥2.95 | <2.95 and ≥2.57 | | <2.57 and ≥2.22 | 2.22 | <2.22 | |
| | | | Median 4 | ≥1.38 | <1.38 and ≥1.17 | | <1.17 and ≥0.98 | 0.98 | <0.98 | |
| *E. coli* | Table 9 | *E. coli*/100 mL (number of *E. coli* per hundred millilitres) | % exceedances over 540/100 mL | <5% | 5-10% | | 10-20% | | 20-30% | <30% |
| | | | % exceedances over 260/100 mL | <20% | 20-30% | | 20-34% | | <34% | <50% |
| | | | Median concentration /100 mL | <130 | ≤130 | | ≤130 | | ≤130 | ≤260 |
| | | | 95th percentile of *E. coli*/100 mL | <540% | ≤1000 | | ≤1200 | | ≤1200 | ≤1200 |
| DRP | Table 20 | DRP mg/L (milligrams per litre) | Median | ≤ 0.006 | > 0.006 and ≤0.010 | | > 0.010 and ≤ 0.018 | | >0.018 | |
| | | | 95th percentile | ≤ 0.021 | > 0.021 and ≤0.030 | | > 0.030 and ≤ 0.054 | | >0.054 | |
| Ecosystem metabolism (both gross primary production and ecosystem respiration) | Table 21 | g O2 $m^{-2}$ $d^{-1}$ (grams of dissolved oxygen per square metre per day) | | | | | | | | |

*Note:*

1. *Based on pH and temperature of 20 degrees Celsius.*

# Appendix B: pRPN Water Quality Standards

| Table 10: pRPN Water Quality Standards used in Assessment | | | |
|---|---|---|---|
| **Attribute** | **Unit** | **Compliance Metric** | **'Other Rivers'** |
| Nitrate (toxicity) | mg $NO_3$-N/L | Annual Median | ≤1.0 |
| | | Annual 95$^{th}$ Percentile | ≤1.5 |
| Ammonia (toxicity) | mg $NH_4$-N/L | Annual Median | ≤0.24[1] |
| | | Annual Maximum | ≤0.40[1] |
| Temperature | mg/L | Summer period measurement of the Cox-Rutherford Index (CRI), averaged over the five (5) hottest days (from inspection of a continuous temperature record). | ≤ 24°C |
| DO | mg/L | 7-day minimum | ≥ 5.0 |
| | | 1-day minimum | ≥ 4.0 |
| pH | pH units are dimensionless | Annual minimum and annual maximum | 6.0 < pH <9.0 |
| Temperature change* | Degrees Celsius | Summer period measurement of the Cox-Rutherford Index (CRI)**, averaged over the five (5) hottest days (from inspection of a continuous temperature record). | ≤3 °C |
| *E. coli* | *E. coli*/100ml | Does not exceed any of the four attributes states in Table 9 of the NPSFM<br>% exceedance over 540<br>% exceedance over 260<br>Median concentration 95th percentile of *E. coli* | ≤20% ≤34% ≤130 ≤1200 |
| *Visual Clarity Change* | *Metres* | Maximum | ≤30%<br>Not more than 30% decrease in black disc or equivalent measurement |

**Based on pH 8 and temperature of 20 degrees Celsius. Compliance with the water quality standard should be undertaken after pH adjustment.*

1. *Unless naturally occurring processes as defined in the NPSFM prevent the waterbody from achieving the standard.*
2. *At low risk sites monitoring may be conducted using visual estimates of periphyton cover. Should monitoring based on visual cover estimates indicate that a site is approaching the relevant periphyton abundance threshold, monitoring should then be upgraded to include measurement of chlorophyll-a.*
3. *Rivers are categorised as productive according to types in the River Environment Classification (REC). Productive rivers are those that fall within the REC "Dry" Climate categories (i.e., Warm-Dry (WD) and Cool-Dry (CD)) and the REC Geology categories that have naturally high levels of nutrient enrichment due to their catchment geology (i.e., Soft-*

*Sedimentary (SS), Volcanic Acidic (VA) and Volcanic Basic (VB)). Therefore, productive rivers are those that belong to the following REC defined types: WD/SS, WD/VB, WD/VA, CD/SS, CD/VB, CD/VA.*

** Note: Change is to be measured between appropriately matched habitats upstream and downstream of discharges to water or, where there is no suitable upstream site, between reference condition and downstream site.*

***As referenced in: Davies-Colley R, Franklin P, Wilcock B, Clearwater S, Hickey C 2013. National Objectives Framework Temperature, Dissolved Oxygen & pH thresholds for discussion, NIWA Client Report No:HAM2013-056. Prepared for the Ministry of the Environment. Stark JD, Boothroyd IKG, Harding JS, Maxted JR, Searsbrook MR, 2001. Sediment Assessment Methods: Protocols and guidelines for assessing the effects of deposited fine sediment on instream values. Cawthron Institute: Nelson, New Zealand.*