Assessment of Environmental Effects – Kororāreka/Russell Wastewater Treatment Plant

Prepared for

Far North District Council

December 2023

PATTLE DELAMORE PARTNERS LTD
Level 4, 111 Customhouse Quay
Wellington 6011
PO Box 6136, Wellington 6141, New Zealand

Tel +64 4 **471 4130**
Web www.pdp.co.nz

solutions for your environment

Quality Control Sheet

TITLE	Assessment of Environmental Effects – Kororāreka/Russell Wastewater Treatment Plant
CLIENT	Far North District Council
ISSUE DATE	18 December 2023
JOB REFERENCE	A03576827

Revision History

REV	Date	Status/Purpose	Prepared By	Reviewed and approved by
1	23/11/2023	Draft for Client Review	Claire McKevitt Stephanie Williams	Simon Greening
2	18/12/2023	Final for submission	Claire McKevitt	Simon Greening

DOCUMENT CONTRIBUTORS

Prepared by

SIGNATURE

Claire McKevitt Stephanie Williams

Reviewed and approved by

SIGNATURE

Simon Greening

Limitations:

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Far North District Council. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This report has been prepared by PDP on the specific instructions of Far North District Council for the limited purposes described in the report. PDP accepts no liability if the report 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.

Abbreviations

Table 1: Abbreviations

Abbreviation	Term
AEE	Assessment of Environmental Effects
ADA	Adaptive Management Approach
BPO	Best Practicable Option
$cBOD_5$	Carbonaceous Five-Day Biological Oxygen Demand
CGM	Conceptual Groundwater Model
CIA	Cultural Impact Assessment
CMA	Coastal Marine Area
DO	Dissolved Oxygen
eDNA	Environmental DNA
EMS	Effects Management Strategy
FNDC	Far North District Council
HMP	Hapū Management Plan
HNC	High Natural Character
I&I	Inflow and Infiltration
KM-EHMP	Kororāreka Marae Society Environmental Hapū Management Plan
KMSCI	Kororāreka Marae Society Committee Incorporated
KR-WWTP	Kororāreka/Russell Wastewater Treatment Plant
MCI	Macroinvertebrate Community Index
MLSS	Mixed Liquor Suspended Solids
NBEA	Natural and Built Environment Act 2023
NES-F	Resource Management (National Environmental Standards for Freshwater Management) Regulations 2020
NPS-FM	National Policy Statement for Freshwater Management 2020
NOF	National Objectives Framework

Table 1: Abbreviations

Abbreviation	Term
NRC	Northland Regional Council
NZCPS	New Zealand Coastal Policy Statement
PDP	Pattle Delamore Partners Limited
PLC	Programmed Logic Controller
OMM	Operations and Maintenance Manual
pRPN	Proposed Regional Plan for Northland (October 2023 Version)
QMRA	Qualitative Microbial Risk Assessment
RMA	Resource Management Act 1991
RPS	Regional Policy Statement for Northland 2016
RSI	Regionally Significant Infrastructure
SBR	Sequencing Batch Reactor
SEA	Significant Ecological Area
SRT	Sludge Retention Time
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
UV	Ultra-violet
WAS	Waste Activated Sludge
WED	Whangaruru Ecological District
WSA	Water Services Act 2021

Executive Summary

Far North District Council (FNDC) owns and operates the Kororāreka/Russell Wastewater Treatment Plant (KR-WWTP) and disposal borefield located in Kororāreka/Russell on Russell Whakapara Road. The KR-WWTP has been in operation at this location since the 1990's, and treats wastewater produced by the communities of Kororāreka/Russell and Tapeka Point.

FNDC currently hold two existing consents associated with the operation of the KR-WWTP, AUT.008339.01.03 and AUT.008339.02.03. These two consents authorise the discharge of treated wastewater, including Russell Landfill leachate, to ground via disposal boreholes (AUT.008339.01.03); and the discharge of contaminants to air (primarily odour) (AUT.008339.02.03). FNDC seek to replace these consents which are set to expire on 30th April 2024 as part of this resource consent application.

As this replacement consent application has been lodged five months prior to the expiry of these consents, FNDC propose to continue exercising these resource consents with Northland Regional Council's (NRC) discretion until a decision on this application is made in accordance with s.124(2)(e) of the RMA .

As part of this replacement consent application, FNDC seek to retain the existing discharge limits and contaminant loads as authorised by AUT.008339.01.03. This is considered appropriate as population forecasts show the population is likely to remain the same at about 800 permanent residents, with an estimated peak of 1,350 during holiday periods. As such, it is also expected that there will be no changes in contaminant loads. In addition, as part of this application FNDC has proposed upgrades to the KR-WWTP to improve flow balancing by refurbishing the treatment ponds, replacing the UV system, and cleaning of the disposal bores within the next six months. These upgrades will improve performance of the KR-WWTP which will result in better quality wastewater discharged to the receiving environment.

The proposed activities require resource consent for a discretionary activity under the pRPN and a non-complying activity under the NES-F. Therefore, when bundled the application is assessed as a non-complying activity. In summary, when assessing the effects of the proposal on the existing environment, this Assessment of Environmental Effects Report (AEE) outlines and concludes the following:

- Of the available alternative discharge options assessed, the option to continue with the current method of discharge (with the proposed upgrades) is considered the Best practical Option (BPO).

- The limited monitoring data available for the receiving environment indicates that there is no significant adverse effect of the existing (and proposed) discharge on ecology and water quality.
- However, the available monitoring data is very limited and does not provide a comprehensive view of the impacts. As a result, FNDC propose two years of monthly monitoring of the receiving environment, and if required, revise the BPO so that water quality in the receiving environment meets the standards in Appendix H.3 of the pRPN and the National Policy Statement for Freshwater Management (NPS-FM).
- Engagement with mana i te whenua is ongoing. More engagement is required so that the effects of the proposal on their cultural values are understood and that the decision that is made by the Consenting Authority recognises and provides for mana whakahaere of mana i te whenua. FNDC request that public notification of this application is delayed under s.37 of the RMA until the effects on cultural values are known. FNDC propose to obtain a cultural impact assessment to provide to NRC in accordance with Policy D.1.2 (pRPN). The feedback received from mana i te whenua will also be used to update the BPO, with any updates conveyed to NRC.

With the information currently available, the overall effects of the KR-WWTP discharge are assessed as minor. However, due to the incomplete available data which has limited the assessment of environmental effects, and in the interest of transparency on publicly funded infrastructure, FNDC has requested that this application be publicly notified in accordance s.95A(3)(a) of the RMA.

Table of Contents

Table of Figures

Table of Tables

Appendices

1.0 Introduction

FNDC own and operate the KR-WWTP and disposal borefield located on Russell Whakapara Road. FNDC currently hold two existing consents for the KR-WWTP as follows:

- AUT.008339.01.03 to discharge treated wastewater, including Russell Landfill leachate, to ground via disposal boreholes; and
- AUT.008339.02.03, to discharge contaminants to air (primarily odour) from the treatment plant and borehole disposal areas.

Both consents expire on 30 April 2024 and subsequently FNDC is seeking replacement consents to allow for the continued operation of the KR-WWTP.

The KR-WWTP receives wastewater from the Kororāreka/Russell and Tapeka Point communities in addition to small quantities of leachate from the adjacent Russell Landfill (Figure 1). Treated wastewater is discharged into land via injection into 85 bores split across 3 sections of ridgeline (Figure 2).

This Assessment of Environmental Effects (AEE) has been prepared by Pattle Delamore Partners Limited (PDP) to support the replacement resource consent application for the discharge of treated wastewater to ground and the discharge of contaminants to air. This AEE and resource consent application has been made in accordance with the Resource Management Act 1991 (RMA), the Proposed Regional Plan for Northland (October 2023 version) (pRPN), and the Resource Management (National Environmental Standard for Freshwater) Regulations 2020 (NES-F).

A full statutory assessment of rules is made in Section 6.0. Overall, when bundled, the activity status of this consent application is assessed as a non-complying activity as a result of the proposed activities triggering:

- Rule C.6.2.2 of the pRPN for a discretionary activity; and
- Regulation 54 of the NES-F as a non-complying activity.

This AEE is supported by the following technical reports, which are included within the appendices:

- Best Practicable Option Report (Appendix B);
- Kororāreka/Russell WWTP Performance Assessment (Appendix C);
- Groundwater and Surface Water Quality Effects Assessment (Appendix D);
- Borefield Disposal Performance and Slope Stability Review (Appendix E);
- Ecological Effects Assessment (Appendix F);

- Flood and Coastal Risk Assessment (Appendix G).
- Qualitative Microbiological Risk Assessment (Appendix H);
- Air Quality Effects Assessment (Appendix I); and
- Operations and Maintenance Manual (Appendix J).

2.0 Applicant and property details

The KR-WWTP and associated bore disposal field are located approximately 1 kilometre (km) to the southeast of Russell Township (Figure 1) on a 37 hectare (ha) block of land as is the Russell Landfill and Transfer Station, which is positioned on the western corner of the land parcel.

FNDC details are contained in Table 2. A current Certificate of Title for the site is provided in Appendix A . The location is presented in Figure 1 and 2.

The site is not designated, and FNDC hold resource consent #1980441 from FNDC for the disposal field and pipework which was granted in 1997.

Table 2: Applicant and site details

Applicant	Far North District Council
Site Address	Russell Whakapara Road (Unnumbered property between 130 Florance Ave and 6140 Russell Whakapara Road)
Legal Description	Section 1 SO 310696
Land Acquisition purpose	Sewage Treatment and Disposal and Landfill
Landowner	Far North District Council
Grid Reference (NZTM)	1703355N 6096548E

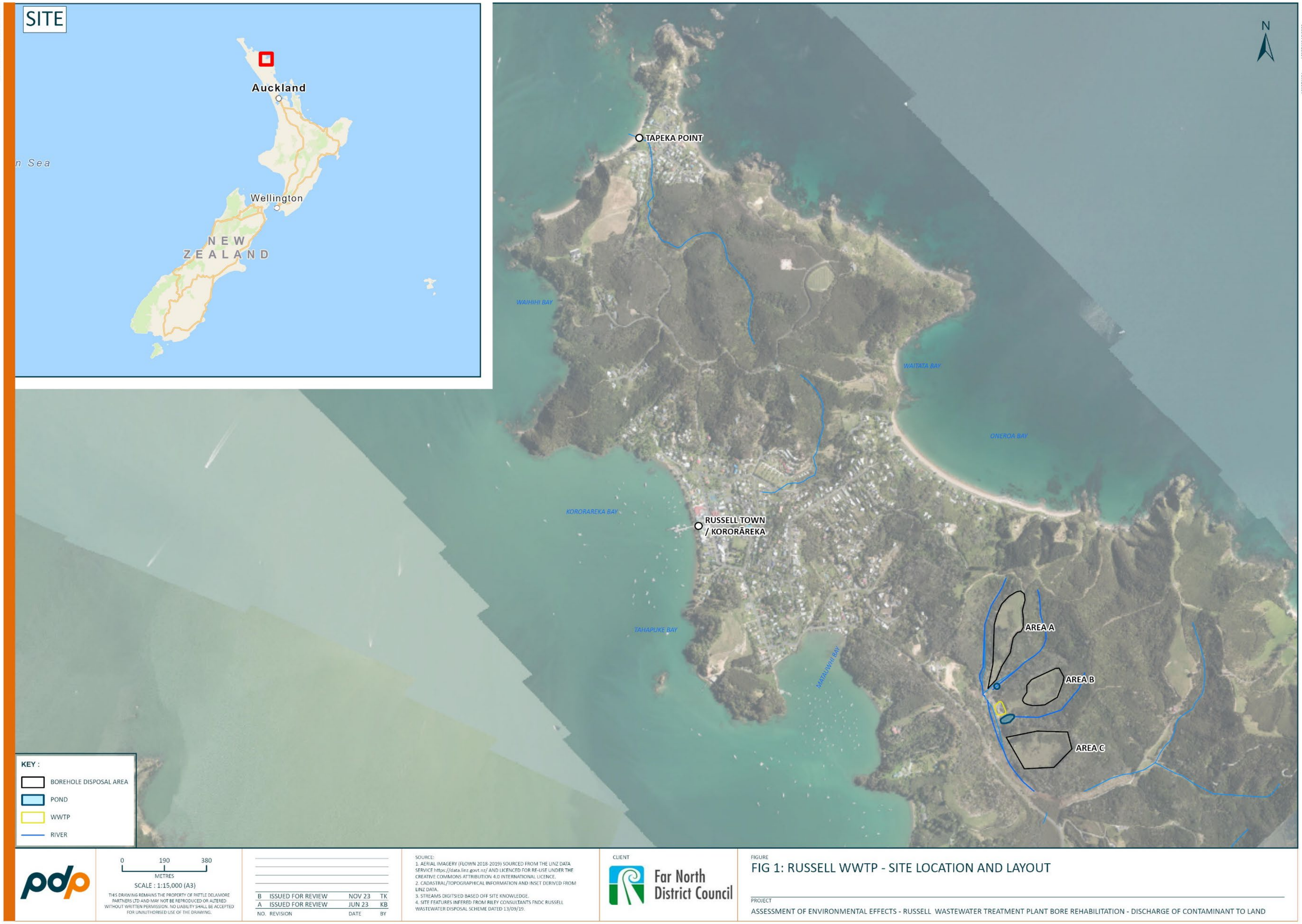


Figure 1: KR-WWTP Location

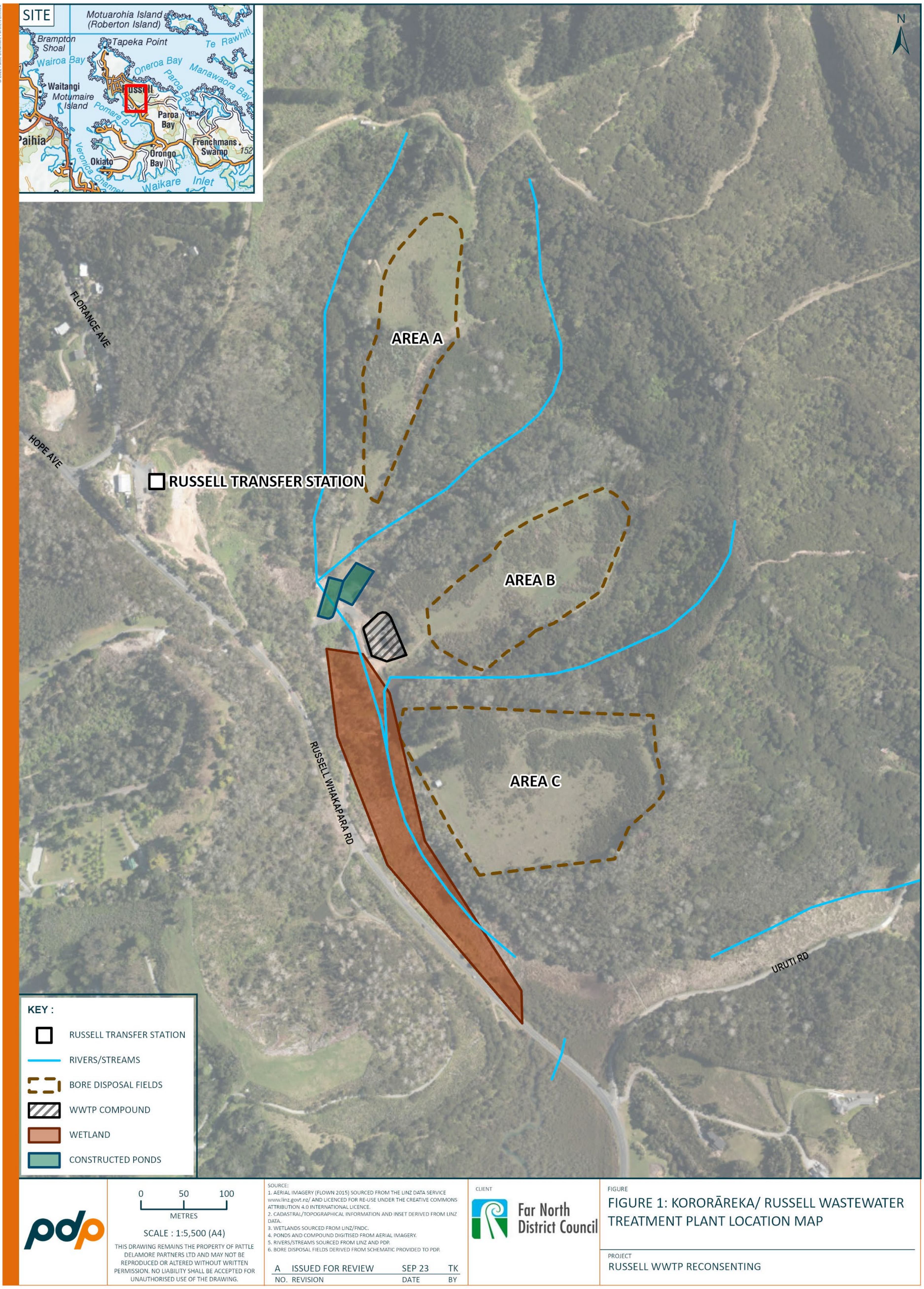


Figure 2: KR-WWTP Overview and layout

3.0 Best practicable option

PDP has prepared a Best Practicable Option (BPO) Report for FNDC (Appendix B) that assesses the possible alternative discharge methods and locations for wastewater from the Kororāreka/Russell and Tapeka Point communities.

3.1 Long list options

The BPO considered potential alternative receiving environments for the wastewater discharge based on the following factors:

- Location of the KR-WWTP in relation to the surrounding district.
- Nature of the discharge.
- Sensitivity of the receiving environment and potential of the treated effluent discharge to cause adverse effects.

An extensive list of potential wastewater discharge options was formed using the wastewater information provided by FNDC and known information about the potential receiving environments. The long list considered options including maintaining the use of deep bore injection, discharging to land, marine discharge, surface water discharge, wastewater reuse and piping the discharge to a larger wastewater treatment plant.

Once the initial long list had been created, a fatal flaw assessment was carried out to identify and remove options which were considered unsuitable for further consideration. Options were then further assessed against objectives that were identified to be important to the project success. The options were further rated using a traffic light system. A full description of the fatal flaw assessment, objectives the options were assessed against, and rating system is covered in Section 4 of the BPO Report.

3.2 Short list options

Through the various options and rating assessments, the BPO Report presents the following 4 shortlisted options:

- Continue discharging treated effluent to the disposal borefield;
- Pipe treated effluent to Paihia WWTP;
- Pipe and discharge (spray) treated effluent onto vegetation; and
- Pipe and discharge treated effluent into the disused ponds (which previously were constructed wetlands), before discharging into the small stream adjacent to the site.

Section 6 of the BPO Report provides a description of these options and assesses the benefits and challenges for each option.

3.3 BPO identified

Of the short-list options, the BPO Report concludes that continuing wastewater disposal via the deep borefield is the BPO, provided the boreholes are adequately remediated and the network conveying treated effluent is fully functional. Issues with the boreholes and network, and the bore cleaning trial to remediate these issues are covered in section 4.11.

Acknowledging that the BPO Report does not have mana i te whenua input, FNDC propose to revise the BPO after engagement with mana i te whenua, prior to a decision being made on this application.

This resource consent application seeks to implement the current BPO to continue discharging to the disposal borefield as outlined in Section 4.0 below.

4.0 Kororāreka/Russell WWTP Processes

4.1 Overview of the KR-WWTP

The KR-WWTP treats wastewater produced by the township of Kororāreka / Russell as well as Tapeka Point (Figure 1). The KR-WWTP has been in operation since the 1990s after concern was raised about groundwater contamination from septic tanks servicing individual dwellings.

The Performance Assessment Report (Appendix C) assesses current and forecast influent and effluent flows and contaminant loads and describes the wastewater treatment process. The report also describes current performance issues with the KR-WWTP and suggests potential improvements. The following subsections summarise the findings of this report.

4.2 KR-WWTP operation

The KR-WWTP consists of a largely mechanical (as opposed to passive) treatment process and can treat a maximum of 1,235 cubic metres (m^3) of wastewater per day. Condition 1 of resource consent AUT.008339.01.03 limits the discharge of treated wastewater to the disposal borefield to 1,235 m^3.

The treatment process involves raw wastewater (influent) entering the KR-WWTP via a pumped rising main into an inlet screen, which removes solids greater than 10 (millimetres) (mm) from the inflow. The flow is then distributed between two sequencing batch reactor (SBR) tanks, where the wastewater undergoes a batch process for aerating the mixed wastewater. Following aeration, the sludge settles. The clear treated wastewater is then decanted into storage tanks that lead to the sand filters and ultra-violet (UV) treatment. The outlet from the UV channel is delivered to a final effluent storage tank which leads to the borehole disposal pumps. The final treated wastewater is discharged into land via a series of deep bores across a ridge line above the KR-WWTP. Figure 3 below presents a block flow diagram of the treatment process.

WAS from the SBR tanks is collected and disposed offsite every 2 to 3 days. There is a desire from FNDC to dispose of WAS within the catchment in the future. However, that potential disposal option does not form part of this consent application.

The entire KR-WWTP system is designed to be automated using a programmed logic controller (PLC), however due to years of alterations to the system, the PLC is not functioning optimally. The key operational parameters such as the Mixed Liquor Suspended Solids (MLSS), Sludge Retention Time (SRT), and Dissolved Oxygen (DO) are monitored to maintain optimal treatment conditions within the SBR's.

The KR-WWTP has two ponds on site. These were constructed for a previous wetland treatment system which has not been in use for over ten years. Pond #1 (Wetland 1 in Figure 3) is currently unused. Pond #2 is lined with polyethylene, and is used for SBR overflow, backwash and leachate. FNDC is committed to upgrading Pond #1 to store raw wastewater inflow.

Leachate from the neighbouring non-operational Russell landfill is collected and pumped to a KR-WWTP leachate buffer tank to the overflow Pond #2 and then to the KR-WWTP for treatment.

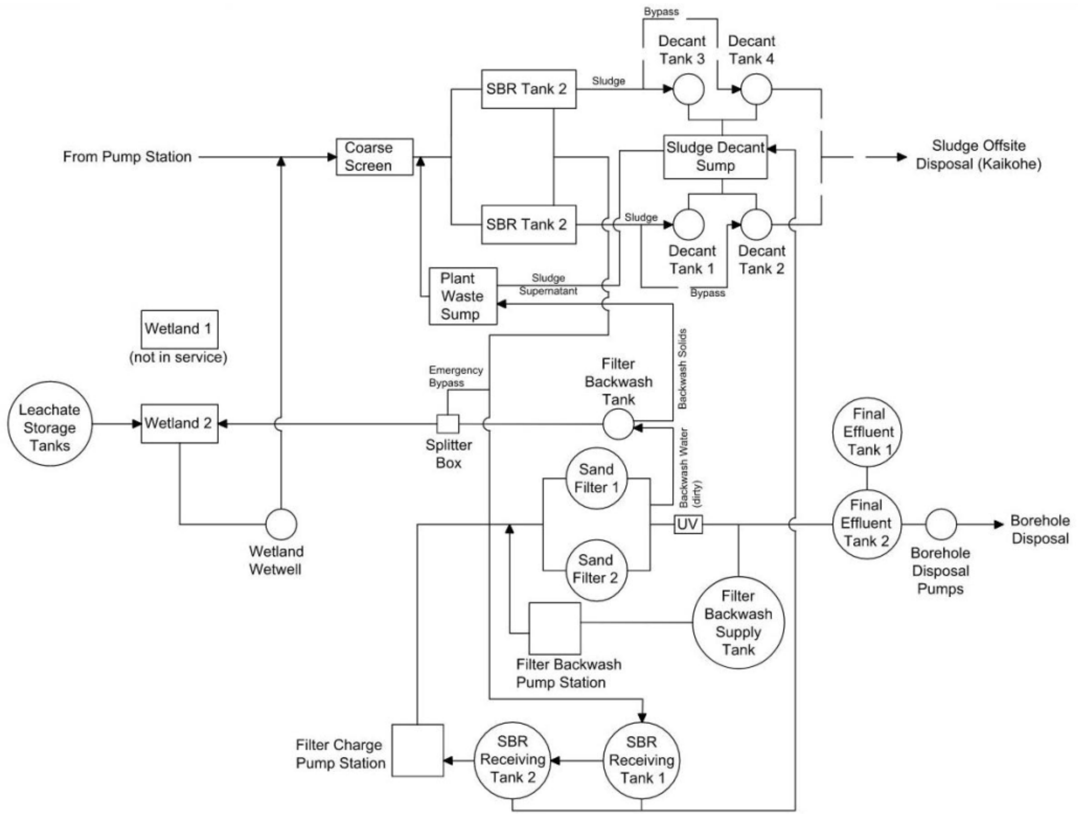


Figure 3: Block flow diagram for the KR-WWTP (FNDC, 2 23).

4.3 Wastewater discharge via boreholes

Treated wastewater is discharged from the KR-WWTP to 85 250 mm diameter disposal boreholes situated between 45 to 80 m RL along an apex of ridgelines near the KR-WWTP. Bores are closely spaced (approximately 3 to 10 m) and are drilled to approximately 30 m bgl. into the fractured Greywacke. The boreholes are separated into three disposal areas (A, B and C), across four ridgelines (Figure 2). Typically, only two borefields are operated at any given time, with one borefield 'at rest' to allow induced groundwater mounding to return to the natural groundwater level. Currently only borefields A and B are operational as borefield C sustained damage during Cyclone Gabrielle in February 2023.

Under the existing consent, groundwater level and mounding within the borefield is monitored via 31 observation bores dispersed across the borefield. The groundwater observation bores are approximately 15 – 30 m deep, depending on the elevation and respective depth to groundwater. There are some known issues with these monitoring wells which are described in Section 4.11.

The Groundwater Assessment (Appendix D) describes how wastewater is distributed and managed throughout the borefield. The report explains both the intended operation, and current operation, which differs due to the PLC system not currently functioning.

Conceptual groundwater modelling (CGM), described further in Section 9.3, indicates that the groundwater table is below the depth of the discharge bores. Therefore, this discharge is considered as a discharge into land, that enters groundwater and infiltrates to surface water. However, this is based on the CGM, and without actual groundwater monitoring depths, this cannot be confirmed at the present time.

4.4 Current Inflow volumes

The KR-WWTP receives mostly municipal wastewater from the community of Kororāreka/Russell and Tapeka Point, with some leachate flow from the neighbouring landfill. Inflow is measured at the KR-WWTP with records from July 2020 – July 2023[1] included in Table 3 below.

[1] A three-year period of data was modelled to provide more insight into issues anecdotally raised as that is sufficient to estimate average daily flow and 90th percentile flow.

Table 3: Historical Inflow Volumes

Flow Statistic	Flow (m^3/day)
Average daily flow	370
Average dry weather flow	290
95th percentile flow	830
Maximum daily flow	2,017

Notes:
1. *Inflow data from 1st July 2020 and 31st July 2023.*
2. *It has been considered that any flow where the previous 3 days have had less than a total of 1 mm of rainfall is a dry weather flow.*

The Performance Assessment Report (Appendix C) has identified that there is a large variation in inflow and outflows and explores possible reasons for why this might be, with faulty inflow and outflow dataloggers as one possibility.

Drinking water for the Kororāreka/Russell and Tapeka Point townships is not reticulated from a central water source, and water is supplied privately via rainwater collection or private bores. Wastewater networks which are supplied by private water supplies generally have lower wastewater flows per population than those that are connected to a public water supply. Assuming a peak population of 1,350 people, the influent flow into the KR-WWTP would be 270 m^3/day. This assumes each person uses 200 litres per day (L/day), which is understood to be generous for populations on private water supply. The average daily flow of 370 m^3/day which covers both peak and off-peak times suggests the network has a combination of stormwater inflow and infiltration (I&I) into it.

The KR-WWTP is currently consented to accept 5 m^3/day of leachate from the Russell landfill. However, the median flow from August 2022 – February 2023 was 22 m^3/day.

4.5 Current Inflow contaminant load

Influent wastewater is not sampled at the KR-WWTP. The Performance Assessment Report (Appendix C) has estimated contaminant inflow load based on typical municipal wastewater concentrations. Leachate quality has previously been measured by OPUS (2006)[2], which shows that the contaminant load within the leachate is lower than that of typical municipal wastewater. Therefore, applying a municipal wastewater concentration to the overall KR-WWTP inflow is a conservative approach when modelling treatment performance.

[2] Opus (2006) Plant Design Capacity Review, February 2006

4.6 Projected flows and contaminant load

Changes in population or land use can result in a change in influent flow and contaminant load. Population forecasts show the population is likely to remain the same at about 800 permanent residents[3]. Based on no population change, it is also expected that there will be no changes to contaminant loads.

Kororāreka/Russell is a popular holiday destination. There is no data for peak populations during the holiday season, however it is estimated to be approximately 1,350 people. This has been based on an average occupancy of two people per household, multiplied by the number of dwellings, noting that the number of dwellings exceeds the number of households suggesting they are holiday homes. The actual peak population could be greater than 1,350 people if there is more than an average of 2 people in each house during peak times.

4.7 Wastewater discharge flows

The existing KR-WWTP consent limits total wastewater discharged from the KR-WWTP to the borefield to 1,235 m^3/day. Based on the recorded outflow volumes alone, this was not exceeded between 1 July 2020 and 30 April 2023.

4.8 Wastewater discharge contaminant load

The existing consent conditions for the KR-WWTP specifies discharge water quality limits which are included in Table 4.

Table 4: Water Quality Re uirements

Parameter	Discharge Limits	
	Rolling Median	Rolling 90th Percentile
Carbonaceous Five Day Biochemical Oxygen Demand ($cBOD_5$) (mg/L)	10	25
Total Suspended Solids (TSS) (mg/L)	10	25
Total Kjeldahl Nitrogen (TKN) (mg/L)	20	40
Total Phosphorus (TP) (mg/L)	15	30
Parameter	Rolling Median	Maximum[4]
Escherichia coli (*E.coli*) (cfu/100 ML)	50	1,000

[3] Retrieved from: https://www.stats.govt.nz/tools/2018-census-place-summaries/russell and https://population.infometrics.co.nz/far-north-district/growth-areas

[4] In any single sample.

4.8.1 E.coli concentrations

E.coli levels in the treated effluent has exceeded consent limits in some sampling rounds. Based on data between September 2013 and May 2023, *E.coli* concentrations have exceeded the 7-point rolling median limit for 50 samples and the 1000 cfu/100 ML threshold for 38 samples. A total of 296 samples have been recorded during this time.

Assuming outflow is spread evenly throughout the day and on aggregated flow data, the 14 L/s design capacity of the UV unit would not have been exceeded during this period. However, the exceedance of *E. coli* levels in some samples suggests that during periods of high inflow, the flow through the KR-WWTP is not even and the treatment capacity of the UV unit is exceeded and unable to work effectively.

4.8.2 Other exceedances

The TSS concentration has also breached the 7-day rolling median and 90th percentile consent limits on 21 and 39 occasions respectively since 2013. The most recent breach was in March 2020. Prior to early 2020, there hadn't been a breach since early 2018.

There have also been occasional breaches in $cBOD_5$ and TKN levels since 2013. $cBOD_{55}$ exceeded the 7-day rolling median and 90th percentile on 3 and 7 occasions respectively while TKN exceeded its limits on 5 and 8 occasions respectively. However, the most recent of these for both $cBOD_5$ and TKN was in 2014 which indicates that previous issues related to these parameters may have largely been resolved. No exceedances of the TP concentrations were reported.

4.9 Capacity study

The Performance Assessment Report (Appendix C) utilises a BioWin model based on average 90th percentile flows and the theoretical maximum flows to model the theoretical maximum treatment capacity of the KR-WWTP. The model excludes the filtering system after SBR treatment, as that is too complex for the BioWin model to compute.

Modelling results show an increase in the concentrations of the parameters of concerns, especially TSS and $cBOD_{5.}$ However, the filter which was not accounted for in the model is expected to reduce TSS and $cBOD_5$ concentrations so that both are below the existing consent conditions during average and 90th percentile inflows. However, the KR-WWTP is unable to provide efficient treatment during existing peak inflows. This will be addressed through the proposal to upgrade and reinstate Pond #1 to better balance flows through the KR-WWTP.

4.10 Known treatment performance issues

Several issues related to the performance of the KR-WWTP have been highlighted in previous studies (MWH, 2002; OPUS, 2006, Far North Waers Alliance 2023) and by the operator when PDP staff visited the site on 25 August 2023. The Performance Assessment Report (Appendix C) provides a full assessment of the issues currently limiting performance. Key issues include:

- Overloading of the system during high flows which reduces the available residence time for wastewater within the settling period, which can result in carry-over of solids. This is mainly attributed to I&I within the wastewater reticulation network prior to arriving at the KR-WWTP.
- Solids carry-over can cause heavy loading of the filter media which potentially impacts its performance. It may also result in the filters and UV unit being by-passed which would further impact on performance.
- The current UV unit is designed to treat flows up to 14 L/s. Flow data indicates that the maximum flow through the KR-WWTP exceeded this from time to time, which could have led to underperformance of the UV unit.

The modelling and performance results of the KR-WWTP indicate that to improve treatment at the KR-WWTP, there is a need for a system that can balance the inflows. FNDC will be addressing these performance issues within the next 6 months, as further discussed in Section 5.2.

4.11 Known issues with the disposal borefield

The Borefield Disposal Performance and Slope Stability Review Report (Appendix E) describes the various performance tests that have been undertaken on the borefield. In summary, there are 29 high performing disposal bores (out of 85) that provide the majority of the disposal capacity. The known issues of the disposal borefield are noted as follows:

- There has been a reduction in bore disposal capacity over time.
- Currently only borefields A and B are operational as borefield C sustained damage during Cyclone Gabrielle in February 2023.
- Operations staff note that a number of disposal bores are routinely flooding at ground surface due to deteriorating bore performance.
- PDP staff witnessed a wastewater ‘seep’ within the immediate vicinity of the discharge bores within borefield A.
- Potential rodent induced damage to switch control valve lines.

- Only 5 of the 31 observation bores could be found in August 2023, all of which were damaged or dry. The other 26 observation bores are considered to be lost, destroyed or damaged.
- No groundwater level data has been collected at site since November 2019 from the observation bores.
- The automated discharge sequence controller is not operational. The KR-WWTP Operator therefore switches flow across the three bore disposal areas manually. The automated discharge sequence was intended to ensure the disposal scheme operates at optimum efficiency to prevent excessive mounding and surface flooding. Since no groundwater level monitoring is undertaken at site, manual switch over is no-longer informed by any groundwater level 'mounding' data.

FNDC was granted resource consents AUT.045446.01.01 and AUT.045446.02.01 from NRC on 23 November 2023 to undertake targeted treatment on 38 bores to clear bio-film accumulation to improve infiltration capacity. This will involve mechanical cleaning using high-pressure jet washing and chemical treatment. The bore cleaning trial will be staged, with 10 bores scheduled to be cleaned in March 2024. If this trial is a success, the balance of the bores will be completed over the following years.

Once cleared, infiltration capacity of the bores is expected to be improved. However, this AEE and the supporting Groundwater and Surface Water Quality Effects Assessment (Appendix D) is based on the existing situation of limited bore infiltration. This is considered a conservative approach.

5.0 Proposal

5.1 Application Parameters

FNDC currently discharges from the KR-WWTP under resource consents AUT.008339.0103 (Discharge to ground), and AUT.008339.02.03 (Discharge to air), which expire on 30 April 2024.

The existing consents were processed without public notification and were granted for a ten-year duration. The treatment process at the KR-WWTP and disposal into the disposal borefield remains largely unchanged, with the exception of efficacy as described in Section 4.10 above.

Section 4.0 describes the KR-WWTP treatment process and disposal system which this application seeks to reconsent. FNDC is seeking to retain the existing discharge limits and contaminant loads as described in sections 4.7 and 4.8. The Performance Assessment Report (Appendix C) determines this to be appropriate based on forecast population growth, treatment capacity of the KR-WWTP, and proposed upgrades.

The proposal does not seek to limit leachate pumped to the KR-WWTP for treatment. Leachate quality sampling shows it has a lower contaminant load than standard municipal wastewater parameters, so there is no reason for this to be limited. The leachate flow will be accounted for in the overall KR-WWTP discharge flow limits. Leachate should also be encouraged to be captured and treated appropriately through a treatment plant.

5.2 Proposed upgrades

Sections 4.10 and 4.11 summarise the known treatment limitations at the KR-WWTP and disposal borefield. To upgrade the KR-WWTP to be able to meet consent limits more consistently, FNDC propose to complete the following upgrades within the next six months:

- Within the next three months, FNDC will improve flow balancing by refurbishing the currently unused Pond#1 so it can be used for temporary wastewater storage during periods of high inflow, until the KR-WWTP has sufficient capacity to treat the wastewater. The upgrade works involve installing a double liner into the existing Pond#1.
- Within the next two months, replace the Ultra-violet (UV) unit. A new UV unit has been procured and delivered to the site. Installation and set-up is due to be completed by the end of December 2023, with final testing and commissioning scheduled over January 2024.

These upgrades form part of this proposal.

In the future, FNDC would like to dispose of waste activated sludge (WAS) within the catchment, rather than the current process of disposing it offsite by trucking it to Kaikohe. Suitable land for disposal that could accept WAS needs to be identified, and approvals sought, before this could commence. Therefore, this does not form part of this proposal.

5.3 Effects management strategy (EMS)

The National Policy Statement for Freshwater Management 2020 (NPS-FM) and pRPN requires the health and well-being of degraded water bodies and freshwater ecosystems to be improved, and the health and well-being of all other water bodies and freshwater ecosystems to be maintained and (if communities choose) improved. However, it is difficult to determine the extent of effects from the current operation as the existing KR-WWTP resource consents do not require any monitoring of the receiving environment downstream of the observation bores.

To help inform this application, two rounds of freshwater quality sampling, one round of coastal water sampling and a wetland condition assessment was completed. The monitoring results form part of the effects assessment within the AEE in section 8.0. As the KR-WWTP discharge is existing, the monitoring confirms that the discharge is not causing any significant adverse effects on the receiving environment. However, the NPS-FM water quality standards should be based on five years of data, and PDP consider at least two years of water quality data is needed to get an indication on water quality health such that the short-term dataset should be used for indicative purposes only at the moment.

To better understand the effects the KR-WWTP is having on the receiving environment, ensure any future investment in the KR-WWTP is targeted/needed, and ensure the KR-WWTP is authorised in accordance with modern policy requirements, FNDC propose to implement an adaptive management approach (AMA).

This AMA is illustrated in

Figure 4 and includes the following steps:

- Design and undertaking of long-term surface water sampling (e.g. monthly grab samples) to provide a better understanding of the effect of discharging treated wastewater to land where it can enter the shallow groundwater aquifer and subsequently on the downstream surface and coastal water receiving environments.
  - Ensure that the parameters analysed align with the guideline values used to assess the ecosystem health in the NPS-FM and pRPN.
  - Ensure the sampling captures a range of weather, stream and operational conditions.
- Completing KR-WWTP upgrades as described in section 5.2 (Refurbish Pond #1, UV upgrade and bore cleaning).
- After two years of collecting receiving environment monitoring results, assess receiving water quality against the NPS-FM National Objectives Framework (NOF) and pRPN water quality standards (Appendix H.3) (or relevant NPS and Plan at that time), to determine if the receiving environment is degraded and requires further improvement or not.
- If it is determined that the receiving environment is degraded, reassessing the BPO to determine if further improvements to the KR-WWTP are possible in order to meet limits, or contribute to achieving limits if cumulative effects exist, or consider whether an alternative discharge should be sought.
- Should the revised BPO assessment determine that further upgrades to the KR-WWTP is the BPO, completing these upgrades in a timeframe mutually agreed with by NRC and mana i te whenua, which is within the duration of the consent, as directed by Policy D.4.1 (4) pRPN. As there may be various upgrade requirements, it is not suitable to determine an upgrade timeframe without knowing what it may involve.

- If the revised BPO assessment concludes that an alternative discharge location or method is the BPO, FNDC will progress designing and consenting (if required) this option within the duration of this consent.

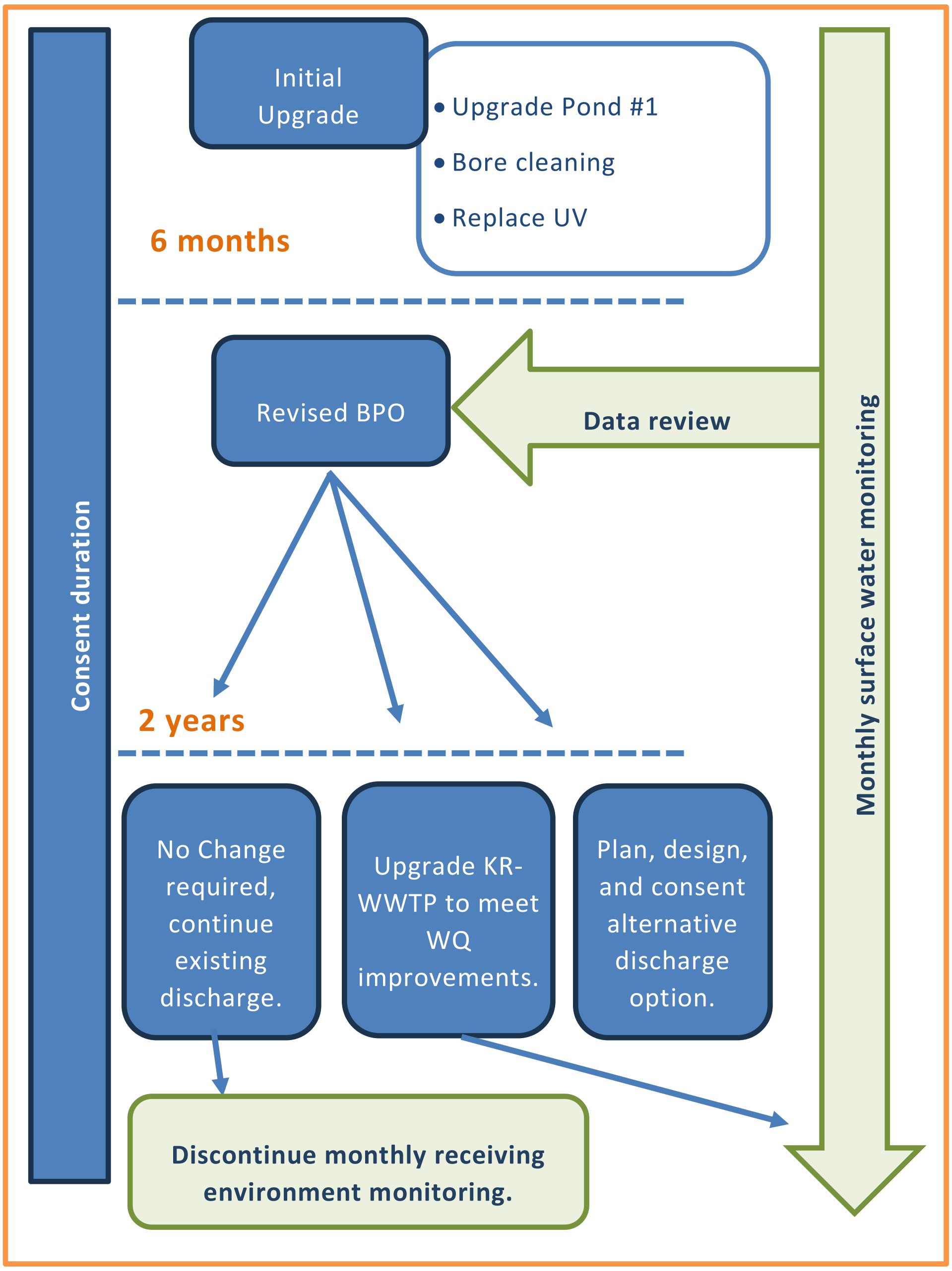


Figure 4: Proposed AMA

5.4 Monitoring and reporting

The KR-WWTP is an existing activity, and effects have been assessed in section 9.0 as less than minor to minor (noting cultural effects are yet to be assessed).

However, most of the technical reports recognise that there is only a limited dataset for the receiving environment and recommend ongoing monitoring and reporting to better establish the effects the discharge is having on the receiving environment. This will help inform the AMA described in section 5.3.

In summary, the following monitoring is proposed:

1. Inflow and Outflows–- continued monitoring of inflows and outflows from the KR-WWTP.
2. Discharge effluent quality – continued monitoring of discharge wastewater quality to confirm compliance with consent conditions.
3. Quarterly groundwater level and groundwater quality monitoring at newly installed monitoring bores at various positions.
4. Monthly receiving environment surface water quality monitoring to provide a better understanding of the impact of discharging treated wastewater to this environment.
   a. Ensure that the parameters analysed align with the guideline values used to assess the ecosystem health in the NPS-FM and NRC Proposed Regional Plan.
   b. Ensure the sampling captures a range of weather, stream and operational conditions.
   c. The frequency of this monitoring will reduce after two years if monitoring shows that receiving surface water quality meets National and Regional water quality guidelines.
5. Annual pest plant and wetland composition monitoring.

The following reporting is proposed:

1. Monthly reporting to NRC and other parties (to be determined), which includes:
   a) Inflow and discharge volumes
   b) Discharge effluent quality
   c) Receiving environment water quality samples.
2. Annual reporting to NRC and other parties (to be determined), which includes:
   a) All monthly monitoring.

b) Notification of verification of flow meters.

c) Wetland composition assessment.

d) Any upgrades completed on the KR-WWTP or reticulation network within the past 12 months, and any proposed upgrades to the KR-WWTP and network over the next 12 months.

3. One-off annual report reviewing groundwater effects after one year of groundwater monitoring.

The following operation plan will be followed and implemented:

1. The Russell WWTP Operations and Maintenance Manual (OMM) (Appendix J) was recently updated. This should be updated again after the proposed upgrades to the KR-WWTP are completed and all activities should be undertaken in accordance with this OMM.

6.0 Planning framework

6.1 Relevant legislation

The following legislation is relevant to the proposal, with some provisions more directly related than others. At the national level, the following planning instruments have been considered in this report:

- RMA;
- Natural and Built Environment Act 2023 (NBEA);
- Water Services Act 2021 (WSA);
- NES-F;
- NPS-FM; and
- New Zealand Coastal Policy Statement 2010 (NZCPS).

The discharge occurs above the Coastal Marine Area (CMA) boundary; however, the CMA forms the ultimate receiving environment. As directed in Clause 1.5 of the NPS-FM, the NPS-FM covers all receiving environments, including the CMA and estuaries.

The NPS-FM does not address preservation of natural character of the CMA, which is a matter addressed under the NZCPS. Noting the Uruti Bay bay-head mangroves are identified in the Regional Policy Statement for Northland 2016 (RPS) as having high natural character (HNC), the natural character provisions of the NZCPS are considered relevant to this proposal.

The following statutory documents were considered but it was determined that they do not apply this application:

- The National Policy Statement for Urban Development 2020 (NPSUD) does not apply as FNDC does not meet the definition of a Tier 1,2 or 3 local authority as it is not listed in the Appendix of the NPSUD and the Russell/Kororāreka Community does not meet the NPSUD definition of 'urban environment' as is it is not, and does not intend to be, part of a housing and labour market of at least 10,000 people.
- The National Policy Statement for Indigenous Biodiversity 2023 is not considered relevant to this application as it only relates to indigenous biodiversity in the terrestrial environment. Only freshwater and coastal water environments are affected.
- The Resource Management (National Environmental Standards for Sources of Human Drinking Water) Regulations 2007 are not relevant to this application as there are no abstraction points for drinking water downgradient of this discharge permit.

At a regional level, the following planning instruments have been considered in this report:

- RPS;
- pRPN;
- Regional Air Quality Plan 2005 (RAQP);
- Regional Coastal Plan 2004 (RCP); and
- Regional Water and Soil Plan 2004 (RWSP).

In accordance with s.86F, the rules in the pRPN are to be treated as operative, as all appeals on the pRPN have been resolved. As such, resource consent is no longer required under the previous Regional Air, Coastal, Water and Soil Plans (Operative Regional Plans).

The KR-WWTP is within the jurisdiction of FNDC, which manages land use through the Operative Far North District Plan 2009 (FNDP) and Proposed FNDP 2022.

6.2 Zones/features/overlays

The planning features/overlays that are relevant to this resource consent application are as listed in Table 5.

Table 5: oning and key features

Feature Type	Feature
RPS	
High Natural Character	Uruti Bay (Unique Id: 08/15).
pRPN	
Airshed	None
Groundwater Management Units	The majority of the KR-WWTP borefield is within the 'Other Aquifers' delineation, however towards Uruti Bay the area is mapped as 'Coastal Aquifer'.
Coastal Water Quality Management Unit	Estuary
River Catchment	Bay of Islands Coast
Significant Ecological Area (SEA)	*Uruti Bay* - Avifauna - Fish - Reptiles - Ecological significance
High Natural Character	Uruti Bay
Significant Marine Mammal and Seabird Area	The entire Northland coastal marine areas is mapped as having significant Marine Mammal and Seabird life. Thirty-five species of marine mammals are known from Northland waters. Some marine mammal species are resident or semi-resident and breed along the Northland coast, and others are transients. The coastal areas and estuary are a stronghold for many threatened birds species and virtually all of the estuaries and coasts are being use by one, or, more often, many species.
Coastal Zone	General Marine Zone

Table 5: oning and key features	
Feature Type	**Feature**
Other	
Natural areas of Whangaruru Ecological District (2016)	The KR-WWTP disposal area partially falls into an area mapped by the Department of Conservation (DoC) as the Edwards/Tikitikioure Coastal Habitat. The habitat is recorded to have extensive coastal vegetation, large, fragmented regenerating shrubland, and sequential gradients to the coast[5].
NRC Natural Hazards (NRCGIS)	Coastal Flood Hazard Zone.
Operative FNDP	
Zoning	General Coastal Zone
Proposed FNDP	
Zoning	Rural Production
Overlays	Coastal Environment River Flood Hazard Zone (100 Year ARI Event) River Flood Hazard Zone (10 Year ARI Event)

6.3 Statutory definitions

The statutory assessment has relied on the following definitions.

<u>NPS-FM</u>

Specified infrastructure *means any of the following:*

(a) infrastructure that delivers a service operated by a lifeline utility (as defined in the Civil Defence Emergency Management Act 2002)

(b) regionally significant infrastructure identified as such in a regional policy statement or regional plan

(c) any water storage infrastructure

(d) any public flood control, flood protection, or drainage works carried out:

[5] https://www.doc.govt.nz/globalassets/documents/conservation/land-and-freshwater/land/whangaruru-ecological-district/whangaruru-ecological-district-report.pdf

(i) by or on behalf of a local authority, including works carried out for the purposes set out in section 133 of the Soil Conservation and Rivers Control Act 1941; or

(ii) for the purpose of drainage by drainage districts under the Land Drainage Act 1908

(e) defence facilities operated by the New Zealand Defence Force to meet its obligations under the Defence Act 1990 National Policy Statement for Freshwater Management 2020 25

(f) *ski area infrastructure*

<u>pRPN</u>

Regionally significant infrastructure is defined as the list in Appendix H.9 which includes:

1) energy, water, communication:

……

h) regional and district council wastewater trunk lines and treatment plants and key elements of the stormwater network, including treatment devices.

…. continues.

Regionally Significant Infrastructure (RSI) extends to the site-related components that enable the asset to function.

Definitions relating to wetlands within the RMA and NPS-FM are defined in Section 3 of the Ecological Effects Assessment in (Appendix F) .

6.4 Resource consents required

6.4.1 NES-F

The NES-F sets rules and standards to regulate activities that pose risks to the health of freshwater and freshwater ecosystems. The NES-F, as relates to the KR-WWTP, only applies to activities within a 100 m setback of a 'natural inland wetland' as defined by the NPS-FM.

The wetland delineation completed by PDP Ecologists within Appendix F) and summarised in section 7.8 confirms that wetlands W4 and W5 are 92 m and 94 m from the closest discharge bores (within borefields A and B).

Clause 46 permits discharges of water within, or within a 100m setback from a natural inland wetland if –

(a) the activity is for the purpose of maintaining or operating specified infrastructure or other infrastructure; and

(b) there is a hydrological connection between the taking, use, damming, diversion, or discharge and the wetland; and

(c) the taking, use, damming, diversion, or discharge will change, or is likely to change, the water level range or hydrological function of the wetland; and

(d) the activity complies with the conditions, including general conditions listed in Clause 55.

The operation of the KR-WWTP is considered specified infrastructure as per the definitions in the NPS-FM and pRPN (see Section 6.3). Based on the hydrological concept model (Appendix D), it is considered that the discharge is hydrologically connected to the wetlands, and the discharge is likely to influence the water level range within the wetland. The discharge is unable to comply with Clause 55 Subclause 3(c) as the discharge into groundwater is considered to alter the natural movement of water into, within, or from the natural inland wetland.

Applications relating to specified infrastructure that cannot meet Clause 46 should then be assessed against restricted discretionary activity Clause 47. For an activity to be able to meet the conditions of Clause 47(5), a baseline assessment of the condition of the affected wetland must be made prior to the discharge occurring, and the wetland returned to its original condition. These conditions cannot be met by an existing and ongoing discharge. Therefore, consent is required under Clause 54 as a **non-complying** activity.

6.4.2 pRPN

The pRPN was notified in September 2017. As of October 2023, all appeals on the pRPN have been resolved. All rules in the pRPN must now be treated as operative, in accordance with s.86F of the RMA (and any previous rule inoperative).

Rule C.6.2.2 of the pRPN is applicable as follows:

The discharge of treated wastewater from a wastewater treatment plant into water or onto or into land, and any associated discharge of odour into air resulting from the discharge, are discretionary activities.

For the avoidance of doubt this rule covers the following RMA activities:

- *Discharge of treated wastewater from a wastewater treatment plant into water or onto or into land where it may enter water and any associated discharge of odour into air (s15(1)).*
- *Discharge of treated wastewater from a wastewater treatment plant onto or into land and any associated discharge of odour into air (s15(2)(A)).*

Therefore, consent is required under Rule C.6.2.2 as a **discretionary activity**. Any resource consents required as part of any future upgrades may be sought as part of this application or at a later date depending on the timing.

This application does not cover the discharge of wastewater overflows from the wastewater network.

For the avoidance of doubt, FNDC is seeking resource consent under the above rules and any other rules which may apply, even if not specifically noted.

6.5 Permitted activities

Should annual monitoring of the wetland determine that pest plants are increasing, it is intended that these will be removed. This is a permitted activity under Clause 38 of the NES-F.

No earthworks are considered necessary to refurbish Pond#1, therefore no permitted activity rules are triggered for that activity.

6.6 Section 104(2A) Value of existing infrastructure

The existing KR-WWTP and borefield is currently valued at around $5,616082 with a depreciated replacement cost of $2,248464 (FNDC, August 2023). These figures include the values for the KR-WWTP, borefield and associated pipe infrastructure onsite.

6.7 Section 104 (2D) – Wastewater network

The WSA came into effect in October 2023. Under the WSA (Section 3(2)(a)), a framework is to be established to provide transparency about the performance of drinking water, wastewater and stormwater networks and network operators. Taumata Arowai is the national water services provider and is to provide oversight regarding the WSA and to prepare national guidelines and best practices for wastewater networks.

Section 138 (1) of the WSA allows Taumata Arowai to prepare wastewater environmental performance standards, which can relate to:

- *(a) discharges to air, water, or land:*
- *(b) biosolids and any other byproducts from wastewater:*
- *(c) energy use:*
- *(d) waste that is introduced by a third party into a wastewater network (for example, trade waste).*

These performance standards may include requirements, limits, conditions, or prohibitions. These standards will apply to all, or classes of wastewater networks (and their operators).

There are currently no wastewater environment performance standards that wastewater networks or operators are required to comply with. However, Taumata Arowai plan to introduce measures for wastewater from early 2024[6].

Section 104(2D) of the RMA will require a consent authority to not grant a consent contrary to a wastewater environmental performance standard made under s.138 of the WSA and resource consents must include, as a condition of consent, requirement to give effect to any wastewater performance standard(s).

6.8 Section 104D – Particular restrictions for non-complying activities

Section 104D applies to the resource consent application as it is being assessed as a non-complying activity. The application therefore needs to pass at least one of the following two s.104D gateway tests before being assessed under s.104 of the RMA:

- Test 1 (s.104D(1)(a)) – the adverse effects of the activity on the environment will be no more than minor.
- Test 2 (s.104D(1)(b)) – the application will not be contrary to the objectives and policies of the relevant plan being the pRPN.

In terms of the first legal test, case law has confirmed the meaning of minor. In Elderslie Park[7], the High Court stated:

> *"The word 'minor' is not defined in the RMA. It means lesser or comparatively small in size or importance. Ultimately an assessment of what is minor must involve conclusions as to facts and the degree of effect. There can be no absolute yardstick or measure."*

The AEE in Section 8.0 of this report concludes that the effects on the environment will be minor at most. However, this does not yet include cultural effects, which cannot be determined without mana i te whenua input. It may be that the application can meet this gateway test without resorting to limb (b) of the s.104D.

Until then, it is appropriate to apply the second test which specifically applies to the 'relevant plan'. Under s.43AA of the RMA a 'plan' is defined as 'a regional plan or a district plan'. This definition does not include a policy statement (either national or regional). Policy D.4.1 provides a route for consent applications like this, that may require further upgrades within the duration of the consent to meet the other freshwater quality objectives and policies.

[6] Taumata Arowai, *Network Environmental Performance – Voluntary Reporting Measures and Definitions for Wastewater and Stormwater Networks (1 July 2022 to 30 June 2023)* (Introduction).

[7] *Elderslie Park Limited v Timaru District Council* [1995] NZRMA 433 (HC) at 445-446

Engagement with mana i te whenua has not progressed enough to be consistent with policies D.1.1 or D.1.2. FNDC request that timeframes for public notification are extended under s.37 (RMA) to allow for meaningful engagement so policies D.1.1 and D.1.2 can be met.

While further engagement is yet to occur, case law has determined that 'contrary to' has the same meaning as 'repugnant to' or 'opposed to in nature' which is a higher threshold than 'inconsistent'. An example of being "contrary to" could be where a new discharge would degrade water quality below specified water quality standards, with no intention to seek and alter the proposal to take into account mana i te whenua values. Therefore, until engagement is complete, PDP do not consider it to be contrary to the pRPN, and with the proposed EMS, will be consistent with the pRPN.

6.9 Sections 105 – Matters relevant to discharge applications

In addition to the s.104 RMA matters which a consent authority must have regard to, s.105(1) sets out additional matters, listed in Table 6, which must be considered when determining a discharge consent application.

Table 6: Section 105 matters

Section 105 Matters	Refer to:
a) The nature of the receiving environment and the sensitivity of the receiving environment to adverse effects; and	Sections 7.0 and 8.0.
b) Applicant's reasons for the proposed choice; and	Section 3.0.
c) Any possible alternative methods of discharge, including discharge into any other receiving environment.	Section 3.0.

6.10 Section 107 – Restriction to grant certain discharge permits

Section 107 of the RMA specifies certain circumstances in which the consent authority shall not grant a discharge permit if after reasonable mixing, the contamination or water discharged (either by itself or in combination with the same, similar, or other contaminants or water), is likely to give rise to all or any of the following effects in the receiving water:

a) The production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials.

b) The production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials.

c) Any conspicuous change in the colour or visual clarity.

d) Any emission of objectionable odour.

e) The rendering of fresh water unsuitable for consumption by farm animals.

As the discharge is into land, where it will enter groundwater, effects listed in (a) – (d) are highly unlikely as the contaminants that would likely cause these effects attach to the soil as the groundwater infiltrates through it.

The freshwater quality as determined by the limited sampling, is determined to be safe for consumption by farm animals (not that they have access to this water body).

6.11 Section 108 – Conditions of consent

Draft conditions of consent are proposed in Appendix L) to demonstrate how FNDC will monitor and mitigate any potential adverse effects of the discharges.

6.12 Section 123 – Duration of consent

A consent term of ten years is sought. This term meets the expectations in Policy D.2.14 of the pRPN. The previous two resource consents for the KR-WWTP were also for ten-year consent terms.

The NBEA came into force on 23 August 2023. Under the NBEA, resource consent applications for discharges of contaminants to freshwater which are lodged with a consent authority are defined as an ‘affected resource consent’ until an NBEA plan is made operative. Schedule 12, Clause 39 limits the duration of an affected resource consent to no more than 5 years after the date the relevant rules in a NBEA Plan have legal effect. This date is currently unknown.

Schedule 12, Clause 40 states when Clause 39 does not apply. This includes discharges from a public wastewater network (Clause 40 s.3(b)). To be eligible for exemption, an application must seek a determination from the consent authority that clause 39 does not affect the duration of this consent. FNDC seek that NRC confirm that Clause 39 does not apply to this application.

6.13 Section 124 – Exercise of resource consent while applying for a new consent

In circumstances where a resource consent is due to expire, s.124 of the RMA allows for the continued operation of the activity under the existing consent while a determination is made on an application for a new consent.

This application includes a new consent for the same activity (s.124(1)(b)) and has been made within the three to six-month timeframe specified in s.124(2)(d). Therefore, until the determination of this consent application, FNDC will continue to operate under its existing resource consents as provided by s.124(3) of the RMA, with NRC’s discretion.

6.14 Section 125 – Lapse period

As provided for in s.125(1) of the RMA, a standard lapse date of 5 years is adequate for the KR-WWTP discharge on the basis that it is for an operative discharge.

7.0 Site description/ existing environment

7.1 Location

The KR-WWTP is located less than 1 km to the southeast of the Kororāreka / Russell township. Kororāreka / Russell is located on a peninsula in the Bay of Islands. The KR-WWTP is approximately 500 m from Pomare Bay and 900 m from the ocean on the other side of the peninsula.

The site shares borders with nearby reserve blocks and the Russell transfer station which is also the site of the non-operational and soon to be closed Russell landfill.

7.2 General site layout

The KR-WWTP consists of a sewage treatment plant compound with two SBR tanks. Two constructed ponds (Pond #1 is unused) are situated to the north of the treatment compound. The disposal borefields are split across a series of ridgelines surrounding the KR-WWTP to the north and northeast of the site. Three small unnamed tributaries drain these areas, eventually discharging into a natural inland wetland located to the south of the KR-WWTP.

Access to the KR-WWTP is obtained through an entrance on Russell Whakapara Road, secured by a lockable farm-style gate. The entire site is encircled by a farm-style fence, with 2.2 m high wire security fence specifically enclosing the KR-WWTP. The KR-WWTP is currently operated by Ventia and senior staff and operators have access to the KR-WWTP.

7.3 Surrounding land use

The land that the KR-WWTP and borefields are located on appears to consist of sparsely populated, vegetated areas. On the other side of Russell Road is a ‘Coastal Living’ zone.

7.4 Topography

The bore disposal area is characterised by a series of steeply sloping grassed ridgelines and densely vegetated gullies situated to the north-east, east and south-west of the KR-WWTP. Small stream tributaries are associated with each gully, which flow generally in a south-west direction into the low-lying wetland area adjacent to the KR-WWTP. The stream located directly downgradient of the landfill is inferred to potentially receive small volumes of landfill leachate.

7.5 Site geology and hydrogeology

The site is underlain by Rangiora clay, clay loam and silty clay loam (RA and RAH) (NRC GIS Layer: Managing Northland Soils). The disposal site geology is comprised of Waipapa Group Greywacke Formation, characterised by variable weathering, fracturing and associated formation permeability (EBG, 2001 and MWH, 2003). Weathered Greywacke generally extends to approximately 24 m below ground level (bgl) (EBG, 2001). The shallow sub-surface (top of the weathering profile) is characterised by a mantle of approximately 2 to 6 m of low permeability clay (completely weathered Greywacke). At depth (>24 m bgl) Greywacke is typically fresh (unweathered with minor fracturing).

The regional groundwater level is situated within the weathered Waipapa Group Greywake formation, approximately 15 m to 24 m bgl (below ground level). Groundwater flow is generally north to south, from the higher topographic elevation ridgelines towards Uruti Bay and the associated streams and wetland situated downgradient of the KR-WWTP. Therefore, the streams, wetlands and bay to the south are considered the primary receptors for the site and may be affected by the current activities onsite.

The Groundwater and Surface Water Quality Effects Assessment (Appendix D) establishes a CGM for the wastewater discharged via the borefield. Due to the damage caused to the observation bores, and lack of recent groundwater data, PDP has not been able to verify the CGM with actual groundwater data. The CGM is based on known geology and estimates groundwater throughflow to the receiving surface water bodies. Based on conservative estimates of hydraulic conductivity (4 m/d), hydraulic gradient (0.1) and cross-sectional area (3,600 m^2), the estimated total volume of groundwater migration across the bore disposal area to the receiving surface water catchment (stream and wetland) is approximately 534,360 m^3/yr.

Groundwater has been assumed to be hydraulically connected to the tributaries and sustaining the wetlands in the gullies at the base of the slope. As a result, all discharged treated wastewater is anticipated to migrate from the bore disposal area to receiving surface water.

7.6 Surface water

The KR-WWTP is located within the Bay of Islands Coast River Catchment.

The nearest surface waterbody (an unnamed tributary) is located approximately 100 m south of the KR-WWTP and flows in a south-easterly direction and discharges into the low-lying wetland area/Uruti Bay mangroves.

Three small headwater streams tributaries are present on site, identified as Stream 1, Stream 2 and Stream 3 throughout this AEE and supporting appendices. The streams have very low baseflow (approximately less than 1 L/s). It is expected that the treated wastewater discharged to the borefields supports the flow in these unnamed streams and without this groundwater recharge of the treated wastewater, they would likely be intermittent overland flow paths.

The small streams flow through vegetated gullies toward the KR-WWTP and are maintained via culverts and pipes beneath associated infrastructure for convergence to the south of the KR-WWTP in the unnamed stream.

The unnamed stream is characterised by the River Environment Classification (REC) as having 'warm, wet hill' origins. Shortly thereafter, flow is discharged into the Uruti Bay estuary.

7.7 Land cover

Land surrounding the KR-WWTP is maintained as a mix of mānuka and/or kānuka scrub in the ridges and gullies, and high producing exotic grassland and herbaceous freshwater vegetation along flat areas of the site around the KR-WWTP (Manaaki Whenua, 2020).

7.8 Ecological context

The KR-WWTP lies within the Whangaruru Ecological District (WED), which contains a high diversity of vegetation types at inland, coastal and island sites (Booth, 2005). One of the most important features is the relative abundance of pōhutukawa coastal forest, which is a nationally rare forest type. Other nationally important habitat types include swamp forest, freshwater wetlands, and estuarine systems.

The most common vegetation types in the WED are secondary forest dominated by tōtara, taraire, or tōwai, and kānuka/mānuka shrubland. Raupō reedland is the most common freshwater wetland type, with oioi saltmarsh and mangrove shrubland common in the numerous estuaries within the district.

A large area of wetland has been identified in the southern portion of the site which is contiguous with saltmarsh and brackish wetlands in the Uruti Bay estuary. This includes areas of HNC identified in both the RPS and pRPN.

On 27-28 September 2023 PDP ecologists undertook a site visit and delineated the extent of 'natural inland wetlands' within a 100 m buffer of the KR-WWTP. The Ecological Effects Assessment (Appendix F) describes the identified wetlands, as follows:

- Five wetlands were identified within a 100 m radius of the discharge borefield.

- Wetland 1 located south of the KR-WWTP is contiguous with the larger area shown as Saltmarsh and Mangrove in the NRC maps. This area includes areas mapped in the RPS and pRPN HNC area overlay. Ecological values of this wetland are considered to be **high** due to the presence of extensive raupō reeds which are of high habitat value for indigenous fauna such as the matuku-hūrepo (Australian Bittern, Threatened-Nationally Critical), pūweto (spotless crake, At-Risk Declining) and mātātā (North Island Fernbird, At-Risk Declining).
- Wetland 2 surrounds the lower reaches of the gully. Habitat values associated with Wetland 2 are considered **moderate**.
- Wetland 3 is formed above the accessway in the northern portion of the site. Overall, Wetland 3 has **high** ecological value.
- Wetland 4 is formed around the base of a gully in Stream 2. Stream 2 flows through this wetland forming a pond at the downstream extent. Overall habitat values associated with Wetland 4 are **moderate**.
- Wetland 5 is located along Stream 1, at the base of the gully below Disposal area. Overall habitat values associated with Wetland 5 are **moderate**.

Incidental observations of birds recorded during assessments are recorded in the Ecological Effects Assessment (Appendix F), as well as records for two species (Weka and pūkeko) which were returned in Environmental DNA (eDNA) sampling results.

7.9 Coastal environment

There are numerous small sandy bays and rocky outcrops along the edge of the Kororāreka/Russell Peninsula where the KR-WWTP is located.

Pomare Bay is located to the southwest of the KR-WWTP. This bay along with the Veronica Channel separates Kororāreka/Russell from Paihia. Within Pomare Bay, is the smaller Uruti Bay which is an estuary. Uruti Bay is where the small streams containing treated wastewater from the KR-WWTP join the CMA.

The CMA boundary as mapped in the RPS is approximately 320 m from the closest discharge bore, as measured in a straight line. However, following the contour of the land and likely ground and surface water flows, this is approximately 520 m downstream of the KR-WWTP.

7.10 Sensitive receiving environments (odour)

The closest sensitive receiver is a residential property on 6169 Russell Whakapara Road which is 370 m to the west. The surrounding properties are zoned as ‘Coastal Living’ or ‘General Coast Zone’, in the operative FNDP. The proposed FNDP has these areas zoned ‘Rural Lifestyle’ and ‘Rural Production’ respectively. Intensified development is not promoted within these zones under either the operative or proposed FNDPs. Associated policies within the land development provisions of both the FNDP[8] and pFNDP[9] require reverse sensitivity effects to be avoided (RLZ.P3),

7.11 Natural hazards

The KR-WWTP could be exposed to coastal hazards such as inundation, coastal erosion and tsunami waves. To better understand the flood and coastal hazards on the site, PDP completed a Flood and Coastal Hazard Assessment (Appendix G).

The NRC hazard maps indicate that the KR-WWTP is not at risk from coastal inundation or erosion hazards, however it is within the yellow tsunami inundation zone. This inundation zone is calculated from a 3 – 5 m wave threat level with a 2,500-year return period.

7.12 Contaminated land

According to the FNDC GIS maps, the subject site is not classified as an activity under the Ministry of Environment's Hazardous Activity and Industry List (HAIL), however all wastewater treatment sites are considered HAIL.

The landfill located approximately 244 m from the subject site is classified as HAIL ID: G3.

7.13 Cultural and historical significance

Kororāreka/Russell has a history of tensions between Māori and European settlers. In the 1800s it was a busy settlement for sailors, whalers, and traders due to the safe anchorage for ships before it briefly became the capital of Aotearoa/New Zealand in 1840[10]. There is a significant number of historical buildings including 11 under the protection of Heritage New Zealand Pouhere Taonga. There are also numerous archaeological sites surrounding the town.

According to the FNDC GIS Historic Sites Map, there are no District Plan or Heritage New Zealand Pouhere Taonga historic sites, sites of cultural significant to Māori, District Plan or New Zealand Archaeological Authority archaeological sites, or heritage areas within the property boundaries of the KR-WWTP.

The KR-WWTP site, borefield, and receiving environments are not listed as a site of significance to mana i te whenua in the RPS or pRPN, or in an area of statutory acknowledgement. However, this does not mean that the discharge is not of interest to mana i te whenua.

---

8 Policy RLZ.P3, I-O1, I-P7
9 13.3.2
10 https://nzhistory.govt.nz/keyword/russell

Hapū and iwi that have been formally recognised by the Crown to represent Māori interests in this area are Ngāpuhi and Ngātiwai. Ngāpuhi is divided into eight Takiwā, with Taumārere ki Rākaumangamanga associated with the Kororāreka /Russell peninsula. Taumārere ki Rākaumangamanga is made up of eight hapū[11]. The main groups identified with interests in this site are: Patukeha, Ngāti Kuta, Ngāti Manu and Te Kapotai which have a marae based in Kororāreka.

Historical rights to whenua were not limited to mana i te whenua, as they were influenced by practical considerations tied to changing seasons and available resources. The dynamic nature of Māori life, driven by the need to access resources in various locations at different times, meant that these rights extended beyond territorial boundaries. In essence, the utilisation of land was not solely defined by territorial authority[12]. As such, hapū and iwi who have an interest in this resource consent application may extend beyond mana i te whenua.

7.14 Recreational values

The peninsula that the KR-WWTP is located on is a popular tourist location with recreational activities occurring around it. Activities mainly take on the form of boating (including fishing) and swimming, although Uruti Bay and Pomare Bay are not mapped swimming beaches on NRC GIS Maps. The receiving environment is an aquacultural exclusion area.

There are also walking and cycling tracks in the area, including the Russell – Okiato Walkway that passes directly next to the KR-WWTP.

8.0 Consultation

FNDC has commenced consultation with the following parties, which is summarised in Table 7.

Table 7: Summary of consultation

Party or Person	Identified interest	Consultation status
Kororāreka Marae Society	Collective of hapū of the area	Waiting for Wānanga
Patukeha	Identified Interests in the area	Waiting for Wānanga
Te Kapotai	Identified Interests in the area	Waiting for Wānanga
Ngāti Kuta	Identified Interests in the area	Waiting for Wānanga
Ngāti Manu (Karetu Marae)	Identified Interests in the area	Followed Up - No Response

11 Te Puni Kōkiri, Ministry of Māori Development, Directory of Iwi and Māori Organisations.
12 Tupu.nz

Table 7: Summary of consultation

Party or Person	Identified interest	Consultation status
Russell Protection Society	Had an interest last time	Email Letters ready to send
Te Rūnanga O Ngāti Rehia	Unsure of Submission on previous consent	Email Letters ready to send
Paihia Ratepayers & Citizens Association Inc	Had an interest last time	Email Letters ready to send
Te Tiriti o Waitangi Marae Trust Board	Had an interest last time - Backed Ngati Manu Position	Email Letters ready to send
Te Rūnanga O Ngāti Hine	Unsure of Submission on previous consent	Email Letters ready to send
Te Rūnanga A Iwi o Ngāpuhi	Unsure of Submission on previous consent	Email Letters ready to send
Te Rūnanga O Taumarere Ki Rakaumangamanga	Unsure of Submission on previous consent	Email Letters ready to send
Waikare Inlet Taiapure Management Committee	Unsure of Submission on previous consent	Email Letters ready to send
Waitangi Marae Trustees	Unsure of Submission on previous consent	Email Letters ready to send
Bay of Islands - Whangaroa Community Board	Likely to have an interest	Information only briefing paper to inform Russell-Opua representative
Oyster Farmers	Likely to have an interest	Email Letters ready to send
General Public	-	None
NRC	Regulator	None

As mentioned throughout this report, FNDC requests public notification of this application to be delayed under s.37, while further consultation with mana i te whenua is carried out to ensure the effects on their cultural values are understood and mitigated where possible.

9.0 Assessment of Environmental Effects

9.1 Positive effects

The KR-WWTP is recognised in the pRPN as significant regional infrastructure. This means the function that it provides in treating reticulated wastewater is critical for the social, economic, and health benefits this provides the region. In this case, the benefits are experienced more directly by the community the KR-WWTP serves.

The positive effects of a wastewater treatment system are best understood by considering what the alternative effects on the environment would be if no wastewater treatment was provided. If wastewater was not collected, individual septic systems would likely be used which, considering the urban environment of Kororāreka /Russell, could result in wide-spread groundwater degradation, and in some locations degraded coastal water quality within popular swimming locations. Adverse health effects are also more likely in areas of high septic tank usage (e.g. ponding on lawns).

If the sewage were to be collected, and discharged without treatment, depending on the receiving environment this could cause significant adverse effects.

The KR-WWTP has been operating for over 20 years in this location, utilising and upgrading the existing infrastructure is considered to be the BPO, and good financial value to the local community, as many alternative options are cost prohibitive.

9.2 Cultural effects

Wastewater disposal can have significant adverse effects on cultural values if not done appropriately. FNDC and PDP have commenced consultation with various hapū. As consultation is ongoing, no assessment of the cultural effects of this application can be made at this stage. An assessment of cultural effects will be provided once further consultation to understand the impacts of the discharge has been completed.

As assessment against the environmental values within the relevant Hapū Management Plans is included in Section 11.5.5.

9.3 Effects on groundwater quality

As stated above, groundwater quality samples were unable to be collected due to the damaged and dry monitoring wells. As such, surface water sampling results have been used instead of groundwater quality sampling to assess the effects of the proposed discharge on groundwater quality and the receiving environment. This approach is supported by the hydrogeological CGM which anticipates all groundwater migrating from the bore disposal area discharges down-gradient to surface water (identified streams and wetland areas). This means no conclusive assessment on groundwater can be made at this point in time. In this instance, because groundwater is entirely linked to surface water, and groundwater is confined to its own catchment, there is greater certainty of effects within the catchment even though data is limited.

Despite this, there is still value in monitoring groundwater quality and depths to ensure the effects on groundwater are managed. FNDC propose the following:

- Design and install a new groundwater monitoring network to assess the effect of treated wastewater on groundwater quality and mounding.
- Reinstate quarterly groundwater level and groundwater quality monitoring at newly installed monitoring positions.
- After one year of groundwater monitoring, assess if the effects are acceptable, and if not, what further mitigation or monitoring is required.

9.4 Effects on other groundwater users

Data from NRC GIS Maps shows the closest consented water take to the discharge field is AUT.040557.01.01 which is approximately 600 m to the northwest of the disposal field, on the other side of the ridgeline near Oneroa Bay.

NRC GIS Map bore log data shows that there are approximately 60 active bores within 1 km of the disposal borefield, it is unclear if these are for groundwater abstraction. None of these mapped bores are downgradient to the disposal borefield. All groundwater migration through the disposal area is anticipated to discharge to receiving surface water at the base of the groundwater catchment. This is because the groundwater catchment is topographically constrained and therefore any effects of the KR-WWTP discharge bores is not expected to influence groundwater users in adjacent catchments.

Therefore, there are not considered to be any effects on other groundwater users.

9.5 Effects on surface water quality

The Groundwater and Surface Water Quality Effects Assessment (Appendix D) provides surface water monitoring results and how they relate to the freshwater quality standards in the NPS-FM and pRPN (Table 22).

Two rounds of surface water quality samples were taken from the three unnamed small streams on 6 September 2023 and 2 October 2023. Upstream samples were taken within each stream to represent water quality prior to the influence of the wastewater. These are monitoring sites SW1, SW4 and SW6 (see Figure 5 below). Downstream samples were taken at SW2, SW5 and SW7 to determine the effects wastewater seeps into the stream are having on stream quality.

In summary, the two rounds of monitoring results indicated similar water quality trends. For most of the water quality parameters analysed, the results were below guideline values presented in the NPS-FM and Table 22 of the pRPN.

Nitrate-N concentrations were consistently above guideline values across Streams 2 and 3 which is an indication that there is a notable effect from the disposal of wastewater to the shallow aquifer system.

While *E.Coli* concentrations were below the 95th percentile Band E guideline presented in the NPS-FM, there was a general trend of increasing *E.Coli* between the upstream and downstream sites which indicates there is an effect from the disposal of wastewater to the borefields. Furthermore, the 95th percentile bottom line guideline has been used to assess *E.Coli* concentrations simply to provide an indication of the current level of *E.Coli* contamination in the receiving surface water bodies. However, the 95th percentile value provides the worst-case scenario in a long-term data set and as such, it is proposed that longer-term sampling is conducted to enable the calculation of median and percentile concentrations. This will provide a better understanding of *E.Coli* contamination associated with the KR-WWTP.

In summary, the effect from the KR-WWTP on the surface water receiving environment is considered to be minor based on indicative exceedances, but additional long-term sampling is required to further assess these effects and implement the AMA if required. FNDC is committed to this sampling and have suggested a condition of consent to this effect.

It is expected that the proposed upgrades to the KR-WWTP as listed in Section 5.2 will result in improvements in the downstream water quality and contribute toward achieving NPS-FM and pRPN limits.

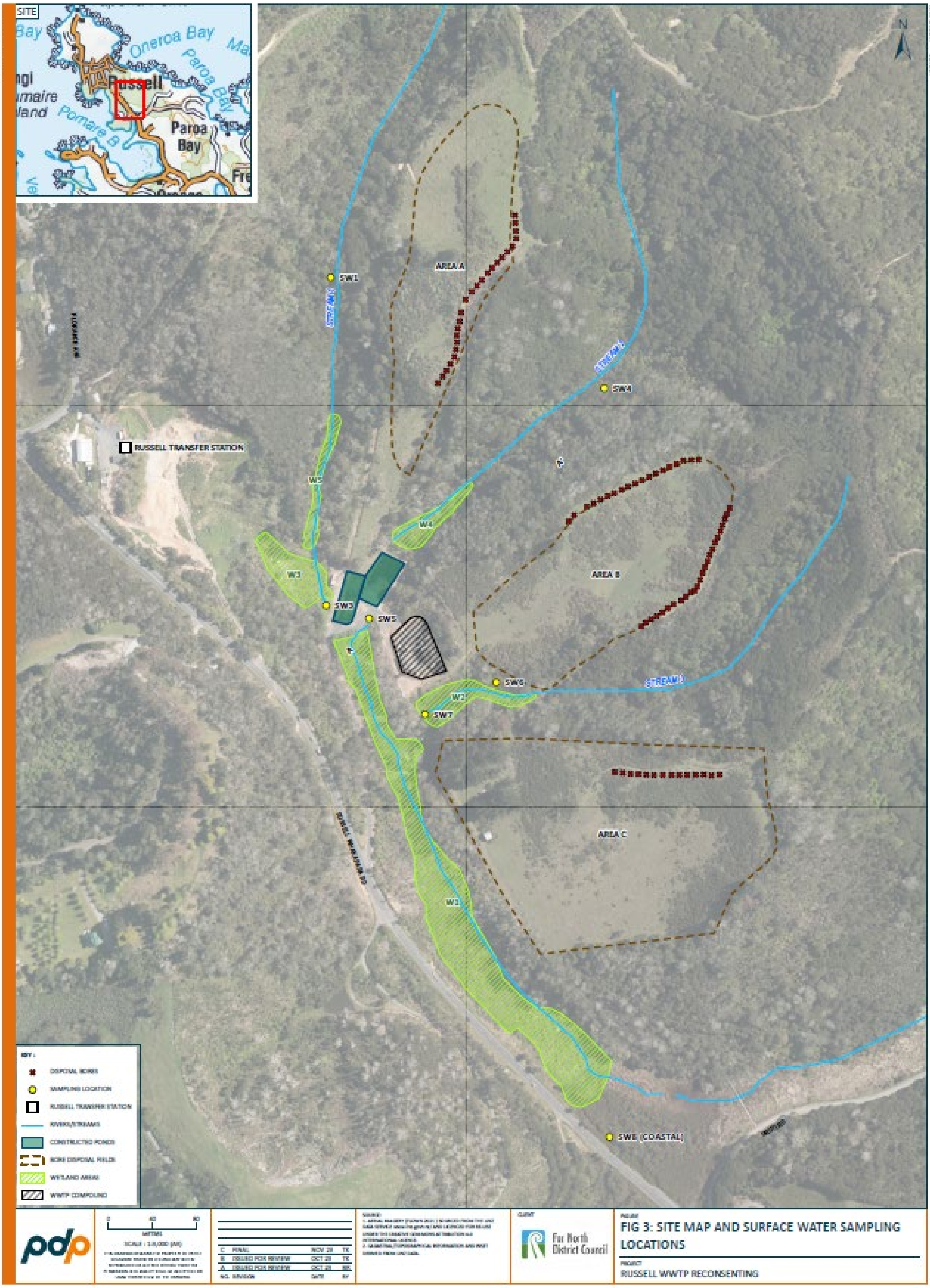


Figure 5: Surface water sampling locations

9.6 Effects on coastal water quality

One water quality sample was taken from the downstream coastal environment (SW8) on 2 October 2023 and has been compared against the water quality guidelines in Table 25 of the pRPN (Appendix D) which maintain ecosystem health, contact recreation and shellfish consumption in coastal waters.

The sample results from SW8 show that the quality of water was below all of the guideline values apart from nitrogen. The guideline value for total nitrogen (TN) is <0.600 g/m^3 however on October 2nd, the grab sample returned a TN concentration of 0.73 g/m^3. It is noted that the guideline values presented in Table 25 of the pRPN are anticipated to be compared to regular, long term water quality results (e.g. monthly monitoring) and then reported as either annual medians or percentile values. Therefore, a single grab sample is not representative of the water quality of the coastal receiving environment through time and provides only indicative results.

The one-off sample result is unsuitable to determine the effects on contact recreation, shellfish consumption or ecosystem health. To support this application, a Qualitative Microbial Risk Assessment (QMRA) (Appendix H) was completed by Crown Research Institute Environmental Science and Research (ESR) and is assessed in Section 9.7.

Considering the KR-WWTP discharge is an ongoing discharge that has been in operation for approximately 20 years, there are no signs within the receiving environment to indicate that it is causing a significant adverse effect on coastal ecosystem health. In addition to this, the wetland habitat assessment on Wetland 1 which the wastewater passes through before reaching the coast, suggests the discharge is only causing a less than minor, and at most potentially minor effect. Therefore, it is reasonable to assume that the discharge is causing a lesser or similar effect on coastal waters.

9.7 Human health effects

The QMRA (Appendix H) provides a technical assessment on the risk associated with being infected by norovirus from discharges from the KR-WWTP when undertaking recreation activities within Uruti bay, the small tributary streams, and Orongo Bay.

The QMRA (Appendix H) first determines the level of risk by identifying the likely hazard, in this case norovirus which is considered the 'worst case' microbial pathogen with available data in New Zealand. An exposure assessment has then been undertaken which considers the dose that the hazardous agent is likely to be ingested, absorbed, or inhaled.

This has then been modelled and compared against the classification criteria for gastrointestinal risk, and what corresponding viral reduction level is required from the KR-WWTP. The KR-WWTP, when operating as designed with the UV unit, is expected to result in at least a 4 $\log_{10}$ viral reduction.

9.7.1 Health effects from contact-recreation

The QMRA has considered the exposure of contact-recreation based on a single day of water-contact recreation. It also takes into consideration that children often spend more time in water and ingest more water than adults. The QMRA has used a conservative ingestion rate of 800 millilitres (ml).

As a conservative surrogate, the QMRA has calculated the health risk to contact-recreation based on the quality of water within the small streams (Streams 1-3, Figure 5), which is where wastewater within the groundwater is known to seep into.

Based on this location, the QMRA calculates that based on a 2 log_{10} viral removal by the KR-WWTP, the risks of norovirus illness from discharge of effluent would equate to a B recreational water quality classification[13]. This is a 1-5% gastrointestinal risk. The KR-WWTP when operating as designed is expected to provide a 4 log_{10} viral reduction, which is modelled to be a 0.2% gastrointestinal risk.

However, it’s important to note that these are not swimming streams, with limited public access. Extended contact-recreation is not only unlikely but also not possible due to the shallow nature of the streams. Uruti Bay is the nearest likely area for contact recreation and the QMRA references previous QMRA’s with discharges in similar coastal environments and notes that hydrodynamic models report dilutions of at least 1000-fold in such marine environments. If this dilution occurred in Uruti Bay, the norovirus risk for contact-recreation would be reduced to a <0.1%. This is considered by ESR to be a less than minor risk.

9.7.2 Health effects from shellfish consumption

Commercial oyster farming operations are present in Orongo Bay, immediately to the south of Uruti Bay. No publicly accessible information was found on recreational shellfish gathering locations.

Bivalve molluscan shellfish feed by filtering large volumes of seawater. This means that they may bioaccumulate contaminants, including viral pathogens. The QMRA has considered the exposure based on a single meal of raw shellfish. There is no similar classification framework for assessing shellfish consumption risk as there is for contact-recreation. However, the QMRA has used the same risk classification as both are voluntary recreational activities in Uruti Bay.

The QMRA concludes that due to the bioaccumulation of viruses by shellfish, the risks associated with this activity are higher than those associated with swimming at the same locations. Based on the surrogate discharge point within

[13] *Microbiological water quality guidelines for marine and freshwater recreational areas* (MfE, 2003)

the small streams, a 5 $\log_{10}$ viral removal would be required for a less than 1-5% gastrointestinal risk. It is considered the KR-WWTP can only achieve a 4 $\log_{10}$ viral removal with its current set up.

The QMRA acknowledges that shellfish would not be present in the surrogate location within the small streams, and considers the risk for shellfish collected from Uruti Bay which would provide additional dilution and viral reduction. Assuming a 1000-fold dilution, the risk of gastrointestinal illness from raw shellfish consumption would be 0.03%.

9.7.3 Summary of health effects

The QMRA concludes that the reduction of viral concentration between the influent to the KR-WWTP and points of likely recreational contact is sufficient to reduce risks of viral illness to a negligible level. This is considered to be a less than minor effect. However, on occasion, during wet weather when inflows are high, the KR-WWTP has previously not performed optimally. During such times, effects may be minor when the KR-WWTP has reduced viral removal. This is not uncommon across New Zealand's wastewater treatment plants and is consistent with public health messaging to not swim in the coast within 48 hours after rainfall. Considering the proposed upgrade to Pond#1 to provide for stormwater overflow, this should reduce this risk to less than minor.

9.8 Effects on ecology

The Ecological Effects Assessment (Appendix F) involved a desktop assessment and was supported by field assessments and the delineation of five wetlands within the receiving environment.

On site, PDP Staff assessed the habitat of the identified wetlands and Streams 1-3. This involved field measurements, in-situ water quality samples, benthic macroinvertebrate community index (MCI) surveys and visual observations. eDNA samples were also taken to gain understanding of the species distribution in the wider catchment. The Ecological Effects Assessment (Appendix F) provides a full explanation of the methodologies used, and the results.

In summary, the results show:

- Stream water quality for DO, temperature and pH met the water quality standards within Table 22 of the pRPN which provides for acceptable ecosystem health. However, the results indicated an upstream-downstream change in electrical conductivity which may be attributable to the KR-WWTP.

- For MCI and QMCI, the scores ranged from 'fair' to 'excellent' which have been assessed against the NPS-FM standards. Monitoring site EC05 located within the Uruti Bay wetland measured below the NPS-FM national bottom-line.
- eDNA results show that bacteria from the KR-WWTP is found within the stream and wetland, which confirms wastewater is migrating into these environments. eDNA from five different species of freshwater fish, plants, cattle, black rat, and for site ECO4, weka and pūkeko was also recorded.

The Ecological Effects Assessment (Appendix F) concludes that MCI survey results did not appear to have been influenced by any change in water quality, with differences in community composition between upstream sites and the receiving environment largely attributed to habitat availability.

The absence of eDNA results for certain fish species upstream could be attributed to a number of factors, including the significant natural change in habitat between the upstream and downstream sampling sites. Further monitoring is suggested to understand the freshwater community composition.

Wetlands onsite are dominated by predominantly tolerant wetland plant species such as raupō with frequent exotic herbs and indigenous rushes and sedges. Increased nutrient levels from discharges may influence pest plant growth in wetlands leading to reduced indigenous plant diversity (Sorrell, 2012). Increased nutrient levels will generally increase the growth rate of species such as raupō which can outcompete other native plant species and increase the production of leaf litter. This can result in greater rates of decomposition leading to increased nutrient levels within the water column.

There was no substantial evidence to suggest that discharges from the KR-WWTP are impacting significantly on wetlands at the site due to the absence of nuisance growth of algae or excessive growth of raupō or exotic pest plants. Vegetation communities were more or less as expected for their position in the landscape.

Effects of the discharge on the hydrological functioning of the wetland are expected based on the locations of the bores as these are hydrologically linked to the wetlands through surface water flow. This may result in small changes in the water levels and hydrological functioning of the wetland however this could not be quantified based on the site visit. Overall, the impact of discharges on the wetlands are considered to be **low**.

Based on the Ecological Effects Assessment (Appendix F) findings, the effects of the KR-WWTP discharge on freshwater and wetland ecology are considered to be less than minor, however the Ecological Effects Assessment (Appendix F) acknowledges that this is based on a limited number of samples and one site visit assessment.

PDP Ecologists have recommended ongoing monitoring which FNDC propose to undertake as covered further in Section 5.4. This monitoring will enable the effects to be measured to ensure they are within an appropriate effects envelope.

9.9 Effects on slope stability

The disposal borefield consists of shallow residual clay material which is susceptible to slope stability issues when steep slopes become saturated due to increased groundwater levels from mounding. The discharge of wastewater into the ground can cause such groundwater mounding and subsequent slope stability.

Groundwater mounding is a localised rise in the groundwater table which can occur when the hydraulic conductivity of the recharge basin is less than the discharge rate into the borefield. Considering the steep hydraulic gradient of the site, excessive mounding can result in additional springs or seeps down gradient of the disposal bore. This increased susceptibility could potentially result in slumping of clay material and overlying topsoil. If evident, this is most likely to occur on lower slopes within the gullies, where slope angles are steepest and groundwater level mounding as result of treated wastewater discharge is likely to be most pronounced.

To monitor the mounding risk, Condition 8 of the previous resource consent required two-weekly monitoring of the observation bores following significant rainfall. The purpose of this monitoring was to provide a regular assessment of groundwater levels against the analytically derived groundwater trigger levels developed by Riley Consultants Ltd (2006) as a 'factor of safety'. No groundwater level monitoring has been undertaken since November 2019. In lieu of recent groundwater level data, Section 8.0 of the PDP Borefield Disposal Performance and Slope Stability Review Report (Appendix E) assesses the long-term risk of the KR-WWTP discharge on slope stability.

PDP's review notes there is no indication of any long-term trends in rising groundwater levels at site as a result of treated wastewater discharge. Previous assessments did indicate high groundwater level fluctuations potentially attributed to groundwater mounding from treated wastewater discharge. However, this has never been conclusively determined due to the non-continuous nature of the groundwater level monitoring. Several minor trigger level exceedances of monitoring bore water levels have been reported. However, previous interpretation of the data has been unable to determine the causes of these exceedances.

Overall, the assessment concludes that despite minor trigger exceedances, there has been no evidence of slope instability or deterioration reported at the site. The historic groundwater level monitoring has been characterised as non-continuous. This is likely because monitoring rounds do not typically coincide with heavy rainfall events, and discharge loading rates have never been concurrently reviewed alongside groundwater level data. As a result, PDP Groundwater scientists consider the previously required fortnightly manual groundwater level monitoring of observation bores to be impractical and onerous for the site, as there is no evidence of slope instability for the previous twenty years of operation. The effects of slope stability are considered minor.

9.10 Effects on air quality

Odour is generated during the treatment of wastewater through the decomposition of organic material present in the effluent or produced in the treatment process.

The Air Quality Effects Assessment (Appendix I) used the FIDOL[14] factors to assess odour risk from the KR-WWTP, as well as an onsite odour assessment by PDP staff. Sensitive receptors, which were defined using the definition in the pRPN were identified. Sensitive receptors within 500 m are listed below in Table 8.

Table 8: Location of Sensitive Receptors located close to the WWTP

Receptor Name	Address	Closest Distance to KR-WWTP (m)	Direction Relative to the KR-WWTP
R1	6169 Russell Whakapara Road	370	Southwest
R2	6169A Russell Whakapara Road	400	West Southwest
R3	43 Florance Avenue	400	Northwest

The Air Quality Effects Assessment (Appendix I) concludes:

- Based on the meteorological data for the area, the closest receptors would only be downwind of the KR-WWTP between 2.1% and 9.4% of the time which is considered infrequent to moderately frequent. As the odour emission rates from the KR-WWTP can vary, there is an even lower probability of higher emissions rates occurring at the same time as low wind speeds blowing in the directions of these receptors.

[14] FIDOL – Frequency, Intensity, Duration, Offensiveness and Location. This assessment is recommended by the Ministry for the Environment Good Practice Guide for Assessing and Managing Odour (MfE GPG Odour).

- During field odour observation undertaken by PDP Staff, the intensity of the odour from the KR-WWTP was typically very weak to weak close to the source, with occasional distinct odours. Within 50 m of the KR-WWTP, the odour became indiscernible, or no odour associated with the KR-WWTP was detected at all.
- The duration of the odour from the KR-WWTP can vary. Some odorous activities like the removal of sludge or screened material can take up to one hour but is infrequent. However, the normal operation of the KR-WWTP would be more constant. Based on PDP's observations and experience at other similar sources when approximately 10 to 50 m from the source, the odour becomes more intermitted as a result of wind fluctuations such as wind direction and wind speed changes.
- There have been no odour complaints received by the NRC for the site, which would indicate that the site operations and management is working well with respect to managing odour.

Based on these finding, odour from the KR-WWTP is currently considered to be having a less than minor effect on the receiving environment, and this is expected to remain the same.

Currently, the KR-WWTP does not have any specific odour control devices. Odour is managed through the wastewater treatment process, by ensuring the KR-WWTP is working at optimal conditions. This level of control appears to be sufficient as there have been no recorded odour complaints. It is considered that FNDC will be able to continue to manage the KR-WWTP so that odour remains at an acceptable level, and effects of odour will continue to be less than minor.

9.11 Natural hazard risk

The Flood and Coastal Risk Assessment (Appendix G) and Section 7.11 conclude that the KR-WWTP is not at risk from coastal inundation or erosion hazards. Furthermore, the NRC hazard maps suggest that the KR-WWTP is not at risk of flood inundation under a 10-year or 50-year Annual Return Event (ARI) flood scenario. However, the constructed Pond#1 which is proposed for refurbishment for overflow storage, and Pond#2 which is currently used, are shown to potentially be inundated under a 100-year plus climate change scenario.

It has been determined that the region wide flood modelling likely did not incorporate the bund height of these ponds given the model outputs and the 5 m grid resolution used for the model. Therefore, the flood hazards are not considered an issue for the site.

In the unlikely event of a flood of this scale, the bunds around the ponds would prevent flood waters entering. To ensure the integrity of the bunds for the life of the consent, FNDC propose to visually assess the structural integrity of the bunds annually. This has been proposed as a condition of consent.

9.12 Conclusion of environmental effects

Overall, the proposal will result in adverse effects that will be minor at most. Consultation with mana i te whenua will inform cultural effects, therefore FNDC will consider further mitigation options (if required) to ensure adverse effects on the environment are avoided where possible or remedied, or mitigated.

10.0 Notification of application

In accordance with s.95A(3)(a) RMA, FNDC request that this resource consent application is publicly notified.

11.0 Statutory assessment

11.1 Introduction

Section 104(1) of the RMA identifies the matters that a consent authority must have regard to (subject to Part 2) when considering an application for a resource consent. The legislation that is relevant for this application are listed in Table 9.

Although the pRPN may give effect to higher order documents, all relevant documents have been assessed in full for completeness. Section 104(1)(b)(vi) RMA states that any decision should have regard to a regional plan. Until the pRPN is made fully operative, the Operative Regional Plans still need to be considered.

The RMA does not distinguish between the weight that should be accorded to the objectives and policies of an operative plan as compared to those in a proposed plan. The requirements of s. 104 RMA for having regard to various matters relate to the exercise of discretion and have been tested in case law.

As directed by the NRC website, the objective and policies of the operative plan have been considered, but as all appeals have been resolved of the pRPN, the objectives and policies of the pRPN should be given greater weight.

Table 9: Relevant s.104(1)RMA documents

s.104(1) subsection	s.104 matter	Document
s.104(1)(b)(ii)	National Environmental Standards	NES-F (See Section 6.4.1)
s.104(1)(b)(iii)	National Policy Statement	NPS-FM
s.104(1)(b)(iv)	New Zealand Coastal Policy Statement	NZCPS
s.104(1)(b)(v)	Regional Policy Statement or proposed regional policy statement	Northland Regional Policy Statement
s.104(1)(b)(vi)	A plan or proposed plan	pRPN RAQP RCP RWSP
s.104(1)(c)	Any other matter	Ngāti Kuta ki Te Rawhiti Hapū Management Plan Kororāreka Marae Society Hapū Environmental Management Plan

11.2 NES-F

The NES-F regulates activities that pose a risk to freshwater health and ecosystems, including activities in and adjacent to natural inland wetlands, riverbed reclamation, and the passage of fish affected by structures.

The KR-WWTP discharge requires resource consent under the NES-F because the discharge is within 100 m of a natural inland wetland and is hydrologically connected to the wetland, as identified in Section 6.4. The NES-F contains no objectives or policies against which to assess the application.

11.3 National Policy Statements

11.3.1 NPS-FM

The NPS-FM provides local authorities with direction of how they should manage freshwater under the RMA. Primarily, the NPS-FM introduces the concept of Te Mana o Te Wai, which refers to the fundamental importance of water and recognises that protecting the health of freshwater protects the health and wellbeing of the wider environment.

Objective 1 of the NPS-FM provides a hierarchy of obligations for Te Mana o te Wai, that prioritises:

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

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

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

Policy 1 requires freshwater to be managed in a way that gives effect to Te Mana o Te Wai. Policy 2 seeks to ensure mana i te whenua are actively involved in freshwater management, and that Māori freshwater values are identified and provided for. Policies 6-9 address extent and values (including habitat) of natural inland wetlands, rivers, and outstanding waterbodies and Policy 12 addresses national targets for water quality improvement.

The proposal has been assessed against the provisions of the NPS-FM in Appendix K) of this report. Overall, the continued discharge from the KR-WWTP is considered to be consistent with the NPS-FM for the following reasons:

- Freshwater quality will be at least maintained by discharging wastewater at the same rate and contaminant load as to what is currently occurring. The limited monitoring is insufficient to accurately confirm if the small streams meet the NOF attribute states. The proposal involves a monitoring regime for the receiving environment to better assess effects against the NOF target attribute states.
- Should the monitoring show that water quality in the receiving environment is degraded, as per the NES-FM definition, the BPO assessment will be updated. The revised BPO will need to consider improved treatment for any options that involve continuing to discharge at this location.
- To allow mana i te whenua to have mana whakahaere in this application, FNDC request that the timeframe for public notification is extended under s.37 (RMA) until mana i te whenua have had sufficient input into the proposal, and the cultural effects of the discharge are understood.

The application is considered to maintain water quality within the receiving environment, and the proposed future monitoring and upgrades will allow for water quality to be improved if required.

Te Mana o te Wai which relates to the health and wellbeing of water covers both the physical properties, but also elements of mauri. The existing monitoring does not indicate that any physical properties of the water are adversely affected to an unacceptable state, however without out mana i te whenua input, the effects on the mauri of the water is unknown. This information will be provided to NRC before a decision is made on this application.

11.3.2 New Zealand Coastal Policy Statement

The ultimate receiving environment for the KR-WWTP is Uruti Bay which is within the coastal marine environment. Therefore, the NZCPS could be considered relevant to this application. The NZCPS objectives and policies which apply to this application relate to natural character, protecting ecosystems and biodiversity, recreation, and the role of mana i te whenua. These have been assessed in the following sections.

Natural character, ecosystems, and biodiversity

Uruti Bay is recognised in the RPS and pRPN as having HNC, and within the pRPN as a SEA, and an area with significant marine mammal and seabird activity. Objective 1 seeks to safeguard the coastal environment by protecting significant natural ecosystems and maintaining the diversity of New Zealand's indigenous coastal flora and fauna. It also seeks to enhance coastal water quality where it may be having a significant adverse effect on ecology or habitat. Policies 11 (Indigenous biodiversity) and Policy 13 (Preservation of natural character) support Objective 1.

The KR-WWTP has been operating for over 20 years within this environment. Whilst this discharge has been occurring, the natural character, and significant ecological values of the bay have been recognised through the RPS and PRPN mapping exercises, which shows that the values remain even with the discharge occurring. FNDC is not aware of any monitoring records for this environment prior to the discharge to assess whether the discharge has degraded the value of Uruti Bay.

To ensure these values are protected and maintained going forward, FNDC propose to monitor the coastal water quality and Uruti Bay wetlands. Should annual wetland assessment monitoring indicate a decline in wetland health and habitat, FNDC will remove pest plants growing within the wetland.

Objective 4 of the NZCPS seeks to maintain and enhance recreation opportunities of the CMA by recognising the CMA is an extensive area of public space for the public to enjoy. Policy 21 seeks to enhance water quality where it has deteriorated so that water-based recreation activities including shellfish gathering are given priority. To do this, Policy 21 directs Regional Councils to identify such areas of coastal water and include them in their plans. Uruti Bay is not a known recreational bay and is not listed in the NRC maps as such. It is also not monitored as part of the recreational swimming programme.

Despite this, the QMRA results show that the Uruti Bay is safe for contact recreation. As for shellfish consumption, Orongo Bay, around the headland from Uruti Bay which is the most likely location for shellfish gathering, has the equivalent of an A recreational water categorisation, which is a <1% gastrointestinal illness risk, even if only a 3 $\log_{10}$ removal from the KR-WWT was occurring. This would reflect water quality from the KR-WWTP under suboptimal performance.

FNDC propose to undertake regular water quality monitoring within Uruti Bay to compare against the water quality standards in Table 25 of the pRPN – Coastal Water Quality Standards. This will allow coastal recreation risk to be continually assessed.

Role of Tangata Whenua

Objective 3 requires applicants and decision makers to take into account the principles of the Treaty of Waitangi, and the role of Tangata Whenua as kaitiaki, and to provide for involvement in the management of the coastal environment. This is supported by Policy 2, which extends to recognising the traditional and cultural relationships with areas of the coastal environment and providing opportunities for Māori involvement in decision making with consent applications and taking into account iwi management plans.

Uruti Bay, the primary coastal receiving environment is not identified as a culturally significant location, nor are the small tributary streams. However, FNDC do not want to proceed with the processing of this application, until mana I te whenua have had more opportunity to input into the application, to provide for mana whakahaere.

The Iwi Environmental Management Plans for Ngāti Kuta and Kororāreka Marae Society have been assessed in Section 11.5.5 below.

11.4 Northland Regional Policy Statement (RPS)

The RPS provides an overview of resource management issues within Northland, including those in the coastal marine area. It sets out the general objectives, policies and methods to be used in the region as a whole to achieve integrated resource management.

The RPS has been operative since May 2016. An assessment against the relevant provisions of the RPS is included in Appendix K).

The proposal is considered consistent with the following provisions of the RPS:

- Objective 3.4 and policy 4.4.1 which relate to maintaining and protecting SEA and habitats. The significance of the habitats has been identified while the discharge from the KR-WWTP has been occurring, and further monitoring of the habitat will ensure its values continue to be maintained. This also includes policy 4.6.1 for natural character since natural character values are based on the high wetland values.
- Objective 3.7 and policies 5.3.2 and 5.3.3 which relate to RSI.
- Objective 3.8 and policies 5.21 and 5.2.2 which relate to the efficient and effective use of infrastructure, which aligns with FNDC's proposal to upgrade and optimise the performance of the KR-WWTP.
- Once further consultation with mana i te whenua has occurred, the proposal intends to be consistent with objective 3.12 and policy 8.1.1 as mana I te whenua will have had the opportunity to be involved in developing the proposal. Furthermore, FNDC is requesting a publicly notified application to ensure all opportunities for involvement, not just that with direct consultation.

The proposal is not considered consistent with the following provisions of the RPS:

- Water quality objective 3.2 and policy 4.2.1 which strive to improve overall water quality within Northland. The proposed contaminant load in the quality of the discharged wastewater is intended to maintain the existing discharge quality. However, since the RPS was written, the pRPN has been produced which establishes freshwater quality objectives and settings which Policy 4.2.1 of the RPS directs. The water quality will be monitored, and if required, improved, to meet those freshwater standards in Appendix H.3 of the pRPN.

11.5 Regional Plans

11.5.1 Proposed Northland Regional Plan

The pRPN – Appeals Version was updated in October 2023. All rules and relevant objectives and policies relating to the proposal have been resolved.

Appendix K provides a full assessment of the objectives and policies of the pRPN that relate to the discharge of wastewater. This section summarises the key objectives and policies.

Water uality

Objective F.1.2 and policy D.4.1 provide strong direction regarding what is required for resource consents that discharge into water. Although this discharge is understood to first discharge into land, above the groundwater table, due to the close proximity and uncertainty about the water level relative to the discharge point, the application has been assessed against this policy as a precautionary. The first requirement of policy D.4.1 is for water quality to be maintained. To demonstrate this, FNDC propose to commence monthly water quality monitoring of the receiving small streams and groundwater monitoring. As the proposal is to continue with the existing effluent quality limits, water quality will be maintained.

The second requirement of policy D.4.1 is to improve water quality if the standards in H.3 are not met. The limited sampling undertaken to date is too small of a sample set to be conclusive. For some parameters, the standards in H.3 were not met. FNDC propose to reassess how well the receiving environment compares against the standards in H.3 after two years of regular monitoring. This will enable a better indication of whether the receiving environment water quality needs to be improved or not to meet water quality standards in Appendix H.3 pRPN.

Under requirement (4) of policy D.4.1 if after two more years of monitoring it is determined that further treatment at the KR-WWTP is required to improve the state of the receiving environment, FNDC will update the BPO and implement upgrades within the term of the consent.

Natural Character, SEAs and Marine Mammal and Seabird Life

The Natural Character of the Uruti Bay wetland (Wetland 1) is due to the high values of what has been assessed in the Ecological Assessment. The Ecological Effects Assessment demonstrates that the discharge does not result in significant adverse effects to the Uruti Bay mangrove vegetation.

Policy D.2.7 provides for minor adverse effects from the operation of RSI. The AEE concludes for all matters except cultural effects, which are yet to be fully assessed, will be minor at most.

The BPO process, demonstrates the functional need for the discharge, and that at present, continuing the discharge at this location is the BPO. FNDC propose to revise the BPO once cultural effects are known.

The proposal is considered to be generally consistent with the direction of the pRPN, over the duration of the consent. It is recognised that there is insufficient data on the receiving environment to conclude as to whether further upgrades are required, however there is sufficient evidence that the discharge does not result in significant adverse effects which is considered an acceptable standard for two years until further monitoring data has been collected and assessed.

11.5.2 Regional Air Quality Plan (RAQP)

The RAQP has three objectives, objectives one and two are relevant to this proposal as they relate to the avoiding, remedying or mitigating adverse effects of discharges to air to the environment and the maintenance of the of the environment form offensive and objectionable discharges of odour.

These two objectives are supported by the following policies:

- Policy 1 – Maintaining the existing high standard of ambient air quality.
- Policy 2 – Avoid, remedy or mitigate the adverse effects generated by discharges to air.
- Policy 3 – Recognise that many activities which discharge contaminants to air have a minor effect on the quality of Northlands air quality.
- Policy 6 – Where necessary, apply the BPO to discharges of contaminants to air.
- Policy 7 – Recognise that discharges of contaminants to air may adversely affect other receiving environments.
- Policy 10 – To promote the integrated management of natural and physical resources in order to avoid, remedy or mitigate the adverse effects of discharges of contaminants to air.

The Air Quality Effects Assessment (Appendix I) and assessment in Section 9.10 consider the effects of odour from the KR-WWTP will be less than minor, which is consistent with the objectives and policies of the RAQP.

11.5.3 Regional Coastal Plan (RCP)

The RCP is split into different topics affecting the coastal environment. The following objectives and policies are considered relevant to this proposal:

- Natural Character
  - Objective A – Preservation of Natural character
  - Policy 1 – Recognising all parts of the coast have some natural character that needs protecting.
  - Policy 6 – To promote an integrated approach to preservation of the natural character of the coast.
  - Policy 7 – To promote where appropriate, the restoration and rehabilitation of natural character on the coast.
- Protection of Significant Indigenous Vegetation and habitats

  - Objective A – The protection of areas of significant indigenous vegetation within Northland’s coastal marine area from the adverse effects of subdivision, use and development.
  - Objective C – Greater integration between land management planning, catchment management planning and marine (or coastal) environment planning leading to a reduction in the sediment and nutrient runoff.
  - Policy 7 – To avoid where practicable, the introduction and spread of exotic species which represent a threat to significant indigenous vegetation.
  - Policy 8 – To promote, when appropriate, the restoration and rehabilitation of degraded areas of significant indigenous vegetation.
- Protection of habitats of indigenous fauna
  - Objective A – The protection of significant habitats of indigenous fauna within Northland’s coastal marine area.
  - Policy 2 – Provide for restoration and enhancement of significant habitats of estuarine and marine fauna.
  - Policy 4 – Avoid where practicable the introduction and spread of exotic species which represent a threat to natural character.

The HNC of the coast within Uruti Bay is recognised for the wetland values which are significant indigenous and vegetation habitats. The HNC and habitat values have been assigned to Uruti Bay while the KR-WWTP discharge has been occurring. The Ecological Effects Assessment (Appendix F) has concluded that the effects of the KR-WWTP discharges on the wetlands to be low. The restoration of the Uruti Bay wetland is only to be undertaken if monitoring shows that the nutrients from the discharge are contributing to pest plant growth within the wetland.

- Recognition of the provision for Māori and their culture and traditions
  - Objective 1 – Management of the natural and physical resources within Northland’s coastal marine area in a manner that recognises and respects the traditional and cultural relationships of Tangata whenua with the coast.
  - Policy 1 – Recognise and as far as possible, provide for concerns and cultural perspectives of Tangata whenua.
  - Policy 2 – To recognise and, as far as practicable, provide for the concerns and cultural perspectives of Tangata whenua in regard to the disposal of waste into water.

  - Policy 4 – To investigate options for involving Tangata whenua in monitoring the effects of use, development and protection of resources within the coastal marine area.

Policy 2 relates to the discharge of waste into water. The CGM assumes the wastewater to be discharged into land, above the water table. However, as this is conceptual only, and it is known that the wastewater infiltrates into the close receiving environment, this policy has been assessed as a precautionary measure. Therefore, this policy should still be considered. To recognise the importance of mana I te whenua input into this resource consent decision, FNDC request that the public notification of this application is delayed under s.37 (RMA) until sufficient engagement has been undertaken. This will allow all cultural effects to be identified and avoided or mitigated if required.

- Water quality and discharges to water
  - Objective 1(Discharges) – Avoid the effects of discharges of contaminants to the CMA and mitigate adverse effects when unavoidable.
  - Policy 1 – The maintenance, and where practicable, enhancement of water quality within Northland's coastal marine area.
  - Policy 2 – As far as practicable, to identify any parts of the coastal marine area which are, or which have the potential to be, significantly degraded by use and development and institute appropriate remedial action giving priority to areas of high use by the general public.
  - Policy 1 (Discharges) – Consider the BPO for discharges from wastewater treatment plants.
  - Policy 2 (Discharges) – Progressively eliminate direct discharges of human sewage to the CMA.
  - Policy 3 (Discharges) – Establish whether wastewater discharges give rise to s107 effects.
  - Policy 4 (Discharges) – Ensure individual and cumulative discharges to the CMA do not compromise the maintenance of coastal water quality.

The objectives and policies of the RCP are no more onerous on wastewater discharges than those in the pRPN. Specific to existing wastewater discharges is Policy 1, which is to consider the BPO. The BPO assessment findings for the KR-WWTP are described in Section 3.0. The effects of the discharges on water quality will be regularly monitored going forward, and the process adapted to meet environmental limits to provide more certainty that the effects are no more than minor.

There is no evidence to suggest that the existing discharge is inconsistent with Policy 3.

- Air Quality
  - Objective 1 – To maintain the high standard of air quality within Northland's coastal marine area.
  - Objective 2 – To achieve the integrated management of coastal air quality across the administrative boundary of the line of Mean High Water Springs.
  - Policy 2 – recognition that discharges to air can drift to the CMA.

As assessed under the RAQP, the effects of odour on the environment, including the CMA have been assessed as low, therefore the activity is considered consistent with these objectives and policies.

11.5.4 Regional Water and Soil Plan (RWSP)

Section 8 of the RWSP addresses discharges. The following objectives and policies within the RWSP are considered relevant to this proposal:

- Objective 1 - The effective treatment and/or disposal of contaminants from new and existing discharges in ways which avoid, remedy or minimise adverse effects on the environment and on cultural values.
- Policy 2 - To require by the year 2004 or according to an upgrading programme established as part of the conditions on a discharge permit all existing discharges of sewage or discharges with a high organic content to be: (a) By land disposal; or (b) To water, if after reasonable mixing: (i) it does not cause a discernible adverse change in the physicochemical and/or microbiological water quality of the receiving water at the time of discharge; and (ii) it is the best practicable option (as defined by Section 2 of the Act).
- Policy 3 - To ensure there are adequate separation distances between water bodies and discharges to land to avoid or mitigate adverse effects on water quality.
- Policy 4 - To promote effective effluent treatment and disposal systems which are: (a) Low maintenance and low risk; (b) Land based, where the soil types, available disposal areas, back-up facilities and pumping systems are adequate.

The CGM shows that in theory the KR-WWTP disposal boreholes are above the water table, therefore the discharge is considered to land, therefore it meets the criteria of Policy 2. However, the small stream water quality sampling has confirmed that treated wastewater is migrating into the freshwater environment. This is inconsistent with Policy 3. Existing issues with the bore infiltration also mean the discharge method is not entirely consistent with Policy 4. Provided the bore cleaning trial is successful, and the KR-WWTP is maintained in accordance with the OMP, the discharge from the KR-WWTP is considered to be the BPO.

11.5.5 Section 104(c) Other matters

11.5.5.1 Ngāti Kuta ki Te Rawhiti Hapū Management Plan (NK-HMP)

Chapter 4 is the roopu mana taiao, which addresses how Ngati Kuta would like the environment to be managed.

Policy 4.5.4 relates to consultation, and acknowledges that Ngati Kuta can be consulted directly, and that involvement should not necessarily be limited through formal RMA processes. Policy 4.5.5 is for applicants to appreciate that Ngati Kuta have limited resources. FNDC has considered this policy, and have requested that public notification of this application is delayed under s.37 of the RMA so Ngati Kuta have an opportunity and time to effectively be involved in this application. Further, in accordance with policy 4.5.7, reliance on the Hapū Engagement Plan does not constitute engagement, and consultation needs to be kanohi ki te kanohi.

Section 5 of the NK-HMP relates to resource consent consultation post lodgement with NRC. FNDC has requested that the application is publicly notified, therefore Ngati Kuta will also have an opportunity to submit on the application as part of that process.

Sections 2.1.1 relates to ecosystem quality and requires strict methods of management to be implemented to maintain ecosystem quality. The proposed monitoring of the receiving environment is considered to comply with this.

Section 2.1.2 relates to water quality and acknowledges that this is the most important food basket, but also a place where children play, learn and grown. The water quality in the small streams is not considered suitable for contact recreation, but as assessed in section 9.7, it is also not an easy place to access nor is the water deep enough to be exposed to for a significant period of time. Additionally, the QMRA has assessed the risk of gastrointestinal illness from collecting shellfish and contact recreation to be less than minor in locations where this is likely to happen.

Section 2.4.1 (b) specifically relates to sewage and that current sewage treatment and disposal is of serious concern to Ngati Kuta. The existing treatment from the KR-WWTP is not optimal, however the proposed upgrades to balance flow, improve UV performance, and bore remediation will directly improve the wastewater discharged to the receiving environment.

Section 2.4.2 (a) relates to water quality in the CMA, and requires water quality to be maintained, and that this is an over-riding policy. The one-off water quality sample taken shows that water quality within the coastal environment generally meets the standard set in the pRPN Table 25 for coastal water quality, except for TN. However, a one-off sample cannot provide a robust assessment of water quality. FNDC propose to revise the BPO assessment after two years of freshwater quality monitoring.

11.5.5.2 Kororāreka Marae Hapu Environmental Management Plan (KM-EHMP)

The KM-EHMP establishes Kororāreka Marae environmental baselines and tools to help achieve and protect taonga within the Kororāreka rohe. The KM-EHMP goals relating to water are:

- *Kororāreka Marae asserts and exercises rangatiratanga and kaitiakitanga over waters within the Kororāreka rohe.*
- *Protect and enhance the mauri for future generations.*
- *Protect maintain and enhance nga wai tai to ensure that the ability of our moana to produce is sustained.*

The KM-EHMP directs this to be done through promoting the involvement in resource consent conditions and involving the KMSCI in review processes for resource consents. FNDC has commenced consultation with KMSCI and invite KMSCI to help refine the draft conditions of consent so that cultural values are protected. This may include the identification of suitable environmental performance indictors to help monitor the mauri of the water.

Tauranga ki Ika describes KMSCI’s goals, issues, policies and methods for protecting and enhancing fisheries within Kororāreka. Should mahinga kai be identified by KMSCI within Uruti Bay, FNDC will recognise and seek to protect it from adverse effects from the discharge of wastewater through the implementation of the proposed AMA.

With the proposed monitoring and revision of the BPO with KMSCI’s values, and KMSCI’s input into conditions of consent, the proposal is considered to be consistent with the overall direction of the KMSCI’s EHMP.

11.5.5.3 Compliance history

The Natural and Built Environment Act 2024 (NBEA) came into force on 23 August 2023. Currently resource consents continue to be processed under the RMA, however the NBEA provides for regulatory authorities to consider the compliance history of an applicant when determining any consent application.

Compliance history is also a matter NRC is to have regard to when determining a resource consent duration through Policy D.2.14 of the pRPN. FNDC’s compliance with the exiting KR-WWTP consents is reported in section 4.0.

11.6 Part 2 - Purpose and Principles

Recent case law[15] has directed when decision making should employ "*an overall broad judgement*" in respect of resource consent applications. As found by the Court of Appeal in *RJ Davidson*, it would be "*appropriate and necessary*" to refer to Part 2 when considering consent applications, but only where there is doubt that a plan has been "*competently prepared*" under the RMA.

The matters listed in Part 2 of the RMA of relevance to this resource consent application have been given adequate regard in the NPS-FM, NZCPS and pRPN in particular.

The proposal is consistent with the policy direction of these documents. As such, it is not necessary to revisit Part 2 of the RMA or make an overall broad judgement consistent with the Court of Appeal direction in *R J Davidson.*

12.0 Conclusion

FNDC is applying for a replacement consent for the discharge of wastewater into land where it will enter groundwater, and the associated discharge of contaminants to air from the KR-WWTP.

The selection of the continued discharge of wastewater to the disposal borefield is considered to be the BPO at this time. This is in the context of the KR-WWTP already operating for approximately 20 years and the continuance of this option being most affordable for the local community when compared to other available options.

Overall, when bundled, a resource consent is required under the pRPN and the NES-F as a non-complying activity. The proposed discharge activity has been assessed against the statutory requirements of the RMA including the NES-F, NPS-FM, NZCPS, RPS, pRPN and the operative regional plans.

It is considered that the adoption of the BPO, and the proposed AMA to update the BPO achieves an outcome which is consistent with statutory provisions and with the provisions set out in Part 2 of the RMA.

---

[15] *RJ Davidson Family Trust v Marlborough District Council [2018] NZCA 316.*

Appendix A: Record of Title

RECORD OF TITLE
UNDER LAND TRANSFER ACT 2017
GAZETTE NOTICE

Search Copy

R.W. Muir
Registrar-General
of Land

Identifier	**100427**
Land Registration District	**North Auckland**
Date Registered	03 July 2003 09:00 am

Prior References
NA311/261

Type	Fee Simple	**Instrument**	GN 5644054.1
Area	37.4620 hectares more or less		
Legal Description	Section 1 Survey Office Plan 310696		
Purpose	Sewage treatment and disposal and landfill		

Registered Owners
Far North District Council

Interests

Subject to a right of way and right to convey electricity and telecommunications over part marked N on DP 414711 created by Easement Instrument 9243789.12 - 18.12.2012 at 10:36 am

The easements created by Easement Instrument 9243789.12 are subject to Section 243 (a) Resource Management Act 1991

Extract from *New Zealand Gazette*, 22/5/2003, No. 53, p. 1381

Land Acquired for Sewage Treatment and Disposal, and Landfill Purposes—Russell Road, Russell

Pursuant to section 20 (1) of the Public Works Act 1981, and to a delegation from the Minister for Land Information, Stephen Robert Gilbert, Land Information New Zealand, declares that, an agreement to that effect having been entered into, the land described in the Schedule to this notice is hereby acquired for sewage treatment and disposal, and landfill purposes and vested in the Far North District Council on the date of publication of this notice in the *New Zealand Gazette*.

Schedule

North Auckland Land District—Far North District

Area ha	Being
37.4620	Part Lot 2, D.P. 13738; shown as "Section 1" on S.O. Plan 310696 (part Computer Register NA311/261).

Dated at Christchurch this 9th day of May 2003.

S. R. GILBERT, for the Minister for Land Information.

(LINZ CPC/1998/1023)

ln3178

NOTICE NO: 3178

Appendix B: Best Practicable Option

Kororāreka/Russell Wastewater Treatment Plant Discharge Reconsenting – Best Practicable Options Assessment

Prepared for

Far North District Council

November 2023

PATTLE DELAMORE PARTNERS LTD
Level 5, PDP House
235 Broadway, Newmarket, Auckland 1023
PO Box 9528, Auckland 1149, New Zealand

Tel +64 9 523 6900
Web www.pdp.co.nz

solutions for your environment

Quality Control Sheet

TITLE	Kororāreka/Russell Wastewater Treatment Plant Discharge Reconsenting – Best Practicable Options Assessment
CLIENT	Far North District Council
ISSUE DATE	28 November 2023
JOB REFERENCE	A03576827

Revision History

REV	Date	Status / Purpose	Prepared By	Reviewed by	Approved
1	28/11/23	Final	Lucy Douglas	Wageed Kamish	Daryl Irvine

DOCUMENT CONTRIBUTORS

Prepared by

SIGNATURE

Lucy Douglas

Reviewed by

SIGNATURE

Wageed Kamish

Approved by

Daryl Irvine

Limitations:

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Far North District Council. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This report has been prepared by PDP on the specific instructions of Far North District Council for the limited purposes described in the report. PDP accepts no liability if the report 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.

Table of Contents

Table of Figures

Table of Tables

1.0 Introduction

Far North District Council (FNDC) maintains the Kororāreka/Russell Wastewater Treatment Plant (KR-WWTP) (the Plant), which treats wastewater produced by the township of Kororāreka/Russell including from Tapeka Point. The KR-WWTP was constructed in the 1990s after concern was raised about groundwater contamination from the septic tank system. FNDC currently holds resource a consent (AUT.008339.01.03) with the Northland Regional Council (NRC) for the discharge of treated wastewater (including Russell Landfill leachate) to ground via disposal boreholes. This consent expires on 30 April 2024 and to continue with operation a new consent application needs to be lodged before 30 November 2023.

The consent (AUT.008339.02.03) related to the discharge of contaminants to air is also expiring on 30 April 2024 is dealt with separately.

Schedule 4 of the RMA: Information required in application for resource consent, Section 6.1, states that *"an assessment of the activities effects on the environment must include the following information…:*

> *(a) if the activity includes the discharge of any contaminant, a description of…-*
>
> *(ii) any possible alternative methods of discharge, including discharge into any other receiving environment...*

Pattle Delamore Partners Limited (PDP) has been engaged by FNDC to prepare a Best Practicable Options (BPO[1]) assessment of possible alternative discharge options for the KR-WWTP, to form part of the consent application.

This report provides a summary of the assessment of the BPO for the disposal of KR-WWTP treated wastewater, including:

- Possible alternative methods of discharge; including discharge into alternative receiving environments.
- Selection and justification of the best practicable option for the WWTP upgrade and discharge receiving environment.

This report should be read in conjunction with the *Performance Assessment report for the KR-WWTP* (PDP, 2023) in which the current performance and issues of the KR-WWTP are discussed.

[1] The BPO definition in Section 2 of the RMA was used in this report.

2.0 Background information

2.1 Site Description

The KR-WWTP and associated bore disposal field are located approximately 1.5 km southeast of the Kororāreka/Russell township and east of Matauwhi Bay. The KR-WWTP is situated on a reasonably flat parcel of land. The land to the northeast of the WWTP is relatively steep and consists of a series of three ridgelines and associated valleys. The bore disposal fields are located along these ridgelines. Three small unnamed streams drain these ridgelines, flowing from the northeast to southwest and discharge into a natural wetland located to the southwest of the WWTP.

The KR-WWTP receives wastewater from the Kororāreka/Russell and Tapeka Point communities in addition to small quantities of leachate from the adjacent closed landfill. The closed landfill is located approximately 300 m northwest of the WWTP site. Treated wastewater is discharged into ground via bore injection over 85 bores split across the three ridgelines previously mentioned.

Error! Reference source not found. presents the location of the KR-WWTP and the associated bore disposal field used for treated wastewater discharge to ground. The WWTP consists of a sewage treatment plant compound with two Sequencing Batch Reactor (SBR) tanks. Two constructed ponds are situated to the north of treatment compound. Pond 2 (wetland 2) currently receives SBR overflow, filter backwash and landfill leachate while Pond 1 (wetland 1) is currently not operational. These ponds are both bunded. The ponds were originally constructed as part of the treatment train to hold decanted water from the SBRs prior to discharge into the filters, but are no longer used for that purpose.

2.2 Resource Consent Conditions

The KR-WWTP holds a resource consent (AUT.008339.01.03) with NRC to discharge 1,235 m^3/day of treated effluent (midnight to midnight) to disposal bores located to the north of the Plant (Areas A, B and C in Figure 1).

The Plant can also receive a 7-day rolling average of 5m^3/day of landfill leachate from the Russell Landfill.

The current water quality determinants for the treated wastewater are listed in Table 1.

Table 1: Water Quality Requirements

Parameter	Discharge Limits	
	Rolling Median	Rolling 90th Percentile
Five Day Biochemical Oxygen Demand (BOD_5) (mg/L)	10	25
Total Suspended Solids (TSS) (mg/L)	10	25
Total Kjeldahl Nitrogen (TKN) (mg/L)	20	40
Total Phosphorus (TP) (mg/L)	15	30
E. coli (cfu/100 mL)[1]	50	-

Notes:

1. *A maximum of 1,000 cfu/100mL in any single sample*

This consent expires on 30 April 2024 and to continue with the current discharge a new application must be lodged with NRC before 30 November 2023.

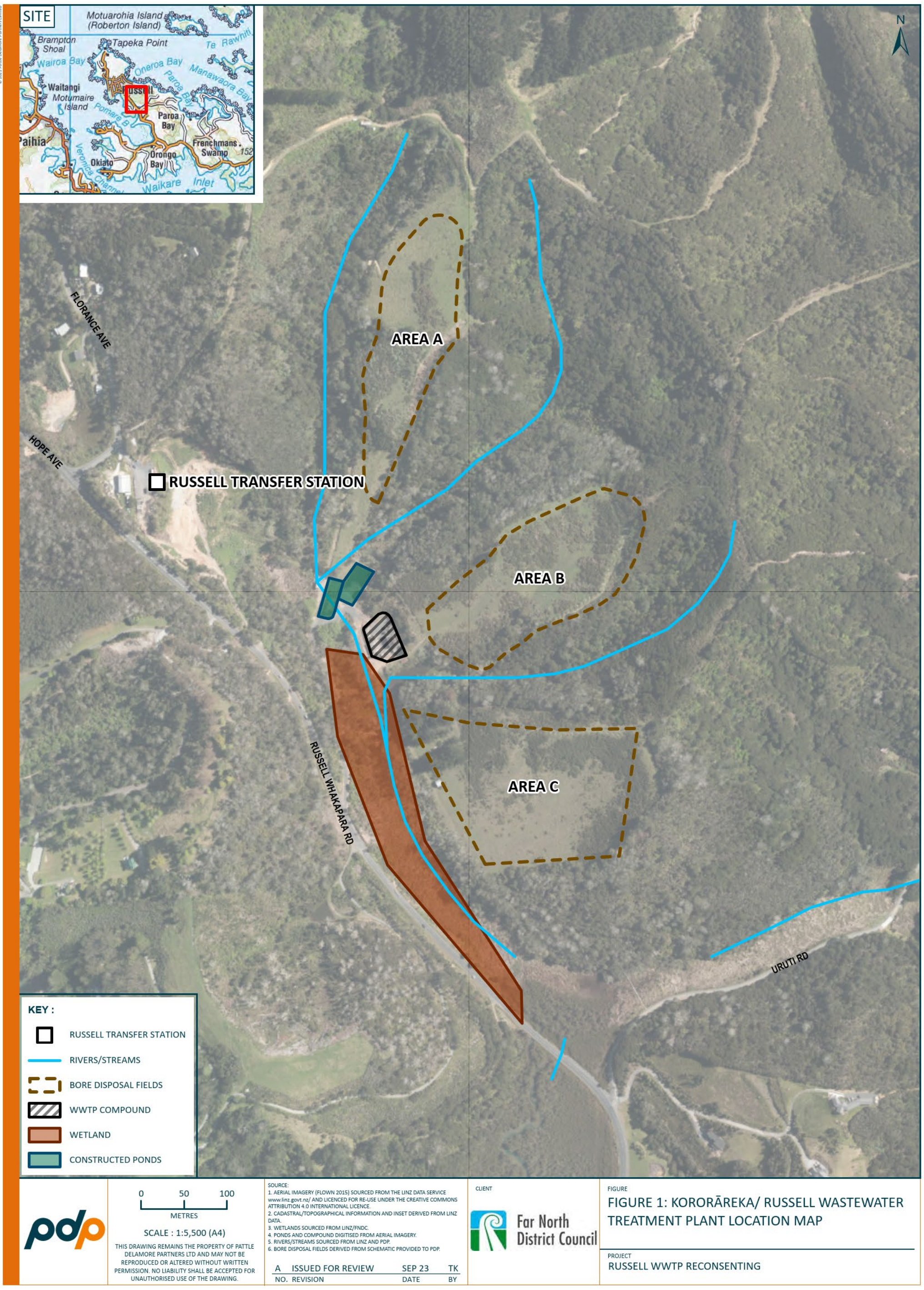


Figure 1: Kororāreka / Russell Wastewater Treatment Plant Location Map

2.3 Existing System

The existing WWTP receives wastewater flows from the residential and commercial areas into two Sequencing Batch Reactors (SBRs). The SBR phases are offset in time so that one SBR can always be filling.

The SBR phases consist of:

- Aeration/Fill Phase: For biological removal of BOD and biological nitrification.
- Settle Phase: For settling of biological solids (mixed liquor suspended solids).
- Decant phase: For decanting treated wastewater.

From the SBRs water is pumped through sand filters before going through UV treatment. The treated effluent is then discharged into a series of boreholes.

The waste activated sludge (WAS) is removed from the SBRs into WAS tanks and removed every 2 to 3 days to be transported off-site for disposal.

A block flow diagram of the process is presented in Figure 2.

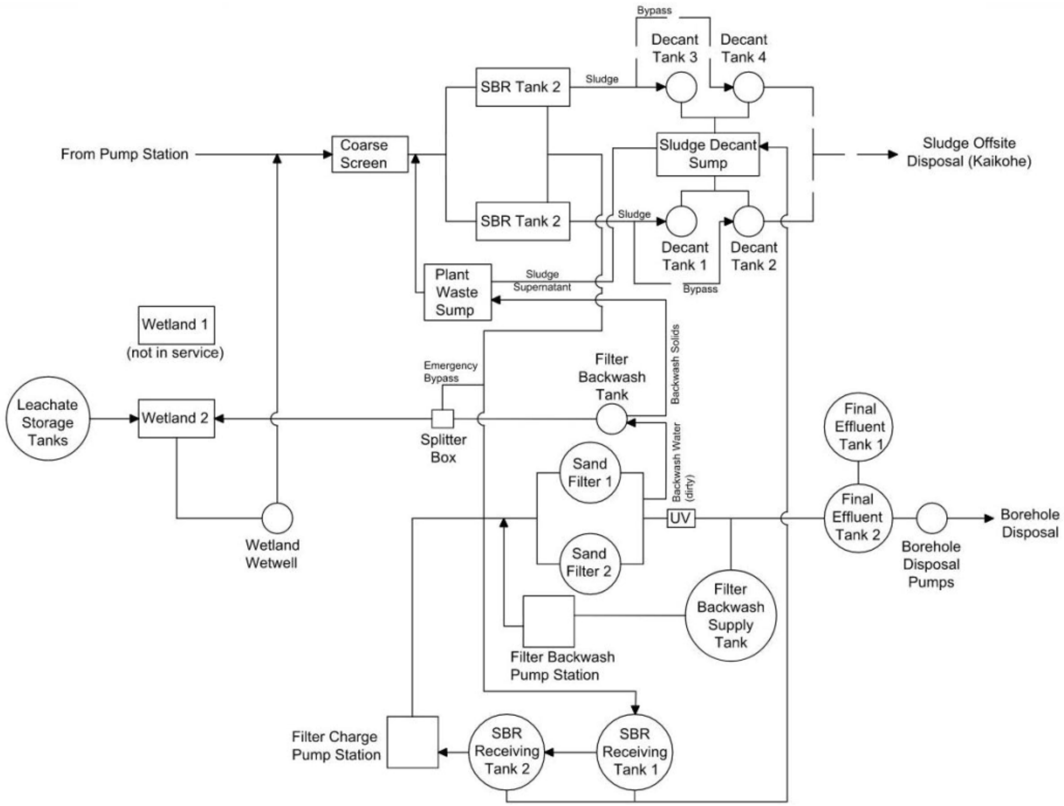


Figure 2: Block Flow Diagram for the KR-WWTP (FNDC, 2023)

2.4 Predicted Flows and Loads

The Performance Assessment report for the KR-WWTP (PDP, 2023) lists the methods used to analyse the current flows and loads into the plant, and into the future. According to population forecasts flows and loads are not expected to change significantly at least until after 2073.

3.0 Receiving Environments

The Kororāreka/Russell Wastewater Treatment Plant is located less than 1 km to the southeast of the Kororāreka/Russell township. Kororāreka/Russell is located on a peninsula in the Bay of Islands. The treatment plant is approximately 500 m from Pomare Bay and 900 m from the ocean on the other side of the peninsula.

3.1 Climate

The mean annual rainfall recorded at Russell between 2020 and 2023 is 1,825 mm. The monthly variation is shown in Figure 3 where it can be observed that rainfall is higher in the winter than the summer. However, three years is not a long dataset and therefore the trends are indicative only.

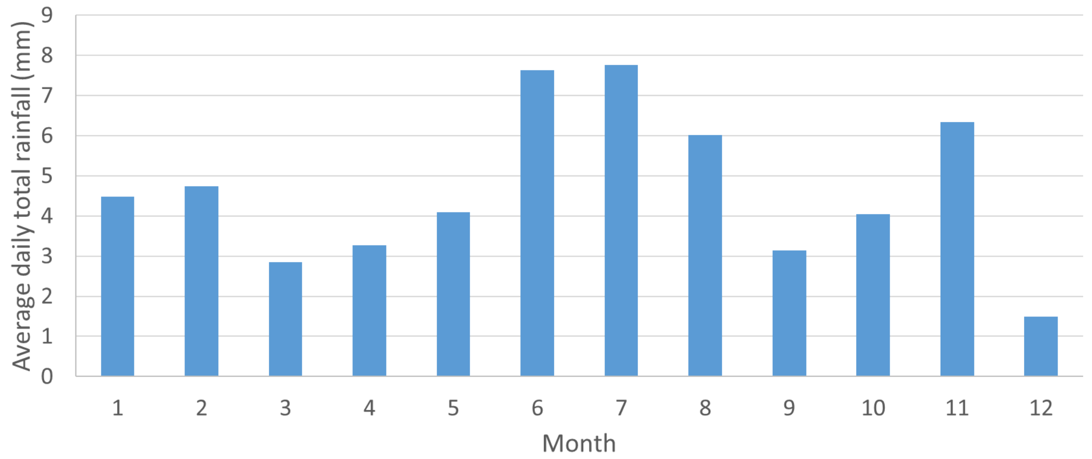


Figure 3: Graph of the average daily rainfall for each month between 1st July 2020 and 31st July 2023

3.2 Land Use

The land that the Kororāreka/Russell Wastewater Treatment Plant is located on including the bore hole fields, is zoned as 'General Coastal' in the Far North District Plan. This appears to consist of sparsely populated, vegetated areas. On the other side of Russell Road is a 'Coastal Living' zone. The township of Kororāreka/Russell is less than 1 km away.

3.3 Surface Water

The closest surface water to the plant is a stream that is between the main plant and the wetlands. The stream travels just over 500 m to a mangrove filled estuary that leads into Uruti Bay. The NRC Natural Hazards GIS Viewer indicates that the WWTP ponds (wetlands) are in the 100-year flood zone.

Due to very small flow observed in the stream below the KR-WWTP, no flow measurements were undertaken as part of this study. However, the 1 in 5-year low flow and Mean Annual Low Flow (MALF) (nzsegment: 1008207) obtained from NIWA's NZ River Maps (Whitehead and Booker, 2020) were estimated at 1.76 L/s and 2.49 L/s, respectively.

3.4 Land

3.4.1 Geological and Geohydrological Setting

The Kororāreka/Russell Peninsula has steep to moderate hills with little flat land. It is underlain by Waipapa Group sandstone and siltstone based on the GNS Geology Map. According to the Landcare Research Soil Portal the underlying soils of the peninsula are imperfectly draining Albic Ultic.

The disposal site geology is comprised of Waipapa Group Greywacke Formation, characterised by variable weathering, fracturing and associated formation permeability.

The shallow sub-surface (top of the weathering profile) is characterised by a mantle of approximately 2 to 6 m of low permeability Rangiora clay (completely weathered Greywacke), characterised by clay loam and silty clay loam (RA and RAH; NRC GIS Layer: Managing Northland Soils).

Beneath the completely weathered residual soil zone, moderately to highly fractured Greywacke extends to approximately 24 m bgl (below ground level) (EBG, 2001; PDP, 2021). At increased depths (>24 m bgl) Greywacke generally becomes increasingly unweathered, although a degree of fracturing is anticipated to persist with depth.

3.4.2 Flora and Fauna

Kiwi are found around the treatment plant and wider peninsula. In 2018 the Department of Conservation has classified the area as having a high-density Kiwi population (more than 5 calls per hour).

3.5 Marine

There are both coastal and Estuarine environments within 6 km of the treatment plant. There is coast on both the northern and southern sides of the plant, with the estuary being to the south.

3.5.1 Coastal

There are numerous small sandy bays and rocky outcrops along the edge of the Kororāreka/Russell Peninsula where the KR-WWTP is located.

Pomare Bay is located to the southwest of the KR-WWT. This bay along with the Veronica Channel separates Kororāreka/Russell from Paihia.

To the north of the treatment plant is Oneroa Bay. A popular swimming location. The smaller Opito Bay is also to the north of the treatment plant. With Paroa Bay to the east.

These bays are all relatively sheltered by either mainland Aotearoa/New Zealand or islands including Motuarohia and Moturua Islands.

3.5.2 Estuarine

There is a small estuary to the south of the KR-WWTP. The stream running past the treatment plant discharges into this estuary, which then flows into Uruti Bay. The estuary is vegetated with mangroves creating habitat for marine and coastal avian species.

3.6 Cultural and Historical Significance

In the 1800s it was a busy settlement for Māori, sailors, whalers, and traders due to the safe anchorage for ships before it briefly became the capital of Aotearoa/New Zealand in 1840. There is a significant number of historical buildings including 11 under the protection of Heritage New Zealand Pouhere Taonga (HNZPT). There are also numerous archaeological sites surrounding the town. These archaeological sites demonstrate that the area has been significant to history of the local Hāpu.

According to the FNDC GIS Historic Sites Map, there are no sites of historical significance within the property boundaries of the Kororāreka/Russell Wastewater Treatment Plant. However, discharges from the plant have the potential to impact some of the significant sites if not properly controlled.

3.7 Areas of Recreational Value

The peninsula that the KR-WWTP is located on is a tourist location with recreational activities occurring around it. These activities mainly take on the form of boating (including fishing) and swimming.

There are also walking and cycling tracks in the area, including one that passes directly next to the treatment plant.

4.0 Best Practicable Option (BPO) Assessment Methodology

4.1 Receiving Environment Alternative Discharge Options

Alternative receiving environment options were identified and considered based on the following factors:

- Location of the plant in relation to the surrounding region.
- Nature of the discharge.
- Sensitivity of the receiving environment and potential of the treated effluent discharge to cause adverse effects.

An extensive list of potential alternative options, for wastewater discharge was formed using the wastewater information provided by FNDC and known information about the potential receiving environments. Once the initial long list had been created, a fatal flaw assessment was carried out to identify and remove options which were considered unsuitable for further consideration. Options were then further assessed against objectives that were identified to be important to the project success. These objectives were based around the Best Practicable Option interpretation outlined in the RMA, and include:

- **Objective 1.** The Wastewater discharge option meets Societal, Cultural and Environmental Legal Requirements (derived from the RMA Section 2: *the nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects*).
- **Objective 2.** The Wastewater discharge option reliably treats wastewater to the required standard (derived from the RMA Section 2: *the current state of technical knowledge and the likelihood that the option can be successfully applied*).
- **Objective 3.** The wastewater discharge option has reasonable financial (Capex and Opex) implications relative to the effects on the environment (derived from RMA Section 2: *the financial implications, and the effects on the environment, of that option when compared with other options)*.

From the objectives 1 and 2, ranking criteria were determined and used to assess the options in a Traffic light assessment. The options which scored the highest from the long list of wastewater discharge options was taken forward to the shortlist assessment process.

Objective 3 is then considered for the shortlisted options to determine their fiscal feasibility by undertaking rough order cost estimates.

4.2 Wastewater Discharge Long List Options

The long list of potential wastewater discharge options is based around the following key discharge methodologies:

- Maintaining the use of deep bore injection (DBI),
- Discharge to land,
- Marine discharge,
- Surface water discharge,
- Wastewater re-use, and
- Piping to a larger wastewater treatment plant.

Sub-options for each discharge method were then considered where multiple receiving environments for each method existed.

4.3 Traffic Light Assessment

A traffic light assessment was used to reduce the long list of options to the short list. A traffic light assessment involves rating each option green (no issues), orange (some challenges) or red (major issues that make the option unfeasible).

The assessment criteria used were:

- Ease of obtaining consent.
- Resilience of the option to meet requirements if regulatory requirements become stricter.
- Cumulative environmental impact.
- Community perception and impact.
- Install complexity of the option.
- Operational complexity of the option.
- Robustness of the discharge option if wastewater characteristics change.
- Resilience of the option to climate change.
- Potential Upgrade Requirements
- Cost
- Cultural Impact

FNDC and Iwi should be consulted on these criteria.

4.4 Cultural Considerations

Because consultation with Iwi regarding cultural implications has not been undertaken at this stage, ranking based on cultural criteria has not yet been finalised. The hapū Patukeha, Te Kapotai, Ngati Kuta and Ngati Manu should be included in the discussion. Notwithstanding this, potential cultural considerations relevant for each option have been noted.

The process followed has thus been to select an option that is technically feasible, which is able to be presented to Iwi along with the other shortlisted options for discussion regarding cultural implications and possible mitigations.

5.0 Longlist Options

The long list options considered are shown in Table 2 with some of the possible advantages and disadvantages for each option outlined.

Output from the application of the traffic light system is shown in Table 3.

Table 2: Long list of options for disposal of treated effluent from KR-WWTP

Receiving Environment	Item	Advantages	Disadvantages
Deep bore injection	1. Continue as now	Less change to consents and public perceptions. Infrastructure set up already.	Shown to have issues with blockage overtime. Would require better maintenance plan. Need to upgrade the existing plant to improve effluent quality (minimising solids carry over and installing disinfection).
Marine discharge	2. Reinstate the outlet to ocean at Tapeka Point	Returning to how the effluent use to be discharged from Tapeka Point. Possibly some usable infrastructure already in place.	Would have to pump effluent from the WWTP back to Tapeka point. Potential negative perception by public. Effluent discharged near population. Cost of pipeline for effluent. Old infrastructure may need complete replacing. Iwi generally do not favour discharging wastewater directly to surface water. Could be difficult/expensive to obtain a consent.
	3. Create new ocean outlet east of Oneroa Bay	Could position outlet away from main population and swimming/fishing areas.	Will be discharging into the Bay of Islands area close to the shore where recreation and fishing occurs. Potential negative perception by public. Iwi generally do not favour discharging wastewater directly to surface water. May need to discharge on outgoing tide to reduce spread around the bay. Could be difficult/expensive to get a consent. Ocean outfalls can be expensive to design and construct.

Table 2: Long list of options for disposal of treated effluent from KR-WWTP

Receiving Environment	Item	Advantages	Disadvantages
	4. Construct a long ocean outlet that carries water away from mainland a significant distance	Reduces chance of public contact with the effluent.	Will still be discharging into the Bay of Islands area where fishing occurs. Potential negative perception by public. Iwi generally do not favour discharging wastewater directly to surface water. Would have to be a very long pipeline to get out of the harbour. Would be expensive. Could be difficult/expensive to get a consent.
Re-use	5. Upgrade the treatment to a level where it can be used for municipal supply	Making more efficient use of water	Potential negative perception by public. Would require major plant upgrades to the treatment plant. Would require the installation of town supply water to Kororāreka/Russell. Could be prohibitively expensive
Surface water discharge	6. Discharge to stream near the treatment plant	Straightforward option. Close to the treatment plant with little additional infrastructure requirements.	Stream is small so would consist almost entirely of treated effluent. Iwi generally dislike discharging effluent to surface water. Stream is short before discharging into the harbour where lots of boating and recreation occurs. Would require an upgrade to the existing plant to meeting surface and marine water quality guidelines
	7. Constructed wetlands – Free water surface wetland	Would allow for denitrification to occur. Usually seen positively by public.	Would still need to discharge to surface water. Would require flat land to construct the wetland (or earthworks to make flat areas).

Table 2: Long list of options for disposal of treated effluent from KR-WWTP

Receiving Environment	Item	Advantages	Disadvantages
			Would require an upgrade to the existing plant to meeting surface and marine water quality guidelines Needs to be maintained properly or it will not provide any treatment.
Join into a larger wastewater treatment plant	8. Pipe treated effluent to Paihia	Would remove effluent from the area to a larger disposal area Potential for upgrades of Paihia system by combining resources. Water already mostly treated, just needs disposal and possibly polishing.	Cost of constructing the pipeline to Paihia. Iwi prefer dealing with wastewater at source. Significant capital cost likely
	9. Pipe raw wastewater to Paihia	Would remove effluent from the area to a larger disposal area Potential for upgrades of Paihia system by combining resources. Could decommission the KR-WWTP eliminating upgrade and maintenance requirement.	Iwi prefer dealing with wastewater at source. Cost of constructing the pipeline to Paihia. Has been considered and rejected in the past. Significant capital cost likely
Discharge to land	10. Irrigate to land	Effluent would be further treated by infiltrating soil. Would add nutrition to the soil. Considered best practice for wastewater disposal. Efficient re use of water as a resource for irrigation.	Would require suitable topography Soils may be limited in the area, restricting irrigation to seasonal operation only A significant area of land would need to be set aside for irrigation. May require considerable piping distance Significant capital cost likely

Table 2: Long list of options for disposal of treated effluent from KR-WWTP

Receiving Environment	Item	Advantages	Disadvantages
	11. Spray onto suitable vegetation within a 5 km radius	Effluent would be further treated by infiltrating soil. Would add nitrogen to the soil.	Soils may be limited in the area, restricting irrigation to seasonal operation only Irrigation capacity less than agricultural land discharge, meaning higher area requirement. Would likely require land use to be converted to forestry for land stability and rainfall interception Moderate capital cost
	12. Decentralise wastewater treatment to private septic tanks	No need to upgrade and maintain the WWTP	Potential for leaking septic tanks in the future. Would have to fund the construction of individual septic tanks, likely public objection. Need collection system for collecting and transporting septage.

Table 3: Traffic Light Assessment

	Deep bore injection	Marine Discharge			Reuse	Surface Water Discharge		Transfer to Paihia		Land Discharge		
	1	2	3	4	5	6	7	8	9	10	11	12
	As now	Tapeka	New	Ocean	Reuse	Stream	Wetlands	Treated	Raw	Field	Spray	Private
Ease of obtaining consent												
Resilience of the option to meet requirements if regulatory requirements become stricter.												
Cumulative environmental impact.												
Community perception and impact.												
Install complexity of the option.												
Operational complexity of the option.												
Robustness of the discharge option if wastewater characteristics change.												
Resilience of the option to climate change.												
Potential WWTP Upgrade Requirements												
Cost												
Cultural Impact												

Notes:

1. *Green cell mean that no major difficulties were identified, orange that some challenges are identified and red means extreme challenges are expected.*

5.1 Traffic Light Assessment

The traffic light assessment conducted by PDP is shown in Table 3. 7 of the 12 long list options received at least one red rating. This means that they have some extreme challenges (including fatal flaws) that make them unfeasible. These options have been excluded from the shortlist.

The marine discharge options have been excluded due to the expected difficulty with obtaining a consent, the potential negative community perception and the KR-WWTP upgrades that would be required to meet the receiving environment water quality objectives.

Discharge to surface water has been excluded due to the lack of assimilative capacity in the stream flowing adjacent to the KR-WWTP and the expected difficulty with obtaining a consent.

Reuse of the treated wastewater has been excluded mainly due to the complexity of implementation as well as the associated cost.

Two of the five options remaining involve piping wastewater to Paihia. It has been decided to progress piping of the treated effluent to Paihia as it is believed that this will be simpler and viewed more favourably by the community. The option would continue to make use of existing infrastructure in a beneficial way.

The short list options are:

- Continue using bore holes.
- Pipe treated effluent to Paihia.
- Spray effluent onto vegetation.
- Discharge to a constructed wetland.

6.0 Shortlisted Options

6.1 Option 1 – Continue Using Bores

The current discharge method is disposal of treated effluent to 85 bores. They are located along the ridgeline in the hills above the KR-WWTP. The bores are designed to rapidly soak the effluent to ground.

The bores are having operational issues and are vulnerable to clogging overtime. This clogging is likely happening during periods of poor water quality as a result of high inflows. Historical instances of very poor water quality have led to excessive bio-film accumulation resulting in clogging. One of the three bore fields (area C as shown in Figure 1) is currently not operational possibly due to damage from high flows resulting from Cyclone Gabrielle. The system is currently relying on a small number of 'performing' bores.

There are also some infrastructure issues that are being investigated, including the daylighting of effluent and poorly functioning switch mechanisms that direct the flows to the bores that should be operational. The disposal system was originally designed to auto cycle between bore fields to reduce concentrated loading/mounding. It is understood that this was never commissioned properly. These issues would need to be remedied if the bore fields continue to be used.

6.1.1 Advantages

Advantages of this option include:

- This is the existing disposal method, which the community is familiar with. Changing to a different disposal option would require a greater level of consultation with the community.
- The infrastructure is already in place.

6.1.2 Disadvantages

Disadvantages of this option include:

- Immediate rejuvenation of the bores and effluent distribution network is required.
- Bores are vulnerable to clogging so will need intensive maintenance to ensure they continue to function well.
- Ideally need to upgrade the existing plant to get better effluent quality to reduce clogging.

6.1.3 Rough Order Cost Estimate

A PDP proposal to rejuvenate the bores ($300k) and a WSP proposal to upgrade the effluent distribution network ($120k) have been presented. With the upgrade of the KR-WWTP with an equalisation volume, a high-level (+/- 50%) cost of roughly $2,130,000 is expected.

6.2 Option 2 – Pipe Treated Effluent to Paihia

Piping the treated effluent to Paihia would involve a pipeline running from the KR-WWTP to the Paihia WWTP. This would include a section of underwater pipe more than three kilometres in length.

The option would eliminate the need to find an appropriate way to dispose of the effluent on the Kororāreka/Russel Peninsula since land is limited on the peninsula making it difficult to find a suitable method that has less than minor environmental effects.

The hapū Patukeha, Te Kapotai, Ngati Kuta, Ngati Manu, Ngati Rahiri and Ngāti Kawa should be consulted and included in decision making before this or any other option is progressed any further.

6.2.1 Advantages

Advantages of this option include:

- Conveying effluent off the peninsula where land is limited, and surface water is in close proximity.
- The KR-WWTP would still be utilised to provide a degree of wastewater treatment.

6.2.2 Disadvantages

Disadvantages of this option include:

- The Iwi don't prefer wastewater to cross Iwi boundaries as would be the case if it is piped to Paihia. However, piping treated effluent to Paihia is more likely to be seen as acceptable than raw effluent. Consultation is required.
- Underwater pipelines are complex and expensive to construct.
- The Paihia WWTP disposal system may need upgrading to have capacity for the extra flow.

6.2.3 Rough Order Cost Estimate

The expense and difficulty of constructing an underwater section of pipe will be a challenge with this option. As well as the piping cost it is likely that the Paihia Wastewater Treatment Plant would need to be upgraded to have capacity to dispose of the extra volume of water. The level of upgrades required has not been investigated.

The estimated high-level (+/- 50%) cost is expected to be in the order of $34,100,000.

6.3 Option 3 – Spray Effluent onto Vegetation Within 5 km Radius

The irrigation of effluent would be to exotic or native forestry as most of the land near the KR-WWTP is too steep to irrigate pasture. Interception losses as a result of the tree canopy reduces the amount of the rain reaching the ground allowing some capacity for external irrigation. Either the existing Kanuka and/or Manuka or establishing some exotic forestry could be used.

Establishing exotic forestry is the recommended option as it allows for the harvesting to occur. Harvests remove nitrogen and other nutrients that the wastewater is supplying from the site.

A similar disposal system to this option is in place at Cooks Beach. Based on this case study, to cover the 90th percentile flows of 680 m^3/day from the KR-WWTP about 20 ha plus some reserve area would be needed for an irrigation rate of up to 3.5 mm/day.

Nitrogen loading to the soil would need to be monitored. An irrigation rate of up to 3.5 mm/day would mean that the nitrogen loading rate is an average of 65 kg/ha/yr. This is well below the fertiliser limit of 150 kg/ha/yr.

The area currently being used for the bore fields is likely to be large enough for irrigation, however it may not be a suitable location. Further investigation would be required to determine the best location for irrigation.

6.3.1 Advantages

Advantages of this option include:

- Effluent would be further treated by infiltrating into the soil.
- Irrigated effluent would add nitrogen to the soil, creating the possibility for harvest of a product like timber with reduced fertiliser inputs.

6.3.2 Disadvantages

Disadvantages of this Option include:

- Obtaining suitable land close to the plant may be challenging. Some potential irrigation areas of grassland that can be converted to forestry or Kanuka and/or Manuka Forest have been identified within the 5 km radius marked on Figure 4.
- Aerosols from spraying, particularly on a windy day.
- The soil types may not be suited to irrigation. According to the Landcare Research Soil Portal the underlying soils are imperfectly draining Albic Ultic. Further investigation would be required to identify suitable land for irrigation.

- Possibility for overland flow to occur, particularly in winter when rainfall is high. Irrigation depths would therefore need to be monitored and irrigation reduced as required. This may require seasonal storage or an alternative discharge to manage wetter seasons.
- Buffer storage would be needed to regulate flows.

6.3.3 Rough Order Cost Estimate

The high-level (+/- 50%) cost of this option is estimated to be $21,190,000 depending on the location of the irrigation field. This cost estimate excludes acquiring land if required, but could add $1,000,000 to the cost estimate (based on $50,000/ha).

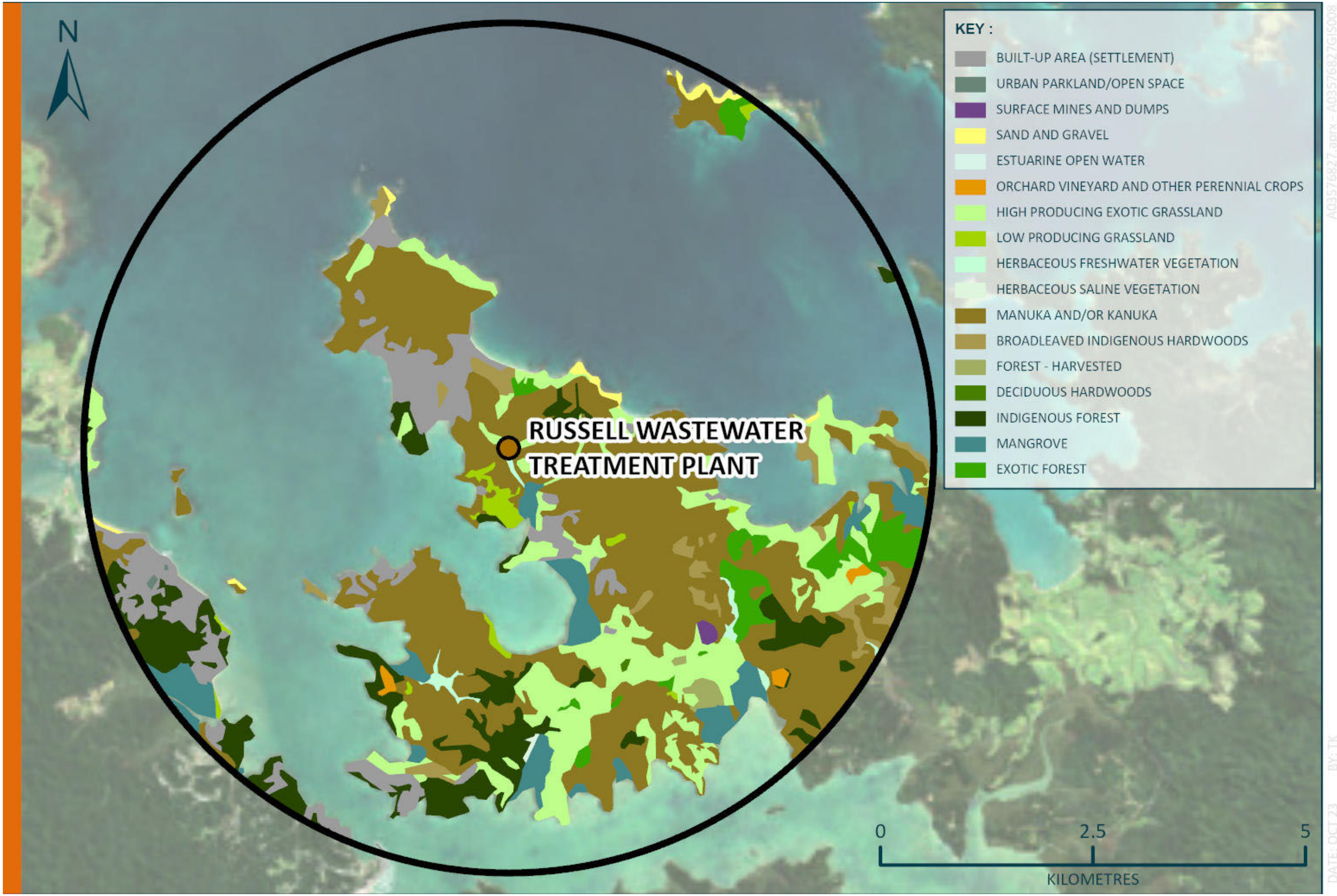


Figure 4: Land use within 5 km of the Kororareka/Russell Wastewater Treatment Plant

6.4 Option 4 – Discharge to a Constructed Wetland

This option involves constructing a free water surface wetland. The existing disused ponds (wetlands) could be modified and expanded for this purpose. The size of the constructed wetland would need to be a total of approximately 8,000 m^2 for a 3-day retention time. Significantly more than the existing ponds (wetlands). Further investigation needs to occur to assess if there is enough suitable space near the KR-WWTP.

The leachate and filter backwash would need to be diverted to a different storage area before being pumped into the SBRs if the existing ponds (wetlands) are incorporated into the new ones.

All the treated wastewater would then flow to the small stream that is adjacent to the site.

6.4.1 Advantages

Advantages of this option include:

- Allowing a degree of denitrification to occur within the constructed wetland. The current wastewater treatment system does not include an anoxic phase for denitrification.

6.4.2 Disadvantages

Disadvantages of this option include:

- All the effluent will end up in the small stream that is adjacent to the site after it has passed through the constructed wetland. The amount of effluent entering the stream will be a large portion of the total water in the stream, and therefore, it is likely that the stream water quality will become a limiting factor for the discharge.
- As this will ultimately be a discharge to a small surface water body, obtaining a workable consent may be challenging.
- Would require earthworks to make enough suitable space for the constructed wetland.
- Needs to be maintained properly to provide any additional treatment.

6.4.3 Rough Order Cost Estimate

Discharging to a constructed wetland has an estimated high-level (+/- 50%) cost \$4,100,000 for an 8,000 m^2 wetland. This assumes that there is adequate suitable space for the wetlands to be constructed near the treatment plant.

6.5 Assessment of Short-Listed Options

Based on the assessment of the short listed options, costs are prohibitive for transfer of wastewater to the Paihia plant. Costs are also very high for the irrigation to land option, there is uncertainty around the ability to obtain land and it will be introducing a new receiving environment. Discharge to a wetland may be achievable from a cost perspective and land availability, however, the discharge will ultimately be to a small surface water receiving environment which may be difficult to obtain consent.

Continuing with the disposal of treated effluent to the borefield is considered to be the best practicable option, on the basis of the following key points

- Is most likely to be granted consent due to a track record of operation that has highlighted its advantages and shortcomings that can be addressed.
- It requires the least amount of financial investment relative to the other short-listed options to continue operating the system.
- It is an existing and understood operation that the community are familiar with.
- Is relatively simple to operate and maintain.

It is noted that the existing system operation needs to improve, with boreholes rejuvenation, the network conveying treated effluent being fully functional and the ongoing upgrades (UV unit, pressure filter and balancing pond) for the KR-WWTP being implemented.

Consultation with Iwi has not occurred at this stage and cultural issues of all the options should be considered in the selection of the BPO.

7.0 Assessment of Technical Best Practical Option

Based on the assessment of the short listed options, costs are prohibitive for transfer of wastewater to the Paihia plant. Costs are also very high for the irrigation to land option, there is uncertainty around the ability to obtain land and it will be introducing a new receiving environment. Discharge to a wetland may be achievable from a cost perspective and land availability, however, the discharge will ultimately be to a small surface water receiving environment which may be difficult to obtain consent.

When assessing all short listed options, continuing with the disposal of treated effluent to the borefield is considered to be the best practicable option, on the basis of the following key points

- It is likely to have the easier consenting pathway due to a track record of operation that has highlighted its advantages and shortcomings that can be addressed.
- It requires the least amount of financial investment relative to the other short-listed options to continue operating the system.
- It is an existing and understood operation that the community are familiar with.
- It is relatively simple to operate and maintain.

It is noted that the existing system operation needs to improve, with boreholes rejuvenation, the network conveying treated effluent being fully functional and the ongoing upgrades (UV unit, pressure filter and balancing pond) for the KR-WWTP being implemented.

Consultation with Iwi has not occurred at this stage and cultural issues of all the options should be considered in the selection of the BPO.

8.0 References

Environment and Business Group Ltd. 2001. Russell Wastewater Proposed Irrigation and Additional Borehole Disposal Description of Proposal and Assessment of environmental Effects. Report prepared for FNDC, June 2001.

FNDC. 2023. Russell WWTP Operations and Maintenance Manual. Rev 1 – Issued for comment.

MHW. 2003. The Preparation of a Combined Wastewater Asset Management Policy and Liquid Waste Management Plan – "A Peer Review of the Russell/Tapeka Point Sewerage System".

PDP (2021) Site Visit: Observations made by PDP during site visit and anecdotal observations made by plant operator.

PDP. 2023. Kororāreka/Russell Wastewater Treatment Plant Performance Assessment.

Whitehead, A.L., Booker, D.J. (2020). NZ River Maps: An interactive online tool for mapping predicted freshwater variables across New Zealand. NIWA, Christchurch. https://shiny.niwa.co.nz/nzrivermaps/.

Appendix C: Kororāreka/Russell WWTP Performance Assessment

Kororāreka/Russell Wastewater Treatment Plant Performance Assessment

Prepared for

Far North District Council

November 2023

PATTLE DELAMORE PARTNERS LTD
Level 5, PDP House
235 Broadway, Newmarket, Auckland 1023
PO Box 9528, Auckland 1149, New Zealand

Tel +64 9 **523 6900**
Web www.pdp.co.nz

solutions for your environment

Quality Control Sheet

TITLE	Kororāreka/Russell Wastewater Treatment Plant Performance Assessment
CLIENT	Far North District Council
ISSUE DATE	28 November 2023
JOB REFERENCE	A03576827

Revision History

REV	Date	Status/Purpose	Prepared By	Reviewed by	Approved
1	28/11/23	Final	Lucy Douglas Michael Chen	Wageed Kamish Daryl Irvine	Daryl Irvine

DOCUMENT CONTRIBUTORS

Prepared by

SIGNATURE

Jiazhe Chen

Lucy Douglas

Michael Chen

Reviewed by

Reviewed and Approved by

SIGNATURE

Wageed Kamish

Daryl Irvine

Limitations:

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Far North District Council. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This report has been prepared by PDP on the specific instructions of Far North District Council. For the limited purposes described in the report. PDP accepts no liability if the report 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.

Executive Summary

Introduction

The Kororāreka/Russell Wastewater Treatment Plant (KR-WWTP) (the Plant) was constructed in the 1990s after concern was raised about groundwater contamination because of pollution from the septic tanks system that was previously used. The plant treats the wastewater produced by the township of Kororāreka/Russell including Tapeka Point. The KR-WWTP currently holds resource a consent (AUT.008339.01.03) with the Northland Regional Council (NRC) for the discharge of treated wastewater (including Russell Landfill leachate) to ground via disposal boreholes. This consent expires on 30 April 2024 and to continue with operation a new consent application needs to be lodged before 30 November 2023.

This performance assessment report forms part of the discharge reconsenting process and the scope of works was to:

- Undertake a site visit and report on current operation of the plant.
- Use available information to report on the population growth and associated wastewater loads on the plant.
- Use available effluent quality data to assess the current performance of the plant.
- Estimate effluent quality of projected future scenario.

Population Growth and Inflow Volumes

Assessment of previously undertaken population estimates for the Russell area indicated that little to no growth could be expected out to the 2032 horizon from two sources[1] and out to the 2073 horizon from another source (Brunsdon, 2022). The peak population was estimated at 1350 people over the summer months. Based on the population estimates it was accepted that inflows would not change significantly into the future.

A review of wastewater flows indicates that there is no obvious seasonality in the wastewater flows. Wastewater flows do, however, respond to Inflow and Infiltration (I&I) and it would be important manage the extent of this. Leachate flows from the landfill adjacent to KR-WWTP also contributes to the inflows.

[1] Retrieved from: https://www.stats.govt.nz/tools/2018-census-place-summaries/russell and https://population.infometrics.co.nz/far-north-district/growth-areas

Current Treatment Process

The main components of the treatment process consist of:

- A rotary screen for the removal of rags etc.,
- Two Sequencing Batch Reactors (SBRs) in which organic material is aerobically degraded and ammonia is converted to nitrates and nitrites,
- Sludge decant tanks to temporarily store waste activated sludge, before collection and off-site disposal,
- Pressurised filters for the removal of particulate constituents from SBR decanted flows,
- UV unit for the disinfection of flows from the pressure filter, and
- A buffer tank from which treated effluent is disposed of to the bore fields and from which water is provided for filter backwashing.

Known Treatment Issues

Overloading of system

The overloading issue has been raised as early as 2002 and was attributed mainly to the Inflow and Infiltration (I&I) into the sewage network. Volume balance calculations undertaken as part of this study suggest that flow balancing before the SBR reactor could lead to better treatment efficiencies during high flows.

Equipment issues

Flow data indicated that maximum flow of 14 L/s was exceeded from time to time and that this could lead to underperformance of the UV unit.

Solids carry-over

This issue is related to high inflows when insufficient time could be available for settling, causing the decanted water to be high in suspended solids, which would result in heavy loading of the filter media and potential impact on its performance. This may also require by-passing of the filters and UV unit which would further impact on performance.

Historical Performance

Based on the outflow data between 1st of July 2020 and 30th of April 2023, the consent condition limiting discharge of wastewater to 1,235 m^3/day was not exceeded.

E. coli levels in the effluent discharged has exceeded consent conditions in some sampling rounds. Based on data between September 2013 and May 2023 *E. coli* concentrations have exceeded the 7-point rolling median limit for 50 samples and the 100 cfu/100 mL threshold for 38 samples. A total of 296 samples have been recorded during this time.

The total suspended solids concentration has also exceeded the 7-day rolling median and 90th percentile consent conditions on 21 and 39 occasions. There have also been occasional breaches in BOD_5 and TKN levels since 2013. BOD_5 exceeded the 7-day rolling median and 90th percentile on 3 and 7 occasions respectively while TKN exceeded its limits on 5 and 8 occasions respectively. No exceedances of the TP concentrations were reported.

High Level Biowin Simulations

High level BioWin simulations were undertaken for an average flow, 90th percentile flow and theoretical maximum flow scenarios. The Peak Wet Weather flow scenario was not simulated since this flow exceeded the theoretical maximum flow that was calculated for the system and was therefore expected to result in poor treatment performance.

For the average and 90th percentile flows the system had sufficient treatment capacity on most water quality parameters but required the pressure filter to meet the consent conditions on the 90th percentile inflow.

For the theoretical maximum flows there was solids carry over from the SBR reactors which could impact the performance of the pressure filter and the UV unit.

Potential Performance Improvements

The modelling results suggest the need for an inflow balancing system to mitigate extreme flow variations, which cause high effluent concentrations. Using one of the existing ponds (wetland) and lining it to serve as an inflow balancing lagoon could be a practical solution if a method for removing primary sludge is incorporated into the redesign and refurbishment. There are, however, risks associated with this approach which would need to be addressed.

Summary

The performance assessment of the KR-WWTP plant showed that managing high inflows is the biggest challenge from an operations perspective. This is due to high influent inflows which result in reduced cycle times for the SBR, which in turn results in reduced treatment capacity. Including a balancing volume upstream of the SBR could attenuate the inflow peaks resulting in a more stable inflow pattern.

Assessment of population growth indicated that little to no growth is expected for the Russell and that inflows would, therefore, likely remain the same. The effect of increased I&I into the network, because of climate change, has not been accounted for in this study as it has been assumed that a network maintenance program will be undertaken in future.

Table of Contents

Table of Figures

Table of Tables

Appendices

1.0 Introduction

The Kororāreka/Russell Wastewater Treatment Plant (KR-WWTP) (the Plant) was constructed in the 1990s after concern was raised about groundwater contamination because of pollution from the septic tanks system that was previously used. The plant treats the wastewater produced by the township of Kororāreka/Russell including Tapeka Point. The KR-WWTP currently holds resource a consent (AUT.008339.01.03) with the Northland Regional Council (NRC) for the discharge of treated wastewater (including Russell Landfill leachate) to ground via disposal boreholes. This consent expires on 30 April 2024 and to continue with operation, a new consent application needs to be lodged before 30 November 2023. Figure 1 shows the location of the KR-WWTP relative to the township of Russell and the landfill.

The consent (AUT.008339.02.03) related to the discharge of contaminants to air is also expiring on 30 April 2024 and is dealt with in a separate report.

Pattle Delamore Partners Limited (PDP) has been engaged by Far North district Council (FNDC) to prepare a Capacity Assessment of the KR-WWTP under current and future operating conditions, to form part of the consent application.

This report provides a summary of:

- Current and future loads on the KR-WWTP,
- Current system performance based on available effluent quality data, and
- Potential improvements that could be made.

This report should be read in conjunction with the *Best Practicable Options Assessment report for the KR-WWTP* (PDP, 2023) in which the options for the discharge of treated wastewater from the KR-WWTP are discussed.

Figure 1: Location of the KR-WWTP Relative to Russell Township

1.1 Scope of Works

The scope of works is as follows:

- Undertake a site visit and report on current operation of the plant.
- Use available information to report on the population growth and associated wastewater loads on the plant.
- Use available effluent quality data to assess the current performance of the plant.
- Estimate effluent quality of projected future scenario.

2.0 Population Growth

Part of assessing the performance of the plant is understanding the flows and loads entering the plant. The flow into the plant is related to the amount of people using the wastewater system and the type of use.

2.1 Average Population

Previous populations projections were used to obtain population projections. The sources used, and projections used are summarised in Table 1.

Table 1: Population estimates and pro ections for Kororāreka/Russell

Source	Population Estimate (year)			
The Far North District Council (FNDC) Population Projections – Statistical Area: Russell[1] (Brunsdon, Nick;, 2022)	802 (2021)	864 (2034)	868 (2053)	867 (2073)
The Far North District Council (FNDC) Population Projections – Service Area: Russell[2] (Brunsdon, Nick;, 2022)	802 (2021)	808 (2034)	807 (2053)	805 (2073)
Census data – Statistical Area – Russell (Russell, 2023)	786 (2006)	702 (2013)	762 (2018)	-
Infometrics population information for the Kororāreka/Russell statistical area. (Population Projections - Growth Areas, 2023)	757 (2012)	819 (2022)	853 (2032)	-
Peer Review of the Russell-Tapeke Point Sewerage System (Brunsdon, Nick;, 2022).	1,600 (2002)	-	-	-

Notes:
1. *Tapeka township is included in the Russell statistical area.*

The FNDC Zone Map attached in Appendix A was used to define the commercial area contributing to the KR-WWTP flows. A 5-ha area has been estimated from the Zone Map.

The FNDC Population Projections (May 2022) Report *Population Projections - Service Area: Russell* was chosen for use in the flow projections. These projection values are based on the area that is serviced by the KR-WWTP. This was deemed to be the most applicable projection due to the catchment area covered and the recent date of the report.

Three of the four sources indicated similar populations of about 800 residents with almost no growth occurring. The 2002 Peer Review of Russell-Tapeke Point Sewage System also suggests little growth but states a much higher normally resident population of 1,600 peaking at 5,200 including 1,900 equivalent population for the commercial area of Kororāreka/Russell. The Peer Review of Russell-Tapeke Point Sewage System (2002) report states that 1,600 is the population that the original KR-WWTP concept was designed for in 1992.

2.2 Peak Population

There is limited information available about the peak population of Kororāreka/Russell during holiday periods. The FNDC Population Projections (May 2022) Report presents the population, number of households and number of dwellings that are projected for 2021, 2034, 2053 and 2073. The difference between the number of dwellings and households is believed to represent holiday homes that are not permanently occupied.

To estimate the peak population the ratio of population:household was multiplied by the number of dwellings. Based on the FNDC population projections for the Russell service area the ratio of population:household is just over 2. It is assumed that this ratio is true during the peak season. This gives a peak population of around 1350 people. The actual peak population could be higher than this if there are more than an average of 2 people in each house during peak times.

2.3 Projected Growth

All the population projections for Kororāreka/Russell from the sources listed in Table 1 indicate that there will be little population growth. Due to lack of information, it has been assumed that there will also be little commercial growth.

3.0 Inflow (Current and Historical)

The influent to the KR-WWTP is mostly municipal wastewater from the community of Kororāreka/Russell with some leachate flow from the landfill neighbouring the treatment plant.

Historical flow data for the plant was available as:

- Aggregated daily inflow (1/07/2020 to 31/07/2023) and outflow (1/07/2020 to 30/04/2023) volumes (email from FNDC, 2023), and
- High frequency inflows and outflows (5-minute intervals) (15/12/2022 to 19/02/2023) (WSP, 2023).

3.1 Inflow Volumes

A summary of the inflow volumes between 1st July 2020 and 31st July 2023 is shown in Table 2. It is worth noting that in inflow volumes are significantly higher than the outflow volumes.

On average the inflows are 100 m^3 larger than the outflows. 10% of the days have a difference between the inflow and outflow that is larger than the average outflow of 260 m^3/d. This could be due to a faulty inflow or outflow meter. The removal of sludge by trucking it away is also a contributing factor. There is too much of a discrepancy for this to be the sole reason, but it will be a contributing factor.

More investigation would be required to confirm the cause for the difference between the inflow and outflow data.

Table 2: Historical Inflow Volumes

Flow Statistic	Flow (m^3/day)
Average daily flow	370
Average dry weather flow	290
95th percentile flow	830
Maximum daily flow	2017

Notes:

1. *Inflow data from 1st July 2020 and 31st July 2023.*
2. *It has been considered that any flow where the previous 3 days have had less than a total of 1 mm of rainfall is a dry weather flow.*

3.1.1 Drinking Water Source

Drinking water supply for the Kororāreka/Russell and Tapeka Point township is not reticulated from a central water source, and households use rainwater tanks to collect roof runoff during rainfall events. Generally, water consumption for supplies supply is less than that on a centralised town supply (Ormiston & Floyd, 2004).

There is a campground with a borehole water source that also supplies the businesses along the main street of Kororāreka/Russell.

3.1.2 Inflow and Infiltration

The flow data suggests that there is a significant amount of inflow and infiltration occurring in the wastewater network. If a peak population of 1350 people is assumed, the influent into the treatment plant would be 270 m^3/day. This assumes that each person uses 200 L per day, which is understood to be generous for populations on tank water supply. The inflow data between 1st July 2020 and 31st July 2023 has an average daily flow (not just during peak times) that is much higher at about 370 m^3/day. This is likely due to a combination of inflow and infiltration.

3.1.3 Leachate Flows

The consent conditions allow for 5 m^3/day of leachate flow from the landfill neighbouring the KR-WWTP to be pumped into the plant. Based on the recorded volumes of leachate flow between 8th August 2022 and 3rd July 2023, the average leachate flow is 35 m^3/day, which is above the consented leachate volume. This average excludes data between the 21st of March 2023 and 6th of June 2023 where the values are all zero. There was also one outlier value that was excluded.

3.1.4 Seasonal Trends

There are no clear seasonal trends in the flow data between 1st July 2020 and 31st July 2023. This can be seen in Figure 2, and which was previously observed in the FNDC Population Projections (May 2022) Report that reviewed data between 2018 and 2021. Figure 2 shows that the inflow volume to the KR-WWTP is linked to rainfall, suggesting inflow and infiltration is significant in the system.

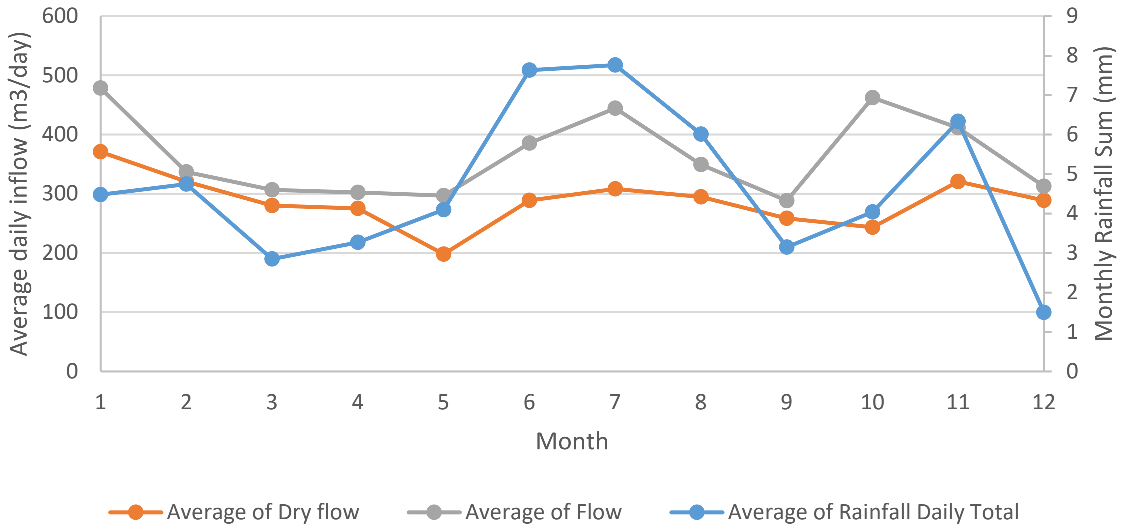


Figure 2: Seasonal flow trends in the flow data between 1st July 2020 and 31st July 2023.

Inflow Loads

Estimated loading of biochemical oxygen demand (BOD), total suspended solids (TSS), total nitrogen (TN) and total phosphorus (TP) have been calculated based on the projected flows and typical expected municipal wastewater concentrations. There is no available inflow water sampling for the KR-WWTP. Based on leachate quality data reported in OPUS (2006), the concentrations in the leachate flows are lower than the concentrations used for the influent flows. Applying the municipal concentration to all of the inflow (including the leachate flows) is therefore a conservative approach.

Three sources for typical concentrations of BOD, TSS, TN and TP have been compared. The sources are:

1. Wastewater Engineering Treatment and Resource Recovery (Metcalf & Eddy, 2014).
2. Biological Wastewater Treatment: Principles, Modelling and Design (Chen et al. 2020)
3. Theory, Design and Operation of Nutrient Removal Activated Sludge Process (Ekama, et al., 1984)

It was decided to use the per capita effluent load contribution reported in Metcalf & Eddy (2014), since this approach would allow for the inflow load to be calculated based on population numbers and then diluted with the volume contribution from the I&I. The loads are reported in Table 3.

Table 3: Influent Water Quality Concentration and Loads

Water quality parameter	Average Concentration (mg/L)	Average Loads (kg/d)	Peak Loads (kg/d)
Biological Oxygen Demand (BOD_5)	183	68	113
Total Kjeldahl Nitrogen (TKN)	32	12	20
Total Phosphorus (TP)	5	2	3
Total Suspended Solids (TSS)	178	66	110

Notes:

1. *Average and peak loads are calculated using typical per capita loads from Metcalf & Eddy (2014:Table 3-16) multiplied by the average and peak populations used in this study (808 and 1350, respectively)*
2. *Based on the average flow contribution of leachate to the inflows, the calculated loads are increased by 10% to account for leachate flows*

3.2 Projected Flows and Loads

Due to the lack of growth mentioned in Section 2.3, there is expected to be little change in the flows and loads reaching the Kororāreka/Russell Wastewater Treatment plant until 2073.

4.0 Description of Wastewater Treatment Process

4.1 General Site Layout

The Kororāreka/Russell Wastewater Treatment Plant (KR-WWTP) is located around one kilometre southeast of Russell Township, positioned between Florence Avenue and Uruiti Road - 6140 Russell Whakapara Road. The site comprises the treatment plant, ponds (wetlands), and disposal fields, all crucial to the treatment process. Additionally, it shares borders with nearby reserve blocks and the local landfill transfer station.

4.2 Description of Treatment Process

4.2.1 Block Flow Diagram

The block flow diagram for the plant is shown in Figure 3 which shows that influent combined with filter backwash, WAS decant and landfill leachate is split between the two sequencing batch reactors (SBRs) with treated effluent discharged to the filter tanks and filters before passing through a UV reactor and discharge to the boreholes via a buffer tank. P&IDs for the plant can referenced in the Russell WWTP Operations and Maintenance Manual (FNDC, 2023a).

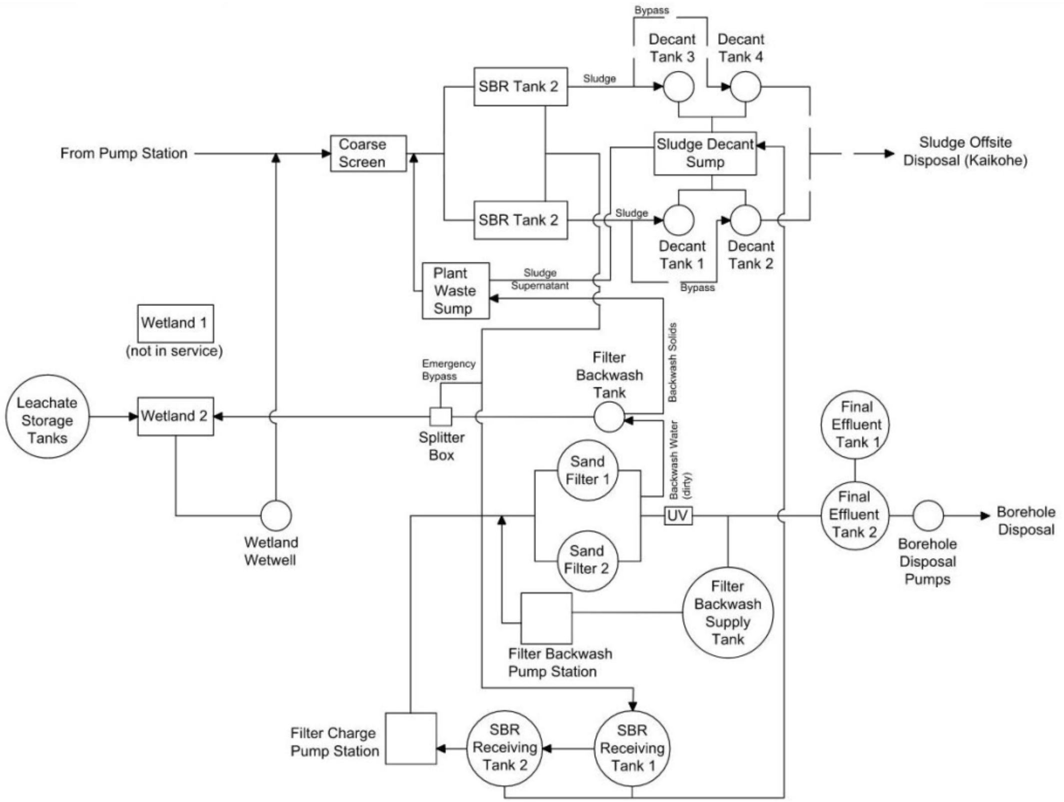


Figure 3: Block flow diagram for KR-WWTP (after FNDC, 2023a)

4.2.2 Operational Strategy

The KR-WWTP employs a structured operational strategy to manage wastewater from the Russell and Tapeka Point communities and a small volume of leachate from the nearby landfill. The strategy is robust enough to accommodate variable daily flows, with a capacity to handle a consented discharge of 1235 m^3 of treated wastewater daily. The operational adaptability is particularly crucial during the peak season, ensuring a consistent level of treatment despite population fluctuations.

At the core of the operational strategy is a Sequential Batch Reactor (SBR) activated sludge process, which cycles through filling, settling, decanting, and idling phases for the reduction of organic and ammonia concentrations in the wastewater. An anoxic phase is not part of the SBR operation, so targeted denitrification is not achieved.

Key operational parameters such as Mixed Liquor Suspended Solids (MLSS), Sludge Retention Time (SRT), and Dissolved Oxygen (DO) are monitored to maintain optimal treatment conditions within the SBRs. Additionally, the operational strategy involves routine removal of waste activated sludge to manage biomass concentration in the system.

Following the SBR biological and settling processes, the wastewater flows through pressure sand filters for further physical removal of suspended solids. The filters are cleaned automatically, with a backwash sequence triggered by the differential pressure readings across the filters. The treated water is then passed through a UV disinfection system before being directed to the final disposal boreholes.

Landfill leachate is currently pumped from a leachate buffer tank to pond 2 (wetland 2) and then to the KR-WWTP via a connection to the main inlet rising main. Pond 2 (wetland 2) still currently receives pressure filter backwash and overflow from the SBR supernatant tanks, or directly from the SBRs themselves when the SBR receiving tanks are out of service. Pond 1 (wetland 1) is under conversion to enhance flow balancing but is not yet operational.

Adherence to critical process control points is integral to the operational strategy, requiring continuous monitoring of key parameters like influent pH, flow, and post-filtration turbidity to ensure compliance with consented water quality discharge limits.

4.2.3 Solids Handling

The current procedure for managing solids involves collecting Waste Activated Sludge (WAS) from the SBRs into designated sludge decant tanks. Within these tanks the sludge undergoes some settling with the supernatant returned to the SBR tanks. Every two to three days the settled sludge is pumped from the sludge decant tanks into a tanker truck to be transported off-site for further processing.

There is a desire to manage and dispose of the WAS within the catchment. Therefore, dewatering and/or land treatment of the settled sludge and local disposal are alternatives that could be investigated further. These options would require the identification of suitable land for biosolids acceptance and application for consent to discharge to land.

4.2.4 Known Treatment Performance Issues

Several issues related to the performance of the plant have been highlighted in previous studies (MWH, 2002; OPUS, 2006) and by the operator on the site visit of 25 August 2023. Some of the issues are related to the process while other are related to sizing and operational life of the unit operations. These are discussed below.

4.2.4.1 Overloading of System during High Flows

The overloading issue has been raised as early as 2002 and was attributed mainly to the Inflow and Infiltration (I&I) into the sewage network. Simulation of the KR-WWTP was undertaken by OPUS (2006) and at that stage they did not consider Peak Wet Weather Flows (PWWF) as a viable scenario to simulate since it was expected to overload the system, resulting in poor performance. To assess the current day performance in terms of the overloading issue, a high-level volume balance was undertaken to provide further insights.

To undertake the volume balance calculations, it was accepted that under normal operating conditions, the SBR undergoes a settling period of 30 minutes. However, during peak flow periods, this settling period is assumed to be reduced to 20 minutes to accommodate the higher flows (FNDC, 2023a). Consequently, when calculating the cycling time of the SBR under peak or theoretical maximum flow conditions, the minimal settling time is designated as 20 minutes, with an additional decanting time of 10 minutes. This ensures that the total period for settling plus decanting during high flow remains at 30 minutes. A settle time of between 20 and 30 minutes is quite short for an SBR and may be a limiting factor for the treatment plant performance.

The occurrence of high inflow therefore reduces the SBR settling time, which could result in solids carry over and other treatment inefficiencies. Receiving inflow during the settling/decant phase can result in poor effluent quality, as this phase would have almost no treatment capacity. Any inflow during this period mixes with the treated decant flow, compromising the effluent quality.

Given the significant fluctuations in the flow data, diurnal hourly flows were used to obtain estimates of the highest hourly inflow rate that could be accommodated without inflows occurring during the decanting phase.

The two SBRs have different volumes and surface areas resulting two potential scenarios under extreme hourly flow rates.

- Scenario 1 - SBR1 reaches full capacity, redirecting inflow to SBR2; and
- Scenario 2 - SBR2 is filled, redirecting inflow to SBR1.

Given that SBR1 is smaller than SBR2, the theoretical maximum inflow for filling SBR1 and SBR2 differs. Under Scenario 1, the theoretical maximum flow rate is 81.2 m^3/hr, while for Scenario 2 the flow rate is 61.6 m^3/hr. For Scenario 1, 8 days over the past three years would have received inflow during the settling/decanting phases, while for Scenario 2 this would be 22 days.

Considering that the inflow during this time could be directed to either SBR1 or SBR2, the number of days on which the SBRs might receive inflow during the settling/decanting phases therefore ranges from 8 to 22 days, and predominantly occurred during July, October, and January.

4.2.4.2 Equipment issues

The high frequency flow data (15/12/22 to 19/02/2023) indicated occurrences where the inflow surpassed the designed maximum flow (14 L/s) of the plant, peaking at 18 L/s. Exceedance of the maximum design flowrate was observed 206 times during the period. The UV unit (Trojan UV 3000 PTP) is suited for flows up to 14 L/s and replacement of the unit is currently underway (Shoebridge, 2023).

4.2.4.3 Solids carry-over

Issues related to solids carry-over have been identified (see section 4.2.4.1), potentially associated with periods of high flow when reduced settling time may inhibit effective sludge settling, resulting in elevated effluent solids levels and consequent breaches of consent limits, as evidenced by the effluent quality data (discussed in Section 5.0).

The pressure filters are designed to accommodate a maximum flow of 14 L/s but there have been instances where flow rates exceeded this threshold, compromising the efficacy of the filter and resulting in higher effluent solids concentrations. It is not known when last the media of the filter was changed, but this should also be included in the maintenance plan for the plant.

5.0 Performance Assessment

5.1 Historical Compliance

Part of the consent conditions for the KR-WWTP specifies water quality limits, which are summarized in Table 4. Under the consent the maximum allowable total discharge from the plant is 1,235 m^3/day (14.29 L/s) while no more than 5 m^3/day of leachate flow should enter the treatment plant.

Table 4: Water Quality Requirements

Parameter	Discharge Limits	
	Rolling Median	Rolling 90th Percentile
Five Day Biochemical Oxygen Demand (BOD_5) (mg/L)	10	25
Total Suspended Solids (TSS) (mg/L)	10	25
Total Kjeldahl Nitrogen (TKN) (mg/L)	20	40
Total Phosphorus (TP) (mg/L)	15	30
E. coli (cfu/100 mL)	50	1000 (max)

5.1.1 Wastewater discharge

As mentioned in Section 3.1 the daily inflow volumes into the tanks are on average 100 m^3/d higher than the outflows. Based on the outflows alone, the consent condition limiting discharge of wastewater to 1,235 m^3/day was not exceeded between 1st of July 2020 and the 30th of April 2023. However, the inflow volumes exceeded 1,235 m^3/d on 13 occasions. There are 4 days between the 1st of July 2020 and the 30th of April 2023 where the difference between the outflow and inflow is more than the consented discharge limit of 1,235 m^3/d. Section 3.1 mentions some of the possible reasons why this is occurring.

5.1.2 *E. coli* Concentration

E. coli levels in the effluent discharged has exceeded consent conditions in some sampling rounds. Based on data between September 2013 and May 2023 *E. coli* concentrations have exceeded the 7-point rolling median limit for 50 samples and the 1000 cfu/100 mL threshold for 38 samples. A total of 296 samples have been recorded during this time.

Based on the aggregated flow data the 14 L/s design capacity of the UV unit were not exceeded assuming outflow is spread evenly across the day. However, the high frequency data showed exceedances of the design flow for periods of time.

If this is the case, the effluent may not be effectively treated during these periods of high flows, resulting in breaches of the *E. coli* consent conditions.

5.1.3 Other Breaches

See section 3.1.3 for the breaches in leachate volume.

The total suspended solids concentration has also breached the 7-day rolling median and 90th percentile consent conditions on 21 and 39 occasions respectively since 2013. The most recent breach was in March 2020. Prior to early 2020, there hadn't been a breach since early 2018.

There have also been occasional breaches in BOD_5 and TKN levels since 2013. BOD_5 exceeded the 7-day rolling median and 90th percentile on 3 and 7 occasions respectively while TKN exceeded its limits on 5 and 8 occasions respectively. However, the most recent of these for both BOD_5 and TKN was in 2014.
No exceedances of the TP concentrations were reported.

5.2 Simple Simulation of Process with BioWin

High-level BioWin simulation was undertaken to provide further insight into the effect of high inflows on treatment efficiency.

5.2.1 Inflow characteristics

The daily aggregated inflows were divided by 24 to establish a stable average hourly inflow to use in the modelling. This method allows for the construction of a higher frequency inflow record as input to the BioWin simulator.

Since no measured data was available the influent concentration for the model was represented using the general concentration of municipal wastewater (Metcalf & Eddy, 2014). The concentrations used are shown in Table 5.

Table 5: Generalised water quality of municipal waste

Water quality parameter	Concentration (mg/L)
Biological Oxygen Demand (BOD)	183
Total Kjeldahl Nitrogen (TKN)	32
Total Phosphorus (TP)	5
Total Suspended Solids (TSS)	178

Leachate flows received from FNDC showed that these flows could account for between 2.5% and 12.4% of the total inflow to the KR-WWWTP. The characteristics of the leachate are detailed in OPUS (2006) and are presented in Table 6.

Table 6: Leachate quality (After OPUS, 2006)

Water quality parameter	Mean	Maximum	90%tile	No. of samples
Total Organic carbon (g/m^3)	52.5	165.1	117.4	8
Chemical Oxygen Demand (g/m^3)	113.7	474.0	162.8	23
Biochemical Oxygen Demand (g/m^3)	15.3	200.0	13	22
Dissolved Oxygen (g/m^3)	2.4	4.4	4.2	11
Ammoniacal-N (g/m^3)	18.56	58	41.8	23
Nitrate-N (g/m^3)	1.41	8.1	2.9	12
Dissolved Reactive Phosphorus (g/m^3)	0.13	0.5	0.3	13
pH	7.01	7.5	7.3	23
Salinity (mg/m^3)	0.82	1.4	1.2	21
Conductivity (µS/m)	322.9	2171	268	23
Alkalinity Total (mgCaCO3/L)	576.4	970	856	23
Hardness Total (mgCaCO3/L)	486.6	791	668	18

The concentrations of the parameters monitored as part of the consent (BOD_5, TSS, TKN, and TP) are lower in the leachate flows than in the municipal wastewater. The generalised concentration for municipal waste was therefore used in the modelling, since it would be conservative in accounting for the effect of the leachate flows on the influent quality.

5.2.2 Future Loads

Based on the population projections the future loads were taken as the same as the current loads.

5.2.3 BioWin Model Configuration

Three models were configured based on the average flow, 90th percentile (both based on last three years of flow in the provided record) and the theoretical maximum (i.e., the flow that could cause the SBR1 to receive inflow during the settling/decant phase, 61.6 m^3/hr).

The Peak Wet Weather Flow[2] (PWWF) has been excluded from the modelling since its hourly average, 97.1 m^3/hr, exceeds the maximum flow rate that could cause SBR2 to receive inflow during the settling/decanting phases (81.2 m^3/hr) and it was accepted that adequate treatment would not be achieved for this scenario. The PWWF was also omitted from the OPUS (2006) study due the issue of overloading the system.

The configuration of the BioWin model is illustrated as below:

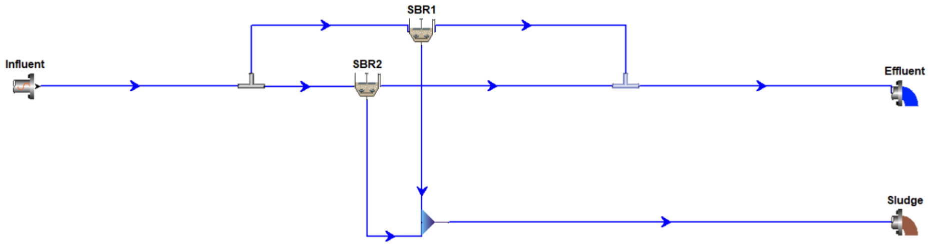


Figure 4: BioWin configuration for the KR-WWTP

The model aims to represent the SBRs under various inflow scenarios and does not incorporate the wetland and filtering system into the simulation. The exclusion of the wetland is due to its current non-operational status, while the filtering system is omitted due to its complex representation in BioWin. Therefore, the model's effluent solely represents the effluent from the SBR system and the inflow to the filtering system.

BioWin does not have functionality for level-based control that is currently used, and a conversion from level control to time-based control was required. This is illustrated below:

At the start of the day, both SBR 1 and SBR 2 working volumes are at low level. Initially, the flow is directed to SBR 1 (dimensions: 14 m x 4.4 m x 6.2 m), starting at a minimal liquid level of 5.2 m. Once filled to its maximum level of 5.7 m, the flow is redirected to SBR 2 (dimensions: 14 m x 5.8 m x 6.2 m), and SBR 1 enters the settling/decanting/idle phase. As SBR 2 fills from level 5.2 m to 5.7 m, the flow shifts back to SBR 1. The total cycle time equals the sum of the filling/reaction phases of SBR 1 and SBR 2. Additionally, one SBR's filling/reaction phase corresponds to the other SBR's settling/decanting/idle phase. For instance, the filling/reaction phase of SBR 1 matches the settling/decanting/idle phase of SBR 2, and vice versa.

[2] The PWWF was calculated from equations presented in the Regional Infrastructure Technical Specifications (RITS).

Assuming an average hourly inflow rate of 20 m^3/hr for a given day, the filling/reaction phase for SBR 1 would be (14 x 4.4 x 0.5)/20 = 1.54 hours, and for SBR 2 it would be (14 x 5.8 x 0.5)/20 = 2.03 hours. Therefore, the total cycle time amounts to 3.57 hours. In the model run illustrated below, rounded values were selected for each phase.

5.2.3.1 Average inflow

Using inflow flow data for the last three years, the average flow rate is determined to be 364 m^3/d (15.2 m^3/hr).

The operating phases obtained from the procedure above resulted in the following duration-based operation for the SBRs.

Cycling time: 5 hr

SBR1 (14 m x 4.4 m x 6.2 m)	SBR2 (14 m X 5.8 m X 6.2 m)
Filling/React: 2h10 minutes	Filling/React: 2h50 minutes
Settling/decanting/idle: 2h50 minutes	Settling/decanting/idle: 2h10 minutes

During the react phase, the SBR maintains a DO level of 1.5 mg/L.

The modelling uses the average hourly flow of average daily flow (364 m^3/day), and since the influent concentrations remain constant, the influent loadings are constant as well, as detailed below:

Table 7: Influent loadings for average inflow

Parameter	Influent load (kg/day)
BOD_5	68
TKN	12
TP	2
TSS	66

Comparing the simulated effluent concentration with the effluent data and consent conditions (Table 8) reveals that for average inflows the treatment system could reduce the concentrations of the parameters of concern close to (or below) the consent conditions before the sand filter. TSS concentrations above the consent limits is expected to be reduced to below the consent limit by the sand filter.

Table 8: Model results for average inflow

Effluent parameter	Simulated effluent quality	Effluent data (median values)	Consent condition - Rolling median
BOD_5 (mg/L)	2.2	3.4	10
Filtered BOD_5 (mg/L)	0.75	-	-
TKN (mg/L)	2	5.1	20
TP (mg/L)	4.1	7.2	15
TSS (mg/L)	13	8.5	10

Notes:

1. *Values in red indicate potential exceedance of the consent condition prior to pressure filtering and UV treatment*

5.2.3.2 Assessment of capacity under 90th percentile flow (Peak flow) conditions

The 90th percentile flow from the last three years of data was calculated to be 668 m^3/d (27.8 m^3/hr).

The duration-based operation for the SBRs is listed below:

Cycling time: 2hr30 minutes

SBR1 (14 m x 4.4 m x 6.2 m):

Filling/React: 1h10 minutes

Settling/decanting/idle: 1h20 minutes

SBR2 (14 m X 5.8 m X 6.2 m):

Filling/React: 1h20 minutes

Settling/decanting/idle: 1h10 minutes

During the react phase, the SBR maintains a DO level of 4 mg/L.

The modelling uses the average hourly flow of the peak daily flow (668 m^3/day), and since the influent concentrations remain constant, the influent loadings are constant as well, as detailed below:

Table 9: Influent loadings for 90th percentile flow

Parameter	Influent load (kg/day)
BOD_5	91
TKN	16
TP	3
TSS	89

Modelling results are presented in Table 10, which shows an increase in the concentrations of the parameters of concern, especially TSS. It is however, expected that the pressure filter would reduce the TSS concentration.

Table 10: Model results for 90th percentile flow

Effluent parameter	Modelling results	Effluent data (peak values)	Consent condition - Rolling 90th Percentile
BOD_5 (mg/L)	7.5	6	25
Filtered BOD_5 (mg/L)	1.0	-	-
TKN (mg/L)	2.9	10	40
TP (mg/L)	4	11	30
TSS (mg/L)	39	14	25

Notes:

1. *Values in red indicate potential exceedance of the consent condition prior to pressure filtering and UV treatment.*

5.2.3.3 Theoretical maximum flow

As discussed in Section 4.2.4.1, the theoretical maximum flows corresponding to each of the SBRs are different. The lower theoretical maximum flow (61.3 m^3/hr) is tested with the BioWin model to assess the treatment system's performance under extremely high flow events.

The duration-based operation for the SBRs is listed below:

Cycling time: 1hr10 minutes

SBR1 (14 m x 4.4 m x 6.2 m):	SBR2 (14 m X 5.8 m X 6.2 m):
Filling/React: 30 minutes	Filling/React: 40 minutes
Settling/decanting/idle: 40 minutes	Settling/decanting/idle: 30 minutes

During the react phase, the SBR maintains a DO level of 4 mg/L.

The modelling uses the average hourly flow of the theoretical maximum daily flow (1,478 m^3/day) and since the influent concentrations remain constant, the influent loadings are constant as well, as detailed below:

Table 11: Influent loadings for theoretical maximum flow

Parameter	Influent load (kg/day)
BOD_5	201
TKN	35
TP	6
TSS	196

Modelling results are presented in Table 12, which shows an increase in the concentrations of the parameters of concern, especially TSS, TKN and BOD_5. It is expected that the pressure filter would be overloaded at this TSS concentration.

Table 12: Model results for theoretical maximum inflow

Effluent parameter	Modelling results	Effluent data (peak values)	Consent condition - Rolling 90th Percentile
BOD_5 (mg/L)	118	6	25
Filtered BOD_5 (mg/L)	1.5	-	-
TKN (mg/L)	21	10	40
TP (mg/L)	8	11	30
TSS (mg/L)	400	14	25

Notes:

1. *Values in red indicate potential exceedance of the consent condition prior to pressure filtering and UV treatment*

5.3 Potential Performance Improvements

The modelling results suggest the need for an inflow balancing system to mitigate extreme flow variations. Using the existing pond 1 (wetland 1) to serve as an inflow balancing tank could be a practical solution if a method for removing primary sludge is incorporated into the redesign and refurbishment. The risks associated with this approach have been reported in technical memorandum (FNDC, 2023b) and are listed below:

- There is no mechanism to de-sludge the pond after its use, this creates an odour risk if sludge cannot be removed.
- The location of the pond means a liner will be required. A potential breach in the liner will contaminate the adjacent stream with raw sewage, this stream is a tributary to the harbour and sensitive shellfish beds.

- The use of the pond presents a change in use which may not be covered by the current resource consent, and this change in use may require a consent variation.
- The proximity of a public walkway to this area of the plant presents a reputational risk for the council when members of the public are coming past when the pond is full of sewage.
- The wetland wetwell pumps are not sized to be the primary pumps feeding the plant.

5.4 Alternative Solids Handling Approach

As mentioned previously land treatment of the settled sludge and a dewatering plant are alternatives that could be investigated further. The detail of such systems is beyond the scope of this study since it would require the identification of suitable land for biosolids acceptance and application for consent to discharge to land.

6.0 Conclusions and Recommendations

The performance assessment of the KR-WWTP plant has identified the following key conclusions:

- Based on estimates of population growth, inflows to the plant are unlikely to increase significantly beyond existing flows and loads.
- Assessment of the historical inflows and associated performance of the plant has indicated that the inflows are impacted by I&I volumes and that the treatment system is hydraulically overloaded during peak inflow events.
- Hydraulic limitations are due to the elevated inflow reducing cycle times for the SBR, which in turn results in reduced treatment capacity with a risk of solids washout.
- Assessment of historical effluent quality indicated that exceedances of the consent conditions for *E. coli,* BOD_5 and TKN have been observed. Inadequate treatment performance has anecdotally been related to overloading, solids carry-over and equipment issues.
- High-level Biowin modelling undertaken showed that average and 90th percentile inflows could be accommodated by the KR-WWTP but peak flows resulted in inadequate treatment efficiency due to overloading.

Based on these conclusions, the following recommendations are proposed:

- That investigations are conducted into flow balancing upstream of the SBR to attenuate inflow peaks and result in a more stable inflow pattern to the SBRs.
- That key risks associate with primary balancing are assessed and mitigated;
- That, with potential increased balancing, opportunities for optimising settling times in the SBR sequence are investigated.

In providing these conclusions and recommendations, the following aspects are noted:

- The effect of Increased I&I into the network due to climate change has not been accounted for in this study since it is assumed that a network maintenance program will be undertaken in future.
- Maintenance and operations issues have not been the focus of this assessment but is highlighted in a separate technical memo Russell Wastewater Treatment Plant Issues for consideration (FNDC, 2023b).

7.0 References

Brunsdon, Nick;. (2022). *Far North District Population Projections.* Infometrics on behalf of Far North District Council.

Chen, G., van Loosdrecht, M. C., Ekama, G. A., & Brdjanovic, D. (2020). *Biological Wastewater Treatment 2nd Edition.* London: IWA.

Ekama, G.A., Marais, G.V.R., Siebritz, I.P., Pitman, A.R., Keay, G.F.P, Buchan, L., Gerber, A., Smollen, M. (1984). *Theory, Design and Operation of Nutrient Removal Activated Sludge.* University of Cape Town.

FNDC (2023a).Russell WWTP Operations and Maintenance Manual. Issued for comment.

FNDC (2023b).Russell Wastewater Treatment Plant Issues for Consideration. Memo from Phillip Shoebridge to Mary Moore - Far North Water Alliance.

Johnson, P., Cheetham, N., Brickell, A., & Sharplin, B. (2003). *A Peer Review of the Russell/Tapeka Point Sewage System.* Far North District COuncil.

Metcalf, & Eddy. (2014). *Wastewater Engieering - Treatment and Resource Recovery fifth edition.* New York: McGraw Education.

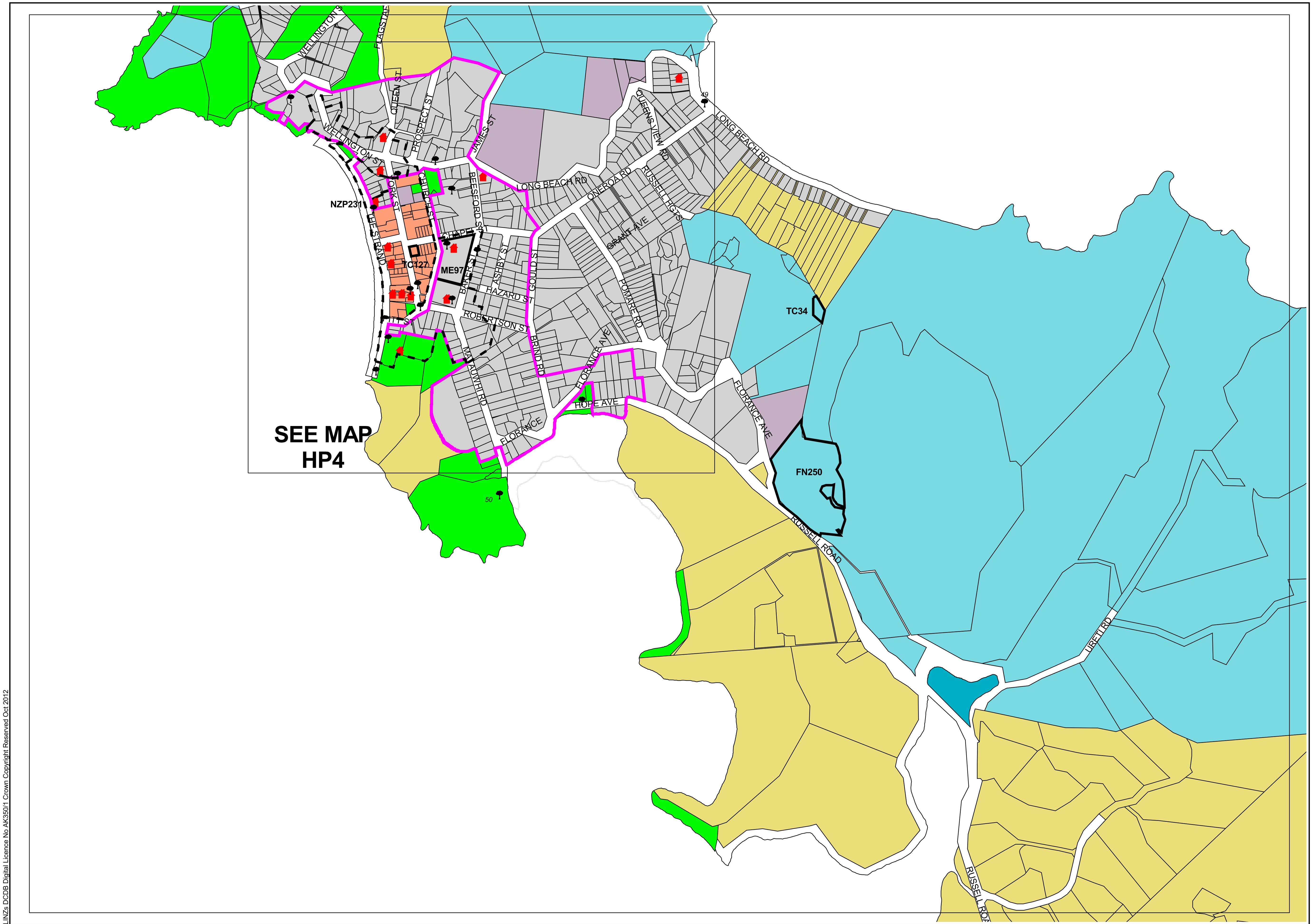
Ormiston, A. W., & Floyd, R. E. (2004). *On-Site Wastewater Systems:Desgin and Management Manual (TP 58).* Auckland Regional Council.

Population Projections - Growth Areas. (2023, September). Retrieved from Infometrics: https://population.infometrics.co.nz/far-north-district/growth-areas

Russell. (2023, September). Retrieved from StatsNZ: https://www.stats.govt.nz/tools/2018-census-place-summaries/russell

Shoebridge, P. (2023). Email from Phillip Shoebridge (WSP) to Wageed Kamish (PDP), 2 November 2023. RE: Russell WWTP flow data. Phillip.Shoebridge@wsp.com

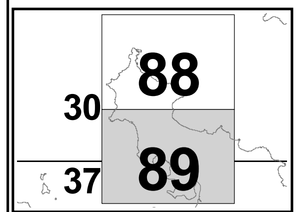
Appendix A: FNDC Zone Map



Zone

- Conservation
- Coastal Living
- Commercial
- General Coastal
- Lakes and Rivers
- Recreational Activities
- Russell Township
- Road
- Coastal Marine
- Designations
- Historic Site
- Notable Tree
- Heritage Precinct
- Russell Township Basin and Gateway Area

Note :-
Roads carry the same zoning as the adjoining land. If a boundary between zones follows a road, the zone boundary is located on the centreline of the formed road, or where unformed, the centreline of the legal road



Map Index
Map 89
RUSSELL

Far North District Plan - Zone Maps

N

0 200 400 600 m
Scale 1:10,000

DISCLAIMER

Considerable care has been taken to avoid errors and omissions, and the latest information has been included in these District Plan maps. However, even with the greatest care inaccuracies may occur and therefore the Far North District Council cannot accept any responsibility for such errors and omissions.

Appendix D: Groundwater and Surface Water Quality Effects Assessment

Groundwater and Surface Water Quality Assessment - Kororāreka/Russell Wastewater Treatment Plant

Prepared for

Far North District Council

November 2023

PATTLE DELAMORE PARTNERS LTD
Level 5, PDP House
235 Broadway, Newmarket, Auckland 1023
PO Box 9528, Auckland 1149, New Zealand

Tel +64 9 **523 6900**
Web www.pdp.co.nz

solutions for your environment

Quality Control Sheet

TITLE	Groundwater and Surface Water Quality Assessment - Kororāreka/Russell Wastewater Treatment Plant
CLIENT	Far North District Council
ISSUE DATE	30 November 2023
JOB REFERENCE	A03576827

Revision History

REV	Date	Status/Purpose	Prepared By	Reviewed by	Approved
1	30/11/2023	Final	Georgia Swan & Florence Dowson	Dave Stafford & Phil Hook	Hayden Easton

DOCUMENT CONTRIBUTORS

Prepared by

SIGNATURE

Georgia Swan

Florence Dowson

Reviewed by

Approved by

SIGNATURE

Dave Stafford & Phil Hook

Hayden Easton

Limitations:

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Far North District Council and Analytica Laboratories. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This report has been prepared by PDP on the specific instructions of Far North District Council for the limited purposes described in the report. PDP accepts no liability if the report 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.

Table of Contents

Table of Figures

Table of Tables

1.0 Introduction

Pattle Delamore Partners Limited (PDP) have been engaged by Far North District Council (FNDC) to undertake a groundwater and surface water assessment of effects to inform the options assessment for the reconsenting of the Kororāreka/Russell Wastewater Treatment Plant (KR-WWTP) located at 6140 Russell Whakapara Road, Russell.

This report outlines the results of groundwater and surface water quality monitoring and provides a discussion on the potential impact of treated wastewater discharge to the receiving environment via the 'disposal' bore field.

It is recognised that there are existing operational issued associated with the bore disposal field, including decreased bore soakage performance due to 'clogging' resulting in surface 'overflow' discharge. PDP have previously undertaken a disposal bore field performance review and provided recommendations for remedial works.

It is understood that FNDC intend to undertake recommended remedial works as part of KR-WWTP reconsenting, assuming the borefield is retained as the preferred discharge option. The remediation work is being undertaken by PDP as a separate package of works, however information relating to the condition of the discharge bores and the performance assessment has been utilised to inform this assessment.

The assessment of effects presented as part of this report is based on the current condition of the bore disposal field.

2.0 Scope

In order the achieve the assessment objectives the following scope of works was proposed.

Desktop Information Review

- Review available geological and hydrogeological information, including available bore logs, aquifer properties test data and groundwater level monitoring data (where available).

Site Visit

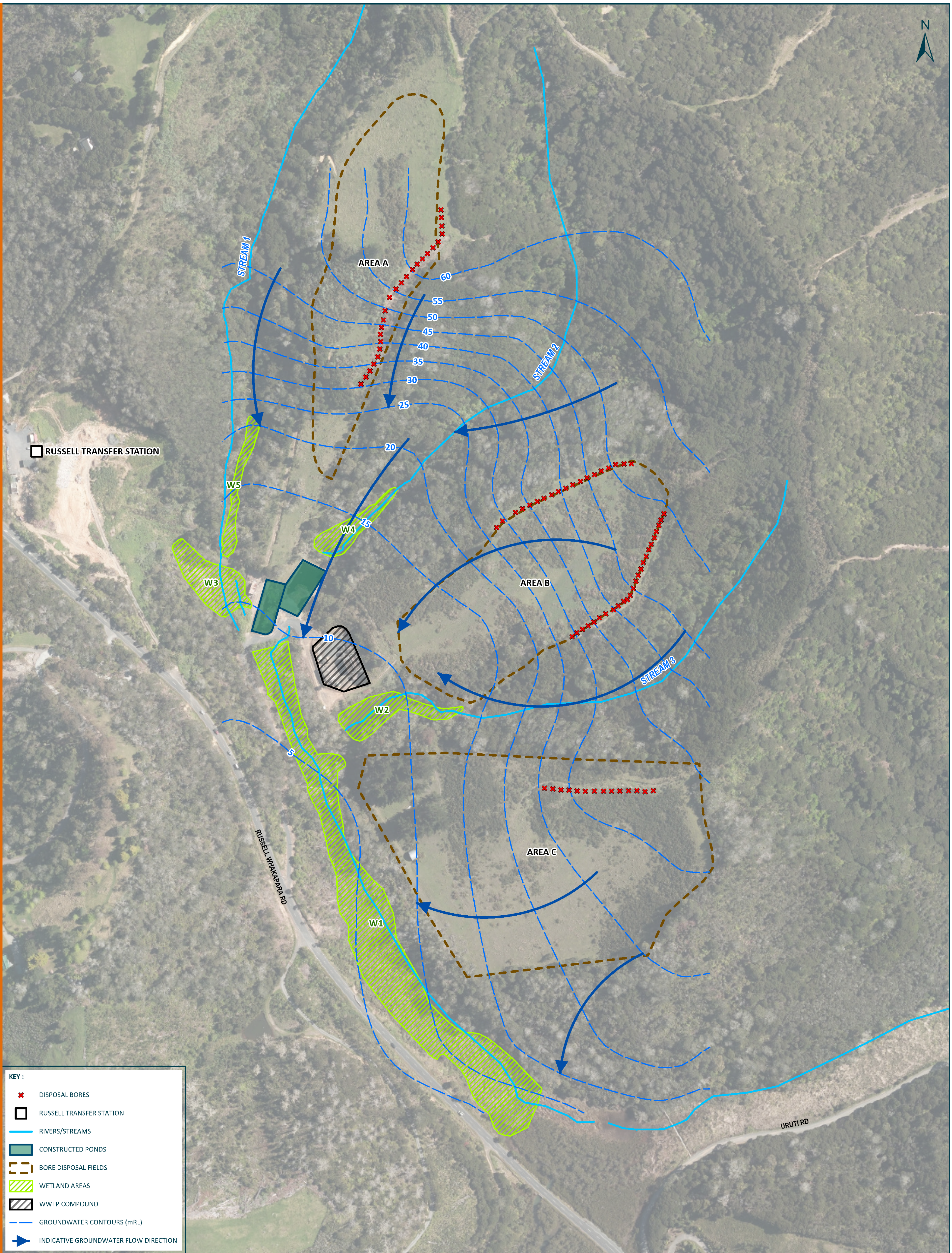
- Undertake condition survey of the groundwater monitoring network. This is required to access suitability of the existing monitoring network for on-going groundwater level monitoring, quality sampling and aquifer permeability testing.

- Undertake two rounds of surface water and ground water quality sampling from available monitoring locations.

- The site visit is also an opportunity to discuss the plant's current discharge regime, bore soakage performance and ongoing monitoring schedule with the KR-WWTP Plant Operator.

Assessment of Effects

- Develop a hydrogeological conceptual model of the site's groundwater setting. This model will be supported by published geological information as well as on site geological logs and aquifer properties information (if available).
- Use the hydrogeological conceptual model to assess the fate and transport of potentially impacted groundwater within the catchment, including point of discharge and hydraulic connection to surface water features (down-gradient streams and wetland areas).
- Assess both groundwater and surface water quality result against appropriate environmental standards to access the overall effects of KR-WWTP discharge to the receiving environment.



A03576827.aprx - A03576827_GIS002

0 40 80
METRES
SCALE : 1:3,000 (A3)

NO.	REVISION	DATE	BY
C	FINAL	NOV 23	KB
B	ISSUED FOR REVIEW	OCT 23	TK
A	ISSUED FOR REVIEW	OCT 23	BR

SOURCE:
1. AERIAL IMAGERY (FLOWN 2021) SOURCED FROM THE LINZ DATA SERVICE www.linz.govt.nz/ AND LICENCED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.
2. CADASTRAL/TOPOGRAPHICAL INFORMATION AND INSET DERIVED FROM LINZ DATA.
3. GROUNDWATER CONTOURS DERIVED FROM INTERPOLATION OF GROUNDWATER LEVEL POINTS.

CLIENT
Far North District Council

FIGURE
FIG 1: GROUNDWATER CONTOURS AND FLOW DIRECTION

PROJECT
RUSSELL WWTP RECONSENTING

3.0 Background Information – Bore Disposal Scheme

3.1 Site Setting & Applicant Details

The KR-WWTP and associated bore disposal areas are located approximately 1km southeast of the Kororāreka/Russell township.

The site location and layout are presented in Figure 1.

Site and applicant details are presented in Table 1.

Table 1: Site and Applicant Details

Applicant	Far North District Council
Legal Description	Section 1 Survey Office Plan 310696, Section 39 Block I Russell Survey District, Eastern Part Deposited Plan 3389 and Lot 1 Deposited Plan 156210
Statute	Acquired for Sewage Treatment and Disposal and Landfill Purposes
Landowner	Far North District Council
Grid Reference	1703355N 6096548E

3.2 Bore Disposal Field

The bore field currently consists of 85 No., 250 mm diameter disposal boreholes situated between 45 to 80 m Relative Level (RL) along four (4) ridgelines. Bores are closely spaced (approximately 3 to 10 m) and are drilled to approximately 20 m to 30 m bgl (below ground level) into the fractured Greywacke. The disposal bores are typically cased to 6 m bgl with 'open hole' sections installed across the unsaturated zone (above the regional groundwater table).

The boreholes are separated into three disposal areas (A, B & C), across four ridgelines (Figure 1). Currently only bore field A and B are operational, following damage to bore field C during cyclone Gabrielle in February 2023.

In addition to disposal bores installed within the unsaturated zone, as many as 31 No. groundwater monitoring piezometers have previously been installed across site for the purposes of monitoring groundwater level mounding and water quality. These observation piezometers are installed to depths of approximately 15 m to 30 m bgl depending on the elevation and respective depth to groundwater.

A high number of these bores are either lost, destroyed or damaged. A bore condition survey undertaken by PDP (August, 2023), located only 5 No. monitoring bores, all of which were either damaged or dry (incorrectly installed to target the regional groundwater table (discussed further in Section 5). There are currently no usable groundwater monitoring piezometer at site.

The location of all disposal bores are depicted in Figure 1.

3.3 Effluent Disposal Process

The following scheme process description is taken from the two preceding Resource Consent Applications lodged in 2001 (EBG, 2001) and 2013 (FNDC, 2013) as well as from discussion with the Plant Operator on site where the current scheme operation differs from that stated by the resource consent.

Effluent Load

The plant receives wastewater from the Russell/Tapeka Point communities in addition to small quantities of leachate from the adjacent Russell Landfill.

Intended Disposal Operation

After treatment, treated wastewater is intended to be distributed via three individual delivery pumps to the three bore disposal areas (A, B & C; Figure 1). Within each of the three disposal areas, bores are further divided into 14 bore groups, consisting of a cluster of between 5 and 7 neighbouring bores. Each bore group is supplied with treated wastewater by a single control valve. At the time of commissioning, the flow of treated wastewater was intended to be controlled by a Programmable Logic Controller (PLC) system. Each disposal bore is installed with a flowmeter and a shut-off 'float' switch designed to close the group diaphragm valve when the float switch is triggered. The PLC is intended to stop pumping through the bore group control valve when the group is full and will resume pumping to the group following a pre-set stand-down period (typically 30 to 60 mins). Following a pre-set pumping duration, the PLC is also intended to cycle through the bore groups at an unknown preselected discharge interval.

Typically, only two bore areas are operated at any given time, with one area 'at rest' to allow induced groundwater mounding to return to the natural groundwater level.

Current Disposal Operation

Based on discussion with the Plant Operator, it is understood that the PLC automation system is not operational, and the current disposal sequence is entirely controlled by manual selection of individual bore areas. With no PLC sequencing, borefield A and B control valves have been manually set to the open position and manual switching between bore discharge areas is based on qualitative assessment of groundwater mounding inferred by review the groundwater levels in surrounding observations bores which are not functional. However, since groundwater level monitoring ceased in 2019, discharge to bore areas has been cycled on an arbitrary basis, typically 2 months on, 1 month off. As of February 2023 bore discharge area C has been un-operational and as such no cycling is being completed between discharge areas A and B.

Based on PDP's understanding, individual bore shut-off switches no-longer control the bore group valve when manually affixed to the open position. This may explain reported instances of the overflowing bores. The Plant Operator also suggested that rodent damage (chewing of the switch control valve lines) may also be responsible for borehead flooding. Alternatively, given the close positioning of grouped bores, the steep ridgeline and interconnected fracturing, overflowing bores may also be the result of short-circuiting flow between hydraulically interconnected bores. For example, the up-gradient bore within a group may flood a down-gradient bore through fracture flow without triggering its own its float switch if the down-gradient bore float switch is damaged.

4.0 Key Sources of Information

The following sources of information have been reviewed as part of this assessment of effects.

- Environment and Business Group Ltd (2001) Russell Wastewater Proposed Irrigation and Additional Borehole Disposal Description of Proposal and Assessment of environmental Effects. Report prepared for FNDC, June 2001.
- MHW (2003) The Preparation of a Combined Wastewater Asset Management Policy and Liquid Waste Management Plan – "A Peer Review of the Russell/Tapeka Point Sewerage System".
- Far North District Council (2013) Resource Consent Application and Assessment of Effects on the Environment: Russell Wastewater Treatment Plant.
- Riley (2015) Addendum Review of Piezometer Monitoring Results – February 2015 to May 2015 Russell Sewerage Disposal Scheme.
- Riley (2017) Bore Infiltration Assessment – Russell Wastewater Disposal Scheme.
- Riley (2019) Review of Piezometer Monitoring Results - June 2015 to June 2019 Russell Sewerage Disposal System, Russell.
- Ventia (2021) Monthly bore disposal volumes and groundwater level spot measurement (2010 to 2019).
- PDP (2021) Site Visit: Observations made by PDP during site visit and anecdotal observations made by plant operator.

5.0 Site Visits

PDP have conducted five (5) site visits between June 2021 and October 2023. Initial site visits were undertaken to assess the condition of the bore disposal field, including review of bore field operations, observable bore performance (soakage capacity) and visual inspection of slope stability.

Subsequent site visits on 25th August 2023, 6th September 2023 and 3rd October 2023 were undertaken to assess the condition of groundwater monitoring bore network, surface water sampling locations and the completion of two rounds of the water quality sampling.

Please note, preliminary site observations relating to bore field soakage performance and slope stability are detailed as part of the Bore Performance and Slope Stability Review (PDP, 2021).

Key observations from the site visit, including anecdotal discussion with the Plant Operator regarding monitoring and compliance related issues relevant to this assessment are summarised as follows.

Groundwater monitoring network condition survey

- Attempts to locate monitoring piezometers at site identified just five (5) of the historically reported 31 positions. Of the five (5) located piezometers, three (3) were dry (OB1, OB2 & OB3) and all other were damaged. As a result, no piezometers suitable for ongoing monitoring were located at site.
- During the site visit, no surface flow was observed from the immediate vicinity of the discharge bores, however a 'seep' was observed at the base of borefield A.

The following remarks are based site observations and anecdotal discussion with the on-site Plant Operator during the 25th August site visit.

- No groundwater level data has been collected at site since November 2019.
- A number of disposal bores are routinely flooding at ground surface due to deteriorating bore performance. The operator reported that flooding at ground surface has increased frequency following cyclone Gabrielle.
- Bore field C is currently un-operational following large discharge and sludge volumes during cyclone Gabrielle 5th February – 11th February 2023.
- The automated discharge sequence controller is not operational. The Plant Operator therefore switches flows across the three bore disposal areas manually. The automated discharge sequence was intended to ensure the disposal scheme operates at optimum efficiency to prevent excessive mounding and surface flooding. Since no groundwater level monitoring is undertaken at site, manual switch over is no-longer informed by any groundwater level 'mounding' data.

6.0 Environmental Setting

6.1 Topography & Geology

The bore disposal area is characterised by a series of steeply sloping gassed ridgelines and densely vegetated gullies situated to the north-east of the KR-WWTP plant. Small stream tributaries are associated with each gully, which flow generally south-west into the low-lying wetland area adjacent to the treatment plant (Figure 1).

The disposal site geology is comprised of Waipapa Group Greywacke Formation, characterised by variable weathering, fracturing and associated formation permeability.

The shallow sub-surface (top of the weathering profile) is characterised by a mantle of approximately 2 to 6 m of low permeability Rangiora clay (completely weathered Greywacke), characterised by clay loam and silty clay loam (RA and RAH; NRC GIS Layer: Managing Northland Soils).

Beneath the completely weathered residual soil zone, moderately to highly fractured Greywacke extends to approximately 24 m bgl (below ground level) (EBG, 2001; PDP, 2021). At increased depths (>24 m bgl) Greywacke generally becomes increasingly unweathered, although a degree of fracturing is anticipated to persist with depth.

6.2 Groundwater

Historic groundwater level monitoring between January 2014 and November 2019 has been used to infer groundwater levels across the site. No recent groundwater level data is available due to the condition of the existing groundwater monitoring bore network (as discussed in section 5.0).

Across the bore disposal area, the regional groundwater level is situated within the fractured Waipapa Group Greywake formation at approximately 15 m to 24 m bgl.

Available historic groundwater level data also indicates the presence of a shallow perched groundwater layer associated with the low permeability Rangiora Clay (completed weather residual soil).

6.2.1 Groundwater Flow Regime

Regional groundwater flow is generally north, north-east to south, from the higher topography ridgelines towards the down-gradient wetland and stream tributaries. Regional groundwater flow contours have been inferred from stream elevations and historical groundwater levels across the site (FNDC 2019 - 2020) and are shown in Figure 2.

Flow direction of shallow perched groundwater across the disposal area is anticipated to follow the more localised topography towards the incised stream gullies. Hydraulic connection to the shallow perched groundwater is likely to contribute the seasonal stream flow.

Based on the anticipated high hydraulic permeability of the fractured Greywacke and low elevation of receiving down-gradient surface-water features, lower reaches of the stream gullies and wetlands are considered to be the primary receptor for discharging groundwater migrating from the disposal area. As a result, all discharged treated wastewater is anticipated to migrate from the bore disposal area to receiving surface water.

The conceptual groundwater flow regime is presented by via means of groundwater flow contours (Figure 1) and a schematic conceptual hydrogeological cross section (Figure 2).

6.2.2 Groundwater Recharge & Throughflow

Low permeability residual geology (Rangiora Clay soil) is anticipated to limit rainfall infiltration across the bore disposal area. This is supported by surface run-off observed by the plant operator during high rainfall events and instance of disposal bore 'overflow' run-off (discussed in further detail in Section 7.1.1).

Estimated groundwater throughflow has been calculated to determine the volume of groundwater migrating across the bore disposal area to receiving surface water.

Groundwater throughflow at the site has been estimated using Darcy's Law, which is described by Kruseman and de Ridder (1991) as:

$$Q = K\frac{dh}{dl}A$$

where Q = volume rate of flow (m^3/d), K = hydraulic conductivity of the material (m^2/d), dh/dl = hydraulic gradient (unitless) and A = the cross-sectional area normal to flow direction (m^2). Throughflow calculation is outlined in Table 2.

Based on conservative estimates of hydraulic conductivity (4 m/d), hydraulic gradient (0.1) and cross-sectional area (3,600 m^2), the estimated total volume of groundwater migration across the bore disposal area to the receiving surface water catchment (stream and wetland) is approximately 534,360 m^3/yr.

Please note this is throughflow estimate is calculated based on available historical groundwater levels (to calculated inferred hydraulic gradient) and therefore includes potential groundwater mounding from treated wastewater discharge.

The annual average volume of treated wastewater discharge is 136,691 m^3/yr based on volumes recorded by December 2020 - February 2023 (WSP, 2023). This accounts for approximately 25% of total groundwater throughflow.

Table 2: Groundwater Throughflow Calculation

Input	Calculation	Justification
Throughflow Calculation Method	Darcy's Law $$Q = KiA$$ Where: K = Hydraulic Conductivity i = hydraulic gradient A = cross-sectional area of saturated aquifer	
Hydraulic Conductivity	4 m/d	Estimated bulk hydraulic permeability for fractured greywacke
Hydraulic gradient	0.1	Based on historical groundwater levels recorded across site
Saturated aquifer area	3,600 m^2	Cross-sectional width of the aquifer transecting the disposal area (approximately 650m). x Saturated thickness of the aquifer based on available groundwater level data and the elevation of the Uruti wetland (primary point of regional groundwater discharge).
Throughflow	**534,360 m^3/yr**	

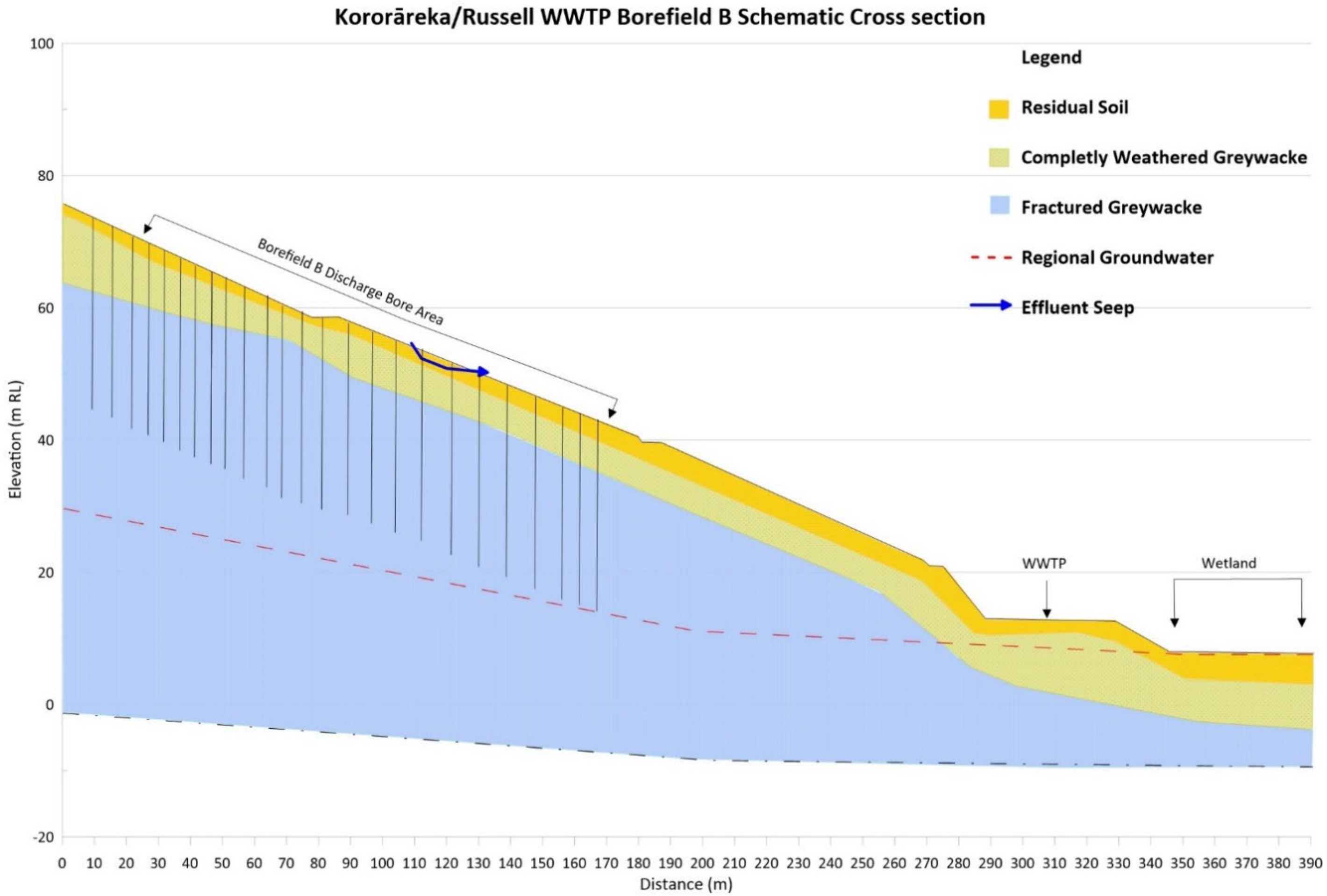


Figure 2: Schematic Hydrogeological Conceptual Model Cross section

7.0 Assessment of Effects

7.1 Groundwater Effects

Groundwater quality analysis was unable to be completed due to degradation (damage and/or loss) of all groundwater monitoring piezometer across the disposal site. New groundwater monitoring piezometers are recommended at the bore disposal area (up-gradient and down-gradient of bore fields) to close this monitoring gap.

In the absence of groundwater quality data PDP are unable to directly assess the impact of treated wastewater discharge to groundwater. This assessment is therefore reliant on sampling of surface water to assess the effects of treated wastewater discharge on the receiving environment. This approach is supported by hydrogeological conceptual understanding of the groundwater flow regime, which anticipates all groundwater migrating from the bore disposal area to discharge down-gradient to surface water (identified streams and wetland areas). As a result, a standalone assessment of the surface water effects within the groundwater catchment is considered an appropriate means to assess the potential effects of treated wastewater discharge from the KR-WWTP to the receiving environment.

Surface water assessment of effects is discussed in detail in Section 7.2.

Groundwater 'Seeps'

During site visits a number of 'seeps' (daylighting 'groundwater') were observed across the disposal area (Bore Field A; Figure 1).

Located down-gradient of active disposal bores, these 'seeps' are assessed to be treated wastewater 'overflow' through the residual soil zone (not naturally occurring shallow perched groundwater springs). This is supported by water quality sampling of the 'seep' flows at surface which indicate elevated chloride (194 g/m^3 at Seep A; Figure 1), indicative of treated wastewater (214 g/m^3; treated wastewater sample collect from the plant), above background (up-gradient surface water) levels (approximately 60 g/m^3 at SW1).

Daylighting of treated wastewater discharge through the residual soil zone occurs when limited disposal bore soakage performance (potentially from 'clogged' fractured Greywacke) results in migration through the residual soil zone (PDP, 2021).

Due to low permeability of the residual soil, it is likely that daylighting treated wasteland will likely migrate rapidly overland to down-gradient surface waters (streams and wetland areas).

7.1.1 Effects on Neighbouring Groundwater Users

The Northland Regional Council bores GIS database indicates that there are no downgradient groundwater users.

All groundwater migration through the disposal area is anticipated to discharge to receiving surface water at the base of the groundwater catchment.

Furthermore, the groundwater catchment is topographically constrained and therefore any effects of the KR-WWTP discharge bores is not expected to influence groundwater users in adjacent catchments.

7.2 Surface Water

The KR-WWTP is located within the Bay of Islands Coast River Catchment. The nearest surface waterbody (an unnamed tributary) is located approximately 100 m south of the KR-WWTP and flows in a south-easterly direction and discharges into the low-lying wetland area/Uruti Bay mangroves.

Three small streams flow within the valleys adjacent to the bore disposal fields which then discharge into the unnamed stream at the south-western extent of the site (Figure 3). These streams flow in a general northeast to southwest direction and have very low flows (approximately less than 1 L/s). It is expected that the treated wastewater discharged to the bore fields supports the flow in these unnamed streams and otherwise they would likely be intermittent flow paths.

Five wetlands have been identified at the site. Four of these wetland areas are located at the downstream extent of the three small surface water streams with an additional wetland associated with the larger stream which the smaller streams discharge to (Figure 3).

7.2.1 Surface Water Quality Results

Surface water sampling was undertaken within the three unnamed streams which, as previously mentioned, are adjacent to the three bore field disposal areas. Sample sites were selected to establish, as best as practically possible, an upstream and downstream location for each stream to establish the potential surface water effects of disposing of treated wastewater to the shallow groundwater system. The upstream sampling locations provide an indication of the water quality prior to any potential mixing from the bore disposal field discharges. The downstream sampling locations were selected to provide an indication of the effects on water quality associated with the discharge (Figure 3).

Two surface water quality sampling rounds were completed at the KR-WWTP site on September 6th and October 3rd 2023. The water quality results provide an indication of the current water quality in the unnamed streams which are adjacent to the bore field disposal catchments and are expected to receive any discharged wastewater once it has moved through the fractured greywacke basement rock. Surface water sampling results are summarised in Table 2, Table 3 and Table 4 for each stream.

The surface water quality results have been compared against national bottom-line values indicated in the National Policy Statement for Freshwater Management (NPS-FM 2020) and against water quality standards presented in Table 22 in the NRC Proposed Regional Plan. In some instances, the NRC Proposed Regional Plan directs the results to be compared against the default guideline values (DGV) for toxicant, metal or metalloid in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZ WQ Guidelines, 2018). These values have been indicated in the associated results tables below.

It is noted that for the limited surface water results available (two sampling rounds), the results are indicative when compared against the NPS-FM as these guidelines are based on monthly sampling where sites are visited on a regular basis regardless of weather and stream conditions with a record length of at least 5 years. While it is not explicitly stated in the NRC Proposed Regional Plan that water quality results are required to be collected over longer term records, the use of annual medians and percentiles along with other statistics in Table 22 (Policy H.3.1) indicates that longer term water quality records are required to compare to the guidelines. As such, it is also noted that the results presented in this report are also indicative when compared against the NRC Proposed Regional Plan.

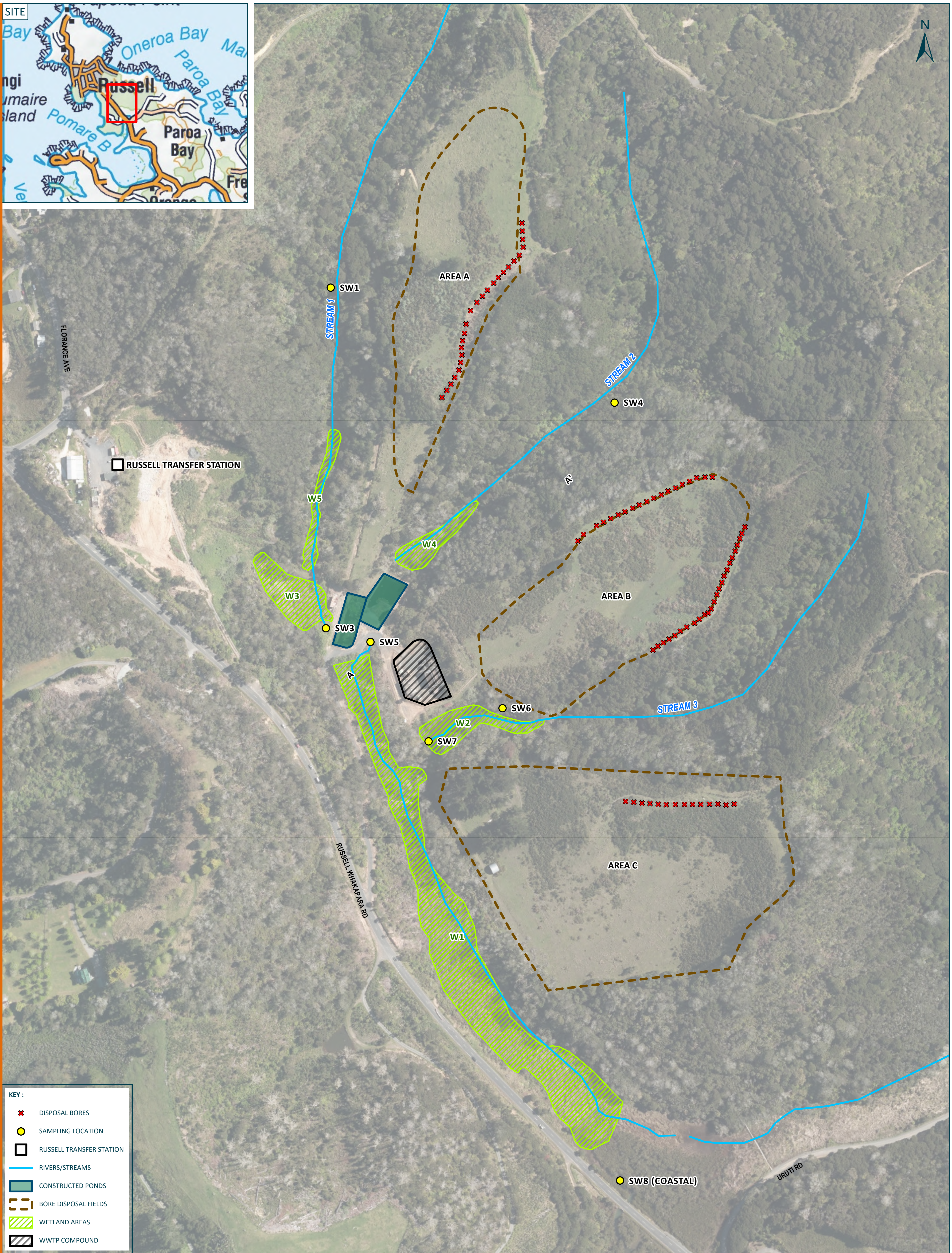
7.2.1.1 Stream 1: surface water quality results

Two surface water samples were collected along Stream 1. SW1 represents the upstream water quality prior to the influence of the bore disposal field Area A and sampling site SW3 represents the downstream surface water receiving environment (Figure 3).

In general, water quality results in Stream 1 were below guideline values where guideline values were available (Table 2). A notable trend of increased concentrations between the upstream and downstream site was evident for pH, electrical conductivity, nitrite-N, ammonia as N, TKN, total nitrogen, total phosphorus, iron, sodium and chloride which is potentially a result of the effect of the treated wastewater discharge.

E.Coli concentrations were below the 95th percentile bottom line outlined in the NPS-FM and NRC proposed regional plan for both sampling rounds for Stream 1 (Table 2). During the first sampling round, there was a notable increase in *E.Coli* between the upstream and downstream sites. However, during the second sampling round, this significant increase in *E.Coli* concentrations was not evident (Table 2).

Ammonia as N was elevated during both sampling events at SW3 which represents the surface water quality in the stream once mixing with the treated wastewater has occurred. Ammonia as N is characteristic of wastewater and as such, this result may provide an indication of the effect of the treated wastewater discharge to bore field area A.



A03578827.aprx - A03578827_GIS001

pdp

0 40 80
METRES
SCALE : 1:3,000 (A3)

NO.	REVISION	DATE	BY
C	FINAL	NOV 23	TK
B	ISSUED FOR REVIEW	OCT 23	TK
A	ISSUED FOR REVIEW	OCT 23	BR

SOURCE:
1. AERIAL IMAGERY (FLOWN 2021) SOURCED FROM THE LINZ DATA SERVICE www.linz.govt.nz/ AND LICENCED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.
2. CADASTRAL/TOPOGRAPHICAL INFORMATION AND INSET DERIVED FROM LINZ DATA.

CLIENT
Far North District Council

FIGURE
FIG 3: SITE MAP AND SURFACE WATER SAMPLING LOCATIONS

PROJECT
RUSSELL WWTP RECONSENTING

Table 2: Surface water quality results Stream 1

Analyte Suites	Parameter	6/09/2023		2/10/2023		NPS-FM[4] Guidelines	NRC Regional Plan Guidelines
		SW1	SW3	SW1	SW3		
Physio-chemical	pH	6.7	7.4	6.5	7.2	-	6.0< pH <9.0
	Electrical conductivity (µS/cm)	228	369	271	430	-	-
Nutrients (g/m^3)	Nitrate-N	0.544	0.409	0.511	0.278	3.5[5]	≤1.0
	Nitrite-N	<0.0010	0.0116	<0.0010	0.00538	-	-
	Ammonia as N	0.005	**0.51**	<0.005	**0.67**	0.40[5]	≤0.40
	DRP[1]	0.005	0.002	0.006	0.006	0.054[5]	-
	TKN[2]	0.17	0.67	<0.10	0.83	-	-
	Total Nitrogen	0.72	1.1	0.51	1.1	-	-
	Total Phosphorous	0.021	0.032	0.01	0.021	-	-
Heavy metals (g/m^3)	Arsenic	<0.00050	<0.00050	<0.00050	<0.00050	-	0.013[7,8]
	Chromium	<0.00020	0.00021	<0.00020	<0.00020	-	0.001[7,9]
	Copper	0.0003	<0.00020	<0.00020	<0.00020	-	0.0014[7]
	Iron	0.15	0.594	0.12	0.908	-	-
	Lead	0.000056	<0.000050	<0.000050	<0.000050	-	0.0034[7]
	Zinc	0.003	0.0012	0.0038	<0.0010	-	0.008[7]

Table 2: Surface water quality results Stream 1

Analyte Suites	Parameter	6/09/2023		2/10/2023		NPS-FM[4] Guidelines	NRC Regional Plan Guidelines
		SW1	SW3	SW1	SW3		
Sodium (g/m^3)		29.4	38.4	34.8	42	-	-
Chloride (g/m^3)		52.5	61.4	59.9	68.4	-	-
TSS[3] (g/m^3)		<3	63	<3	<3	-	-
Turbidity (NTU)		11.6	5.55	5.11	4.91	-	-
E.Coli Count (MPN/100 mL)		55	730	580	370	Band E (>1200)[6]	≤ 1200[10]

- *No guideline value available*

Analyte exceeds guideline value

Analyte does not exceed guideline

Notes:

1. *DRP = Dissolved reactive phosphorous.*
2. *TKN = Total Kjeldahl Nitrogen.*
3. *TSS = Total suspended solids.*
4. *National Policy Statement for Freshwater Management.*
5. *National bottom line as defined in NPS-FM at the 95th percentile. Note, lowest Attribute Band used in lieu of National 'bottom-line' for DRP.*
6. *95th percentile of E.Coli /100 mL. Note, lowest Attribute Band used in lieu of National 'bottom-line' for DRP.*
7. *Criteria from Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZ WQ, 2018) - Accessed 25/10/2023.*
8. *Default guideline value (DGV) for AsV.*
9. *Default guideline value (DGV) for CrVI.*
10. *95th percentile E.Coli for 'Other rivers' in the NRC Proposed Regional Plan.*

7.2.1.2 Stream 2: Surface Water Quality Results

Two surface water samples were collected along Stream 2. SW4 represents the upstream water quality prior to the influence of the bore disposal field Areas A and B and, SW5 represents the downstream receiving environment which is likely impacted by the discharge of treated wastewater to the disposal fields (**Figure 3**).

Similarly, to the Stream 1 water quality results, most of the analytes from Stream 2 were below the default guideline values (Table 3). It is noted that there was a general trend of increased concentrations of analytes between the upstream (SW4) and downstream (SW5) sample locations in Stream 2. This trend is apparent for electrical conductivity, nitrate-N, nitrite-N, ammonia as N, TKN, total nitrogen, total phosphorous, zinc, sodium, chloride, and *E. Coli* which suggests that there is an effect from the disposal of treated wastewater to bore field disposal Areas A and B. However, the effect from the bore fields does not appear to be elevating the concentrations of most analytes above guideline values.

E.Coli concentrations were below the Band E bottom line, 95th percentile concentration in the NPS-FM guideline table for all sites and during both sampling rounds. However, there was a noticeable increase in concentrations between the upstream (SW4) and downstream (SW5) site which suggests the treated wastewater discharge is likely having an influence on *E.Coli* concentrations in the downstream surface water receiving environment.

Nitrate-N concentrations were below the national bottom-line value outlined in the NPS-FM at SW5 however, these values were above the 95th percentile value indicated for nitrate-N in the NRC Proposed Regional Plan guidelines (Table 3) further suggesting a potential effect from the disposal field areas.

Table 3: Surface Water Quality Results Stream 2

Analyte Suites	Parameter	6/09/2023		2/10/2023		NPS-FM[4] Guidelines	NRC Regional Plan Guidelines
		SW4	SW5	SW4	SW5		
Physio-chemical	pH	6.9	7	6.6	6.6	-	6.0< pH <9.0
	Electrical conductivity (µS/cm)	233	354	272	427	-	-
Nutrients (g/m^3)	Nitrate-N	0.21	**2.45**	0.169	**2.54**	3.5[5]	≤1.5
	Nitrite-N	<0.0010	0.003	<0.0010	0.003	-	-
	Ammonia as N	0.009	0.03	<0.005	0.03	0.40[5]	≤0.40
	DRP[1]	0.01	0.006	0.007	0.005	0.054[5]	-
	TKN[2]	0.14	0.24	<0.10	0.24	-	-
	Total Nitrogen	0.35	2.7	0.17	2.8	-	-
	Total Phosphorous	0.033	0.048	0.026	0.041	-	-
Heavy metals (g/m^3)	Arsenic	<0.00050	<0.00050	<0.00050	<0.00050	-	0.013[7,8]
	Chromium	<0.00020	<0.00020	<0.00020	<0.00020	-	0.001[7,9]
	Copper	0.0004	0.00033	0.00026	0.00031	-	0.0014[7]
	Iron	0.13	0.18	0.16	0.14	-	-
	Lead	<0.000050	<0.000050	<0.000050	<0.000050	-	0.0034[7]
	Zinc	0.0016	0.0025	0.0012	0.0025	-	0.008[7]
Sodium (g/m^3)		31.4	44.9	34.5	49.1	-	-
Chloride (g/m^3)		51.2	73.6	56.2	82.1	-	-

Table 3: Surface Water Quality Results Stream 2

Analyte Suites	Parameter	6/09/2023		2/10/2023		NPS-FM[4] Guidelines	NRC Regional Plan Guidelines
		SW4	SW5	SW4	SW5		
TSS[3] (g/m^3)		3	4	26	8	-	-
Turbidity (NTU)		12.2	9.02	15.9	9.53	-	-
E.Coli Count (MPN/100 mL)		13	580	8	260	Band E (>1200)[6]	≤ 1200[10]

- No guideline value available

Analyte exceeds guideline value

Analyte does not exceed guideline

Analyte approaching bottom line/ within a lower attribute band

Notes:

1. *DRP = Dissolved reactive phosphorous.*
2. *TKN = Total Kjeldahl Nitrogen.*
3. *TSS = Total suspended solids.*
4. *National Policy Statement for Freshwater Management.*
5. *National bottom line as defined in NPS-FM at the 95th percentile. Note, lowest Attribute Band used in lieu of National 'bottom-line' for DRP.*
6. *95th percentile of E.Coli /100 mL. Note, lowest Attribute Band used in lieu of National 'bottom-line' for DRP.*
7. *Criteria from Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZ WQ, 2018) - Accessed 25/10/2023.*
8. *Default guideline value (DGV) for AsV.*
9. *Default guideline value (DGV) for CrVI.*
10. *95th percentile E.Coli for 'Other rivers' in the NRC Proposed Regional Plan.*

7.2.1.3 Stream 3: Surface Water Quality Results

Two surface water samples were collected along Stream 3. Access along this stream was difficult and as such, a representative upstream sample was not able to be collected. SW6 was as far upstream as could be accessed during the site visits and represents a mid-stream sample which is likely influenced by wastewater discharged to bore field disposal Areas B and C (note that bore disposal Area C has not been in operation since February 2023 due to large discharge and sludge volumes during Cyclone Gabrielle). Samples collected at SW7 are representative of the downstream receiving environment.

Water quality results collected at SW6 and SW7 during the two sampling rounds are generally below guideline values for most analytes which is the same trend observed from the results collected in Streams 1 and 2 (Table 4). Elevated levels of nitrate-n were recorded at SW6 during both sampling rounds and at SW7 during the first sampling round (Table 4). This suggests that both sampling locations are potentially influenced by the treated wastewater discharge to the bore fields.

E.Coli concentrations showed an increasing trend between SW6 and SW7 during the first sampling round. However, this trend was not apparent in the second sampling round with *E.Coli* concentrations being higher in SW6 than SW7. All *E.Coli* concentrations measured during the two sampling rounds in Stream 3 were below the Band E bottom line for *E.Coli* in the NPS-FM guidelines.

It is noted that unlike the results from Stream 2, there is no distinctive increasing trend in analyte concentrations between SW6 (the upstream site) and SW7 (the downstream location). This is likely because SW6 represents a mid-stream sample rather than a true upstream sample and suggests that both sampling locations are potentially influenced by the treated wastewater discharge.

Table 4: Surface Water Quality Results Stream 2

Analyte Suites	Parameter	6/09/2023 SW6	6/09/2023 SW7	2/10/2023 SW6	2/10/2023 SW7	NPS-FM[4] Guidelines	NRC Regional Plan Guidelines
Physio-chemical	pH	6.7	6.8	6.5	6.8	-	6.0< pH <9.0
	Electrical conductivity (µS/cm)	371	348	481	414	-	-
Nutrients (g/m^3)	Nitrate-N	**3.84**	**2.44**	**4.74**	1.36	3.5[5]	≤1.5
	Nitrite-N	0.002	0.0042	0.0018	0.00858	-	-
	Ammonia as N	0.03	0.02	0.03	0.01	0.40[5]	≤0.40
	DRP[1]	0.009	<0.002	0.012	<0.002	0.054[5]	-
	TKN[2]	0.42	0.58	0.33	0.31	-	-
	Total Nitrogen	4.3	3	5.1	1.7	-	-
	Total Phosphorous	0.06	0.031	0.055	0.016	-	-
Heavy metals (g/m^3)	Arsenic	<0.00050	<0.00050	<0.00050	<0.00050	-	0.013[7,8]
	Chromium	<0.00020	<0.00020	<0.00020	<0.00020	-	0.001[7,9]
	Copper	0.00061	0.00051	0.0004	<0.00020	-	0.0014[7]
	Iron	0.29	0.25	0.072	0.27	-	-
	Lead	0.00011	0.000051	<0.000050	<0.000050	-	0.0034[7]
	Zinc	0.0033	0.002	0.0037	<0.0010	-	0.008[7]

Table 4: Surface Water Quality Results Stream 2

Analyte Suites	Parameter	6/09/2023		2/10/2023		NPS-FM[4] Guidelines	NRC Regional Plan Guidelines
		SW6	SW7	SW6	SW7		
Sodium (g/m^3)		50.6	44.9	60.3	51.4	-	-
Chloride (g/m^3)		75.4	69.8	89.7	80.9	-	-
TSS[3] (g/m^3)		10	4	37	3	-	-
Turbidity (NTU)		21.1	8.14	15.7	5.08	-	-
E.Coli Count (MPN/100 mL)		150	520	250	30	Band E (>1200)[6]	≤ 1200[10]

- No guideline value available
- *Analyte exceeds guideline value*
- *Analyte does not exceed guideline*
- *Analyte approaching bottom line/ within a lower attribute band*

Notes:

1. *DRP = Dissolved reactive phosphorous.*
2. *TKN = Total Kjeldahl Nitrogen.*
3. *TSS = Total suspended solids.*
4. *National Policy Statement for Freshwater Management.*
5. *National bottom line as defined in NPS-FM at the 95th percentile. Note, lowest Attribute Band used in lieu of National 'bottom-line' for DRP.*
6. *95th percentile of E.Coli /100 mL. Note, lowest Attribute Band used in lieu of National 'bottom-line' for DRP.*
7. *Criteria from Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZ WQ, 2018) - Accessed 25/10/2023.*
8. *Default guideline value (DGV) for AsV.*
9. *Default guideline value (DGV) for CrVI.*
10. *95th percentile E.Coli for 'Other rivers' in the NRC Proposed Regional Plan.*

7.2.1.4 Surface water results summary

In summary, the two surface water sampling rounds conducted in the streams proximal to the KR-WWTP indicated similar water quality trends. For most of the water quality parameters analysed, the results were below guideline values presented in the NPS-FM and Table 22 in the NRC Proposed Regional Plan.

Nitrate-N concentrations were consistently above guideline values across Streams 2 and 3 which is an indication that there is a notable effect from the disposal of wastewater to the shallow aquifer system.

While *E.Coli* concentrations were below the 95th percentile Band E guideline presented in the NPS-FM, there was a general trend of increasing *E.Coli* between the upstream and downstream sites which indicates there is an effect from the disposal of wastewater to the bore fields. Furthermore, the 95th percentile bottom line guideline has been used to assess *E.Coli* concentrations simply to provide an indication of the current level of *E.Coli* contamination in the receiving surface water bodies. However, the 95th percentile value provides the worst-case scenario in a long-term data set and as such, it is recommended that longer-term sampling is conducted to enable the calculation of median and percentile concentrations. This will provide a better understanding of *E.Coli* contamination associated with the KR-WWTP.

Overall, while the majority of analytes investigated were below guideline values, there appears to be a potential effect from the KR-WWTP on the surface water receiving environment. Nitrogen concentrations, including nitrates and ammonia, were in some instances above guideline values and there was a notable trend in Streams 1 and 2 of increasing *E.Coli* concentrations between the upstream and downstream sites. However, these results are of limited value as they provide an incomplete indication of the water quality in these streams as they were collected in two sampling rounds only a month a part. As such, the effect from the KR-WWTP on the surface water receiving environment is considered to be minor but additional long-term sampling is required to further assess these effects.

7.3 Coastal Water Quality

A water quality sample was collected from the downstream coastal environment during the second sampling round (2nd October). The results from this sample have been compared against guidelines presented in Table 25 of the NRC Proposed Regional Plan. The guidelines presented in the regional plan are water quality standards for ecosystem health in coastal waters, contact recreation and shellfish consumption. Sample SW8 was collected in the coastal receiving environment downstream of the KR-WWTP. The results have been compared against the guidelines for tidal creeks which is representative of the environment the sample was collected from (Figure 3).

Table 5 presents the sampling results and the relevant guideline values. It is evident that the sample was below all guideline values apart from for total nitrogen. The guideline value for total nitrogen was <0.600 g/m^3 however on October 2nd, the grab sample returned a total nitrogen concentration of 0.73 g/m^3. It is noted that the guideline values presented in Table 25 are anticipated to be compared to regular, long term water quality results (e.g. monthly monitoring) and then reported as either annual medians or percentile values. Therefore, a single grab sample is not representative of the water quality of the coastal receiving environment through time and provides only indicative results. However, the increased level of total nitrogen could be an indication of the effects of the treated wastewater disposal to bore fields and further investigations are recommended. The remaining analytes assessed during the sampling round were below guideline values.

Table 5: Coastal water quality results collected 2/10/2023

Analyte Suites	Parameter	SW8	NRC Regional Plan Guidelines[4]
Physio-chemical	pH	7.6	7.0 – 8.5
	Electrical conductivity (µS/cm)	50,630	-
Nutrients (g/m^3)	Nitrite-nitrate nitrogen	0.0274	<0.218
	Ammonia as N	<0.005	<0.043
	DRP[1]	0.007	-
	TKN[2]	0.71	-
	Total Nitrogen	**0.73**	<0.600
	Total Phosphorous	0.022	<0.040
Heavy Metals (g/m^3)	Arsenic	<0.0050	-
	Chromium	<0.0020	-
	Copper	<0.0020	0.0013
	Iron	<0.050	-
	Lead	<0.00050	0.0044
	Zinc	<0.010	0.0150
Sodium (g/m^3)		10,300	-
Chloride (g/m^3)		19,634	-
TSS[3] (g/m^3)		17	-
Turbidity (NTU)		3.8	<10.8
E.Coli Count (MPN/100 mL)		320	-

Table 5: Coastal water quality results collected 2/10/2023

Analyte Suites	Parameter	SW8	NRC Regional Plan Guidelines[4]

- *No guideline value available*

Analyte exceeds guideline value

Analyte does not exceed guideline

Notes:

1. *DRP = Dissolved reactive phosphorous*
2. *TKN = Total Kjeldahl Nitrogen.*
3. *TSS = Total suspended solids.*
4. *Where applicable, have used the 'Tidal Creeks' guideline value to reflect the environment the sample was collected from.*

8.0 Recommendations

8.1 Groundwater

The following recommendations are advised to address the groundwater monitoring information gap.

- Design and installation of a new groundwater monitoring network to assess the impact of treated wastewater discharge on groundwater quality and mounding.
- Reinstate quarterly groundwater level and quality monitoring at newly installed groundwater monitoring positions.
- Review groundwater assessment of effects (as discussed in this report) with groundwater monitoring data.

8.2 Surface and Coastal Water

Given the limited surface and coastal water sampling which has been conducted at the site, the below recommendations are advised:

- Design and undertake longer-term surface water and coastal sampling (e.g. monthly grab samples) to provide a better understanding of the impact of discharging treated wastewater to the shallow groundwater aquifer on the downstream surface and coastal water receiving environments.
  - Ensure that the parameters analysed align with the guideline values used to assess the ecosystem health in the NPS-FM and NRC Proposed Regional Plan.
  - Ensure the sampling captures a range of weather, stream and operational conditions.
- It is recommended that the existing treatment processes are assessed as to their efficiency in treating the elevated contaminants highlighted in this report. Investigations into whether these processes can be optimised

are recommended to achieve improved water quality for the treated wastewater which is discharged to the disposal fields. This will in turn will likely reduce contaminant concentrations in the receiving environments.

8.3 Conclusion

The operation of the KR-WWTP and subsequent discharge of treated wastewater to the bore disposal areas has been shown to potentially be having an impact on the receiving surface and coastal water bodies. Elevated levels of nitrates, ammonia and total nitrogen in the streams and coastal receiving environment proximal to the KR-WWTP suggest that the treated wastewater discharge is impacting water quality in these locations. Furthermore, a notable trend of increasing concentrations of analytes between the upstream and downstream surface water sites analysed during sampling, specifically in relation to *E.coli* concentrations, further supports that there is a potential effect from the KR-WWTP activities. However, it is noted that limited sampling has been undertaken in the surface water and coastal receiving environment. As such, the effect from the KR-WWTP on the surface water receiving environment is considered to be minor but additional long-term sampling is required to further assess these effects.

9.0 References

ANZ WQ Guidelines. 2018. Australia and New Zealand Water Quality Guidelines: Guidelines for fresh and marine water quality. Accessed 25/10/2023.

Environment and Business Group Ltd (2001) Russell Wastewater Proposed Irrigation and Additional Borehole Disposal Description of Proposal and Assessment of environmental Effects. Report prepared for FNDC, June 2001.

Far North District Council (2013) Resource Consent Application and Assessment of Effects on the Environment: Russell Wastewater Treatment Plant

Kruseman, G. P., & de Ridder, N. A. (1991).Analysis and evaluation of pumping test data. Wageningen, the Netherlands: Institute for Land Reclamation and Improvement.

MHW (2003) The Preparation of a Combined Wastewater Asset Management Policy and Liquid Waste Management Plan – "A Peer Review of the Russell/Tapeka Point Sewerage System".

NPS-FM. 2020. National Policy Statement for Freshwater Management. Accessed 25/10/2023.

PDP (2021) Russell Wastewater Treatment Plant – Bore Field Disposal Performance and Slope Stability Review.

Riley (2015) Addendum Review of Piezometer Monitoring Results – February 2015 to May 2015 Russell Sewerage Disposal Scheme.

Riley (2017) Bore Infiltration Assessment – Russell Wastewater Disposal Scheme.

Riley (2019) Review of Piezometer Monitoring Results - June 2015 to June 2019 Russell Sewerage Disposal System, Russell.

WSP (2023) Russell WWTP Operations and Maintenance Manual.

Ventia (2021) Monthly bore disposal volumes and groundwater level spot measurement (2010 to 2019).

Appendix E: Borefield Disposal Performance and Slope Stability Review

PATTLE DELAMORE PARTNERS LTD
Level 5, PDP House
235 Broadway, Newmarket, Auckland 1023
PO Box 9528, Auckland 1149, New Zealand

Office +64 9 **523 6900**
Web **www.pdp.co.nz**
Auckland Tauranga Hamilton Wellington
Christchurch Invercargill

***solutions** for your environment*

3 September 2021

Louise Wilson
Team Leader - Resource Consents
Far North District Council
Private Bag 752
KAIKOHE

Dear Louise

RUSSELL WASTEWATER TREATMENT PLANT – BORE FIELD DISPOSAL PERFORMANCE & SLOPE STABILITY REVIEW

1.0 Introduction

PDP have been engaged by Far North District Council (FNDC) to undertake the Bore Infiltration Capacity and Land Stability Review at the Russell Wastewater Disposal Scheme (WWDS) in accordance with monitoring Conditions 8 and 9 of the Resource Consent (AUTH.008339.01.03; Appendix A).

Project Background

PDP was initially engaged by FNDC to provide an assessment of the disposal sites slope stability only. The scope of this initial work was limited to a review of the available groundwater level data and a visual site inspection of the bore disposal scheme. Following completion of the site visit the scope was expanded to include the review of the disposal scheme infiltration performance in response to anecdotal feedback from the Plant Operator indicating that the capacity of the disposal bore had reduced significantly.

2.0 Review Objectives

The objective of this report is the meet the following monitoring and compliance conditions in accordance with the Resource Consent (AUTH.008339.01.03; Appendix A).

Condition 8 – Land Instability

- Condition 8 states that *"the exercise of this consent shall not cause land instability within or adjacent to the disposal areas or adjacent properties."* In order to meet the above condition, an assessment of site slope stability is based on review of groundwater trigger levels and visual inspection of site for evidence of slope instability.

Condition 9 – Discharge Infiltration Efficiency

- Condition 9 stipulates *"two -yearly monitoring and reporting of the infiltration efficiency (soakage rate) within each of the disposal areas A, B and C".* The purpose of this review is to enable detection of any reduction in infiltration efficiency in any individual group of bores.

3.0 Scope

In order the achieve the above defined objectives (consent compliance conditions) the following scope of works was undertaken:

Desktop Information Review

- Review available groundwater levels data, bore discharge volumes, previous soakage testing results and bore geological logs (if available).
- Assess the site slope stability risk using the latest groundwater level data (in accordance with Condition 8; AUTH.008339.01.03).
- Assess long-term trends in bore disposal capacity using long-term bore discharge volume data and historical bore soakage testing results (in accordance with Condition 9; AUTH.008339.01.03).

Site Visit

- Undertake a site visit to visually assess the bore discharge with regards to slope stability and seepage (daylighting) between the disposal bores and the adjacent, low-lying streams and wetlands (in accordance with Condition 8; AUTH.008339.01.03).
- The site visit was also an opportunity to discuss the plant's current discharge regime, bore soakage performance and ongoing monitoring schedule with the WWDS Plant Operator.

4.0 Sources of Information

The following sources of information have been reviewed as part of this assessment.

- Environment and Business Group Ltd (2001) Russell Wastewater Proposed Irrigation and Additional Borehole Disposal Description of Proposal and Assessment of environmental Effects. Report prepared for FNDC, June 2001.
- Far North District Council (2013) Resource Consent Application and Assessment of Effects on the Environment: Russell Wastewater Treatment Plant
- MHW (2003) The Preparation of a Combined Wastewater Asset Management Policy and Liquid Waste Management Plan – "A Peer Review of the Russell/Tapeka Point Sewerage System".
- PDP (2021) Site Visit: Observations made by PDP during site visit and anecdotal observations made by plant operator.
- Riley (2015) Addendum Review of Piezometer Monitoring Results – February 2015 to May 2015 Russell Sewerage Disposal Scheme.
- Riley (2017) Bore Infiltration Assessment – Russell Wastewater Disposal Scheme.
- Riley (2019) Review of Piezometer Monitoring Results - June 2015 to June 2019 Russell Sewerage Disposal System, Russell.
- Ventia (2021) Monthly bore disposal volumes and groundwater level spot measurement (2010 to 2019).

5.0 Site Visit

A site visit was undertaken by PDP on 23rd June 2021.

Key findings from the site visit, including anecdotal discussion with the Plant Operator regarding infiltration performance and compliance related issues is summarised as follows. Each of below findings are discussed in further detail within the relevant sections of this report.

- No groundwater level data has been collected at site since November 2019 since the facility's AVT was taken away due to health and safety concerns. As a result, groundwater mounding and slope stability has been assessed based on a visual inspection of site and historic data review.
- There was no visual evidence of slope instability or daylighting (seeps) observed at site.

The following remarks are based on anecdotal discussion with the Plant Operator during the site visit.

- A number of disposal bores are routinely flooding at ground surface. This indicates a reduction of bore capacity and /or that a number of bore shut-off 'float' switches are faulty (float switches should prevent surface overflow). During the site visit, no surface flow was observed from any bores. It is anticipated that borehead flooding occurs only when the schemes discharge capacity is exceeded, most likely during wet-weather, high inflow events.
- The mechanism responsible for diminished soakage capacity cannot be confirmed without further testing, however it was suggested that historical instances of inadvertent discharge of treated wastewater with high suspended sediment load was potentially responsible for bore clogging. Further testing is required to determine the precise cause of bore clogging (sediment clogging, biofouling or chemical incrustation) to accurately inform effective treatment options.
- The automated discharge sequence controller is not operational. The Plant Operator therefore switches flows across the three bore disposal areas manually. The automated discharge sequence was intended to ensure the disposal scheme operates at optimum efficiency to prevent excessive mounding and surface flooding. Since no groundwater level monitoring is undertaken at site, manual switch over is no-longer informed by any groundwater level 'mounding' data.
- The treatment plant/disposal scheme historically accepts approximately 5 m^3/day of leachate from the adjacent landfill. At the time of PDP's site visit, the leachate reticulation pump was broken, preventing leachate from being delivered to the treatment plant. As a result, landfill leachate was overflowing the leachate collection chamber and flowing overground towards the nearby wetland.

Interim Reporting

The above findings of the site visit were reported to FNDC immediately following the site visit and were subsequently presented to both FNDC and Northland Regional Council (NRC) via conference call on 7th July 2021. The actionable outcome of this meeting was that PDP would continue to process the available bore data (discharge rate and water levels) in order to review the long-term discharge capacity of the bore disposal scheme and provide recommendations to increase soakage performance and address the noncompliance issues identified.

6.0 Bore Disposal Scheme – Setting & Operational Description

6.1 Site Setting

The Russell WWTP and associated bore disposal areas are located approximately 1km southeast of the Russell township. The plant receives wastewater from the Russell/Tapeka Point communities in addition to small quantities of leachate from the adjacent Russell Landfill.

The bore disposal area is characterised by a series of steeply sloping gassed ridgelines and densely vegetated gullies situated to the north-east of the treatment plant. Small stream tributaries are associated with each gully, which flow generally south-west into the low-lying wetland area adjacent the treatment plant.

The disposal site geology is comprised of Waipapa Group Greywacke Formation, characterised by variable weathering, fracturing and associated formation permeability (EBG, 2001 and MWH, 2003). Weathered Greywacke generally extends to approximately 24 m bgl (below ground level) (EBG, 2001). The shallow sub-surface (top of the weathering profile) is characterised by a mantle of approximately 2 to 6 m of low permeability clay (completely weathered Greywacke). At depth (>24 m bgl) Greywacke is typically fresh (unweathered with minor fracturing).

6.2 Bore Field

The bore disposal scheme currently consists of 85 No., 250 mm diameter disposal boreholes situated between 45 to 80 m RL along the apex of the ridgelines. Bores are closely spaced (approximately 3 to 10 m) and are drilled to approximately 30 m bgl into the fractured Greywacke. The boreholes are separated into three disposal areas (A, B & C), across four ridgelines.

There are also 16 No. groundwater level observation bores positioned across the disposal site to monitor groundwater level mounding. These observation bores typically reach depths of approximately 15 m to 30 m bgl depending on the elevation and respective depth to groundwater. In addition to deeper observation bores, there is a series of shallow monitoring piezometers, installed to approximately 3 m to 5 m bgl. Originally up to 31 No. piezometers were installed across site, however a number have been damaged. The exact number of remaining groundwater monitoring positions is unclear.

The location of all disposal bores, as well as observation bores and monitoring piezometers are depicted in the bore field schematic attached (Appendix B).

6.3 Disposal Process

The following scheme process description is taken from the two preceding Resource Consent Applications lodged in 2001 (EBG, 2001) and 2013 (FNDC, 2013). Based on the finding of the site visit and discussion with the Plant Operator on site, PDP have provided an update where the current scheme operation differs from that stated by the resource consent where relevant to bore disposal performance.

Intended Operation

After treatment, treated wastewater is distributed via three individual delivery pumps to the three bore disposal areas (A, B & C). Within each of the three disposal areas, bores are further divided into 14 bore groups, consisting of a cluster of between 5 and 7 neighbouring bores. Each bore group is supplied with treated wastewater by a single control value. At the time of commissioning, the flow of treated wastewater was intended to be controlled by a Programmable Logic Controller (PLC) system. Each disposal bore is installed with a flowmeter and a shut-off 'float' switch designed to close the group diaphragm valve when the float switch is triggered. The PLC is intended to stop pumping through the bore group control valve when the group is full and will resume pumping to the group following a pre-set stand-down period (typically 30 to 60 mins). Following a pre-set pumping duration, the PLC is also intended to cycle through the bore groups at an unknown preselected discharge interval.

Typically, only two bore areas are operated at any given time, with one area 'at rest' to allow induced groundwater mounding to return to the natural groundwater level.

Current Operation

Based on discussion with the Plant Operator during the recent site visit, it is understood that the PLC automation system is not operational, and the current disposal sequence is entirely controlled by manual selection of individual bore areas. With no PLC sequencing, all bore group control valves have been manually set to the open position and manual switching between bore discharge areas is based on qualitative assessment of groundwater mounding inferred by review the groundwater levels in surrounding observations bores. However, since groundwater level monitoring ceased in 2019, discharge to bore areas has been cycled on an arbitrary basis, typically 2 months on, 1 month off.

Based on PDP's understanding, individual bore shut-off switches no-longer control the bore group valve when manually affixed to the open position. This may explain reported instances of the overflowing bores. The Plant Operator also suggested that rodent damage (chewing of the switch control valve lines) may also be responsible for borehead flooding. Alternatively, given the close positioning of grouped bores, the steep ridgeline and interconnected fracturing, overflowing bores may also be the result of short-circuiting flow between hydraulically interconnected bores. For example, the up-gradient bore within a group may flood a down-gradient bore through fracture flow without triggering its own its float switch if the down-gradient bore float switch is damaged.

Further investigation is required to determine the precise control mechanism between the individual bore shut-off 'float' switches and the group control valve. This information should be obtainable from engineering design drawings. Furthermore, it is recommended that the Plant Operator begin taking an observation record of overflowing bores to better constrain the likely cause.

7.0 Bore Infiltration Performance Review

In this section, PDP have reviewed all available bore discharge volume and soakage capacity test data previously undertaken at site in order to determine the long-term performance (infiltration capacity) of the bore disposal scheme. This has been undertaken both in accordance with Condition 9 of the resource consent, as well as to verify anecdotal observations that the scheme's disposal capacity is declining.

The aim of the data review is to determine the following disposal scheme performance metrics:

- Which bores have the highest capacity / lowest capacity.
- Assess how the performance of each bore has deteriorated over time.
- Use the above bore performance metrics to recommend cost-effective rehabilitation treatment methods to targeted disposal bores to increase infiltration capacity.

7.1 Previous Performace Testing

General soakage testing was undertaken in 1998 on 20 disposal bores (existing at the time), during the initial trial phase of the bore disposal scheme. This non-standardised soakage testing consisted of calculated infiltration rates, based on the measured volume of wastewater delivered to bores over a range of manual monitoring periods between 1 day and 163 days. Unfortunately, subsequent changes in bore naming conventions have gone unreported during the scheme's expansion. As result, this data is now unassignable to bore locations and has lost its value with regards to monitoring changes in bore soakage rates over time (MWH, 2003).

Since the scheme's commissioning, only one round of standardised soakage testing has been undertaken. Constant rate soakage testing was performed on all 85 discharge bores by Broadspectrum Ltd in 2017, based on a methodology developed by Riley Consultants Ltd (Riley, 2017). Bores were concurrently tested by bore groups (~ 6 bores at a time) over of 3-hour test period. Flow rates were controlled by the bore group control value and groundwater levels were recorded by pressure transducers (loggers) placed within each bore.

Although PDP consider the test duration to generally be too short, the results provide valuable information on scheme performance at the time of testing, despite results from a number of bores being compromised by fluctuating infiltration rates during the test procedure (Riley, 2017).

In the absence of previous test data, no conclusions were drawn regarding the overall capacity of the bore disposal scheme, or the long-term trends in bore performance at the time of testing (2017). The review did however support previous findings (MWH, 2003), that the majority of the overall scheme disposal capacity is attributed to a small number of high-capacity bores.

PDP have summarised the results of this soakage testing in Table 1 below.

7.2 Current Performance

No additional soakage capacity testing has been done at part of this scope of works. However, PDP has undertaken a review of all available long-term monthly bore discharge volume and water level data for each disposal bore in order to infer long-term soakage capacity trends.

Table 1 below provides a summary of the available bore discharge data as well as results from the standardised soakage testing undertaken in 2017 (Riley, 2017).

The inferred soakage rate approximates to bore disposal capacity based on the available monthly average discharge rate and observed groundwater level. Data has been preferentially selected from periods where there is a consistent, multi-month data record and where bore groundwater levels indicate that the bore's capacity has been reached (groundwater level of 0 m bgl or 'FULL').

Due to the non-continuous nature of the data record, variable plant discharge and variable cycling periods between bore groups, it is not possible to directly compare annual monitoring periods over time or with standardised soakage testing undertaken in 2017. However, the data does indicate long-term trends in the overall discharge capacity of each bore relative to the observed groundwater level.

In addition, comparison of the data with 2017 standardised testing validates the relative soakage capacity of individual bores based on the long-term discharge record.

A summary of the key findings of the review are as follows:

- High performing bores are highlighted in green (Table 1). There are 29 highlighted bores which provide the majority of scheme total disposal capacity.
- There is a high dependency on a small proportion of bores to discharge the majority of treated wastewater. This creates increased risk of insufficient disposal capacity due to diminishing bore performance as a result of gradual bore clogging over time.
- There is a largely uniform reduction of the bore disposal capacity over time. This generally supports anecdotal reports based on discussion with the Plant Operator.

Table 1: Bore Performance Summary

Bore (Zone)		Inferred Soakage Rate[1]								Soakage Testing Results[2] (Riley, 2017)	Target[3] for Rehabilitation
		2010		2014		2017		2019			
		Average Discharge Volume (m³/Day)	Average Groundwater Level (m)	Average Discharge Volume (m³/Day)	Average Groundwater Level (m)	Average Discharge Volume (m³/Day)	Average Groundwater Level (m)	Average Discharge Volume (m³/Day)	Average Groundwater Level (m)	Soakage Rate (m³/hr)	
BH01	A	0.25	6.9	-	-	0.23	FULL	-	-	0	
BH02	A	0.41	9.3	-	-	0.115	FULL	-	-	0	
BH03	A	7.4	16	-	-	4.7	3.8	-	-	0.74	Yes
BH04	A	0.08	21	-	-	0.22	FULL	-	-	0	
BH05	A	0.89	14.6	-	-	0.17	2.4	-	-	0	Yes
BH06	A	25	28	-	-	19.8	19	-	-	10.42	Yes
BH07	A	No data		-	-	0.5	0.5	-	-	0	
BH08	A	0.68	12.5	-	-	0.83	FULL	-	-	0	
BH09	A	0.3	5.9	-	-	0.09	FULL	-	-	0	
BH10	A	0.22	5.7	-	-	No data		-	-	0	
BH11	A	No data		-	-	4.3	9.85	-	-	0.6	Yes
BH12	A	14.3	14	-	-	5.5	9.75	-	-	6.6	Yes
BH13	A	3.18	16.5	-	-	0.19	FULL	-	-	0.18	Yes
BH14	A	11.5	15.2	-	-	5.85	9.2	-	-	1.98	Yes
BH15	A	4.1	11.7	-	-	0.9	FULL	-	-	0	Yes
BH16	A	0.55	9.5	-	-	0.035	FULL	-	-	0	Yes
BH17	A	0.16	10.3	-	-	0.09	FULL	-	-	0	
BH18	A	No data		-	-	4.1	FULL	-	-	0.5	
BH19	A	2.4	18.1	-	-	4.8	17.2	-	-	7.21	Yes
BH20	A	2.48	17.6	-	-	1.8	8.4	-	-	2.43	
BH21	A	No data		-	-	0.9	5.4	-	-	1.06	
BH22	A	No data		-	-	1.1	13.3	-	-	2.61	
BH23	A	0.3	18.9	-	-	0.6	3.7	-	-	0.18	
BH24	A	No data		-	-	0.44	2.9	-	-	0.2	
BH25	A	0.75	12	-	-	0.38	2	-	-	0.26	Yes
BH26	A	2.2	12.8	-	-	0.67	5.4	-	-	0.65	Yes
BH27	B	-	-	0.13	FULL	-	-	0.038	4.8	0	
BH28	B	-	-	16.3	2.4	-	-	5.6	6	1.68	Yes
BH29	B	-	-	0.58	1.4	-	-	0.15	2.5	0	
BH30	B	-	-	1.1	2	-	-	0.03	FULL	0	
BH31	B	-	-	14.8	FULL	-	-	14.2	2.1	1.86	Yes
BH32	B	-	-	16.1	3.7	-	-	0.9	2.1	2.7	Yes
BH33	B	-	-	1.03	1.7	-	-	1.09	2.1	3.08	Yes
BH34	B	-	-	1.43	2.89	-	-	4.37	FULL	0.66	
BH35	B	-	-	6.37	1.75	-	-	4.38	FULL	4	Yes
BH36	B	-	-	7.94	3.14	-	-	3.8	FULL	0.64	Yes
BH37	B	-	-	0.33	FULL	-	-	0.07	FULL	0.34	Yes

Table 1: Bore Performance Summary

Bore (Zone)		Inferred Soakage Rate[1]								Soakage Testing Results[2] (Riley, 2017)	Target[3] for Rehabilitation
		2010		2014		2017		2019			
		Average Discharge Volume (m^3/Day)	Average Groundwater Level (m)	Average Discharge Volume (m^3/Day)	Average Groundwater Level (m)	Average Discharge Volume (m^3/Day)	Average Groundwater Level (m)	Average Discharge Volume (m^3/Day)	Average Groundwater Level (m)	Soakage Rate (m^3/hr)	
BH38	B	-	-	0.14	FULL	-	-	0.076	FULL	0.01	
BH39	B	-	-	0.42	FULL	-	-	No data		0.23	
BH40	B	-	-	40.7	1.8	-	-	No data		11.9	Yes
BH41	B	No Data								3.22	Yes
BH42	B	-	-	0.44	FULL		-	0.48	FULL	4.5	Yes
BH43	B	-	-	0.39	2.1	-	-	0.12	2	0.36	
BH44	B	-	-	0.38	1.85	-	-	0.1	3	0.03	
BH45	B	-	-	0.6	2.7	-	-	2.53	FULL	3.92	Yes
BH46	B	-	-	0.39	0.4	-	-	3.6	FULL	2	Yes
BH47	B	-	-	0.42	0.7	-	-	0.11	FULL	0.02	
BH48	B	-	-	0.85	0.6	-	-	0.25	FULL	0.11	
BH49	B	-	-	0.175	0.48	-	-	No data		0.08	
BH50		-	-	0.22	0.7	-	-	0.01	FULL	0.02	
BH51		-	-	0.023	FULL	-	-	0.032	FULL	0.02	
BH52		-	-	0.037	FULL	-	-	No data		0.03	
BH53		-	-	0.98	1.23	-	-	0.5	FULL	1.52	
BH54	B	-	-	7.39	1.96	-	-	No data		4	Yes
BH55	B	-	-	0.06	FULL	-	-	No data		0.44	
BH56	B	-	-	0.067	FULL	-	-	No data		0.08	
BH57	B	-	-	1.89	FULL	-	-	No data		0	
BH58	B	-	-	0.03	FULL	-	-	No data		0.06	
BH59	B	-	-	16.5	2.13	-	-	1.56	1.5	0.04	Yes
BH60	B	-	-	0.24	0.37	-	-	0.33	1.5	1.17	
BH61	B	6.66	12.3	-	-	-	-	4.3	5	9.13	Yes
BH62	B	4.7	9.4	-	-	-	-	7.6	FULL	7.46	Yes
BH63	B	1.11	11	-	-	-	-	0.33	FULL	2.63	
BH64	B	0.37	9.7	-	-	-	-	0.022	FULL	0.3	
BH65	B	-	-	-	-	2.3	4.8	No data		3.7	
BH66	B	-	-	-	-	-	-	2.85	FULL	5.21	Yes
BH67	B	-	-	-	-	-	-	0.35	FULL	0.15	
BH68	B	-	-	-	-	-	-	0.032	FULL	0.32	
BH69	B	-	-	0.037	8.2	-	-	6.3	FULL	6.19	Yes
BH70	B	5.48	7.8	-	-	-	-	12.2	FULL	3.38	Yes
BH71	B	0.57	9.75	-	-	-	-	0.76	FULL	0.6	
BH72	C	2.12	7.6	2.7	1.75	0.5	FULL	-	-	4.69	Yes
BH73	C	7.83	8.3	5.76	3.05	10.15	7.6	-	-	5.79	
BH74	C	2.75	9.6	0.94	4.96	1.6	4.14	-	-	0	

Table 1: Bore Performance Summary

Bore (Zone)		Inferred Soakage Rate[1]								Soakage Testing Results[2] (Riley, 2017)	Target[3] for Rehabilitation
		2010		2014		2017		2019			
		Average Discharge Volume (m^3/Day)	Average Groundwater Level (m)	Average Discharge Volume (m^3/Day)	Average Groundwater Level (m)	Average Discharge Volume (m^3/Day)	Average Groundwater Level (m)	Average Discharge Volume (m^3/Day)	Average Groundwater Level (m)	Soakage Rate (m^3/hr)	
BH75	C	-	-	25.17	1.68	35.44	7	-	-	19.18	Yes
BH76	C	-	-	0.4	7.65	3.3	6.78	-	-	0.38	
BH77	C	2.7	9.97	1.97	5.8	6.7	5.78	-	-	0.52	
BH78	C	8.83	9.46	-	-	5.54	4.96	-	-	2.22	Yes
BH79	C	5.14	11.56	5.3	5.33	2	2.26	2.7	6.5	0.25	Yes
BH80	C	19.8	9.85	34.3	2.4	49.85	FULL	-	-	2.7	Yes
BH81	C	36.17	9.6	24.92	8.23	-	-	0.57	5.6	11.81	Yes
BH82	C	14.3	10.25	13.96	2.27	7.26	1.0	-	-	0	Yes
BH83	C	1.47	9.94	0.28	0.17	10.87	0.69	-	-	0.05	
BH84	C	1.1	7.3	1.35	3.0	1.0	FULL	-	-	0.04	
BH85	C	0.48	7.25	-	-	0.59	2.38	-	-	0.22	

Notes:
1. *Inferred soakage rates are based on monthly average individual bore discharge volumes manually recorded concurrently with in-bore groundwater levels. Multi-month continuous monitoring periods were favoured as well as periods of 'Full' bore capacity.*
2. *Standardised soakage testing results are taken from (Riley, 2017). Testing undertaken by Broadspectrum Ltd, based on test methodology developed by Riley Consultants Ltd (2017).*
3. *Bore rehabilitation targets are selected based on the highest relative infiltration capacity (either at present or historically) as well as bores which show clear evidence of infiltration capacity deteriorated due to clogging.*

7.3 Targetted Bore Rehabilitaion

Based on review of available data, 38 bores are recommended for targeted treatment (Table 1). The bores selected were those with the highest relative infiltration capacity (either at present or historically), as well as bores which show clear evidence of infiltration capacity deterioration.

Given the total number of disposal bores, a targeted approach to rehabilitation is favoured to ensure the greatest cost-benefit to treatment. This is particularly important given the relative dependency of the scheme on a small number of high-capacity bores.

7.3.1 Bore Treatment

In order to effectively rehabilitate impacted bores, it is very important to first determine to cause of bore performance degradation. As a result, chemical sampling and camera inspections of selected bores should be undertaken to ensure the correct treatment method.

A brief summary of the potential causes of bore clogging and potential treatments are outlined below.

Physical Clogging

- Physical clogging of the receiving formation (fracture aperture) with suspended particulates over time.
- Typical treatment options include mechanical agitation of the bore annulus by ’water jetting’, followed by vigorous bore pumping to ‘flush’ out the dislodged sediment. Because the disposal bores at site are predominantly above the saturated zone, bore ‘flushing’ (high-rate abstraction) is not possible. This may reduce the efficacy of the treatment depending on the extent of physical clogging.

Biofilm Accumulation

- Biofouling is typically the most common cause of bore clogging. It is caused as a result of bacterial growth within the bore which forms a sticky biofilm (polysaccharide polymer) which clogs flow paths.
- At site, the effluent nature (high nitrogen load) of the discharged water and prolonged oxygenation of the bore annulus (above the saturated zone) may have resulted in excessive accumulation of biofilm.
- Biofouling is treated with a combination of chorine based chemical bactericide (to breakdown the biofilm an inhibit bacteria growth) and mechanical water ‘jetting’ to dislodge biofilm build-up prior to bore flushing.

Chemical Incrustation

- Chemical blockage is a form of incrustation of the bore and near-formation usually brought about by a chemical actively resulting in the formation of mineral crystals. Common forms of incrustation are carbonate based (calcite), iron or manganese oxides.
- Treatment options for chemical incrustation is highly specific to the type of mineralisation. Acid treatment is typically required to dissolved mineral deposits.

Please note that treatment strategies are unlikely to fully restore bore capacity depending on the clogging mechanism. More significant improvement in bore performance is anticipated if the clogging is the result of biofouling. Physical clogging and chemical incrustation are more difficult to remediate, particularly in bores within the unsaturated zone.

Recommendations for treatment of the project bores are given in Section 10.

8.0 Slope Stability Review

At site, shallow residual clay material is most susceptible to slope stability issues on steep slopes when saturated due to increased groundwater level as a result of mounding. As outlined in the Resource Consent AEE (FNDC, 2013), this increased susceptibility could potentially result in slumping of clay material and overlying topsoil. If evident, this is most likely to occur on lower slopes within the gullies, where slope angles are steepest and groundwater level mounding as result of treated wastewater discharge is likely to be most pronounced.

As part of the required monitoring conditions stipulated by the Resource Consent (Condition 8), review of observation bore groundwater levels recorded on a two weekly basis and following significant rainfall (>60 mm/day) is required on a six-monthly basis. The purpose of this monitoring is to provide a regular assessment of groundwater levels against analytically derived groundwater trigger levels developed by Riley Consultants Ltd (2006) as a 'factor of safety'. In addition, a visual inspection of the site for evidence of slope instability is required on a bi-annual basis.

As previously stated, no groundwater level monitoring has been collected at site since November 2019. In lieu of any recent groundwater level data, PDP have undertaken a review of all previous slope stability reports (Riley, 2021; 2014; 2015; 2019) in order to assess the long-term risk to slope stability at site.

Based on this review, groundwater levels have generally been consistent since monitoring began in 2006. There is no indication of any long-term trends in rising groundwater levels at site as a result of treated wastewater discharge. Previous assessments indicated high groundwater level fluctuations which are in part attributed to groundwater mounding from treated wastewater discharge, however, this has never been conclusively determined due to the non-continuous nature of the groundwater level monitoring.

Several trigger level exceedances have been reported annually (between 2015 and 2019). Previous interpretation of these results has been unable to determine the causes of these exceedances. This is because monitoring rounds do not typically coincide with heavy rainfall events and discharge loading rates have never been concurrently reviewed alongside groundwater level data. This omission is significant, particularly given the reported instances of borehead flooding and saturation of the shallow sub-surface.

Despite minor trigger level exceedances, no evidence of any slope instability or deterioration thereof, has ever been reported at site.

It is noted that in 2017, FNDC sought an amendment of the agreed monitoring requirements at site to suspend the six-monthly slope stability assessments. PDP support this proposal. It is PDP's opinion that the previous groundwater level monitoring requirements were unduly onerous with regards to the level of risk presented to the site and adjacent streams.

Furthermore, fortnightly manual groundwater level monitoring of >50 observation bores, in addition to spot-gauging following heavy rainfall is not practicable at site. PDP recommend installing approximately 8 to 12 automatic groundwater level monitoring pressure transducers (loggers) within a select number of observation bores. These loggers will provide a continuous monitoring record of groundwater levels which can be reviewed concurrently with rainfall and treated wastewater disposal records. Continuous monitoring reviewed on an annual basis, coupled with an annual site inspection is considered appropriate for an assessment of slope stability risk at site.

This approach also allows for easily transition to a telemetered system in the future should real-time groundwater mounding levels be required to inform discharge areas selection.

9.0 Conclusions

Infiltration Performance

- There is a high dependency on a small proportion of bores to discharge the majority of treated wastewater. This creates increased risk of insufficient disposal capacity due to diminishing bore performance as a result of gradual bore clogging over time.
- 29 disposal bores high infiltration capacity have been identified. These bores contribute the majority of the infiltration capacity at the site.
- Review of the available data generally indicates that there has been a reduction in bore disposal capacity over time. This is supported by anecdotal reports based on discussion with the Plant Operator.
- 38 disposal bores are recommended for targeted rehabilitation.
- There are reported instances of frequent borehead flooding (bore surface overflow) at site. Surface flooding of treated wastewater at site further supports the reduction of bore soakage capacity and indicates faulty/damaged bore float switches.
- The PLC discharge sequencing system is non-operational. As a result, all bore group control valves have been manually set to the open position and manual switching between bore discharge areas is cycled on an arbitrary basis.
- It is unknown if individual bore shut-off switches control the bore group valve when manually affixed to the open position. This may explain reported instances of the overflowing bores.

Slope Stability Review

- No evidence of any slope instability has been reported at site.
- There is no indication of any long-term trends of rising groundwater levels at site as a result treated wastewater discharge.
- Previous assessments indicated high groundwater level fluctuations potentially attributed to groundwater mounding from treated wastewater discharge, however, this has never been conclusively determined due to the non-continuous nature of the groundwater level monitoring.
- Several minor trigger level exceedances of monitoring bore water levels have been reported. Previous interpretation of the data has been unable to determine the causes of these exceedances.
- Continuous groundwater monitoring is required to accurately assess the effects of treated wastewater discharge at site.

10.0 Recommendations

10.1 Infiltration Performance

PDP recommend the following scope of works to validate performance deterioration, determine the specific cause of clogging and select appropriate treatment options.

1. Bore Infiltration Testing

- A repeat round of standardised bore infiltration capacity testing should be undertaken to confirm bore deterioration. This testing will allow direct comparison to the standardised soakage testing undertaken in 2017. The testing methodology should be devised considering the in-situ testing limitations i.e., the availability of water, the ability to undertaken testing concurrently with on-going plant operation and the interconnected nature of neighbouring bores on test results.

2. Confirm Bore Clogging Mechanism

- Down-hole camera inspection and chemical analysis of select bores should be undertaken to confirm the process of clogging. This is required in order to determine the correct treatment method.

3. Bore Rehabilitation

- Once the cause of bore clogging has been determined, suitable treatment can be undertaken.
- A second round of bore soakage testing is recommended following bore rehabilitation to assess the efficacy of the treatment.

4. Operational Review of Bore Float Switches

- Further investigation is required to determine the control mechanism between the individual bore shut-off 'float' switches and the group valve. PDP recommend a detailed review of the engineering design reports to confirm the operation of the group valves to ascertain if 'float' switches are operational in the manually affixed position.
- It is recommended that the Plant Operator begin taking an observation records of overflowing bores, to better constrain the likely cause.

10.2 Slope Stability

Given the challenge that manual groundwater level monitoring represents, PDP recommend the flowing amendment to the groundwater level monitoring program.

5. Revised Groundwater Level Monitoring

- PDP recommend installing 8 to 12 automatic groundwater level monitoring pressure transducers (loggers) within a selected number of observation bores.
- Continuous groundwater level monitoring should be reviewed with rainfall and discharge loading data to accurately the determine the effect of discharge on groundwater mounding and the subsequent risk of slope instability. Following this review, an appropriate on-going slope stability monitoring plan can be formulated.

11.0 Limitations

This report has been prepared by Pattle Delamore Partners Limited (PDP) based on information provided by Far North District Council (FNDC). PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This report has been prepared by PDP on the specific instructions of Far North District Council for the limited purposes described in the report. PDP accepts no liability if the report 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.

Yours faithfully

PATTLE DELAMORE PARTNERS LIMITED

Prepared by

David Stafford

Service Leader - Hydrogeology

Reviewed and Approved by

Alan Pattle

Director

Appendix A: AUTH.008339.01.03

AUT.008339.01.03
AUT.008339.02.03

Resource Consent

Pursuant to the Resource Management Act 1991, the Northland Regional Council (hereinafter called "the Council") does hereby grant a Resource Consent to:

FAR NORTH DISTRICT COUNCIL, PRIVATE BAG 752, KAIKOHE

To undertake the following activities associated with the Russell Sewage Treatment Plant on Sec 1 SO 310696 Blk I Russell SD at or about location co-ordinates 1703384E 6096527N:

AUT.008339.01.03: To discharge treated wastewater, including Russell Landfill leachate, to ground via disposal boreholes.

AUT.008339.02.03: To discharge contaminants to air (primarily odour) from the treatment plant and borehole disposal areas.

(*Note: All location co-ordinates refer to Geodetic Datum 2000, New Zealand Transverse Mercator Projection*)

Subject to the following conditions:

AUT.008339.01.03 DISCHARGES TO GROUND

1 The maximum volume of treated wastewater discharged per day, being midnight to midnight, to the borehole disposal system shall not exceed 1,235 cubic metres.

2 The volume of landfill leachate discharged to the treatment plant via the rising main shall not exceed a rolling average of 5 cubic metres per day, as calculated using the seven most recent days, being midnight to midnight.

Advice Note: *The daily volume of Russell landfill leachate discharged to the treatment plant is required to be recorded under the consent CON 4789.*

3 The Consent Holder shall maintain a meter on the outlet of the treatment plant prior to the ultra violet light disinfection system. This meter shall have a measurement error of ±5% or less and shall be used to determine compliance with Condition 1 in accordance with Schedule 1 (**attached**).

4 The electronics of the meter required by Condition 3 shall be verified at least once every five years by 30 June of that year to ensure that the specified accuracy is maintained. Written confirmation from a suitably qualified person that the meter accuracy has been verified shall be forwarded to the Northland Regional Council's Monitoring Manager within one month of the verification being completed.

5 The concentration of the following determinands in the treated wastewater, as measured at NRC sampling site 105944 (Russell Sewage @ Plant after UV), shall not exceed the following limits. All limits are in grams per cubic metre:

Determinand	Rolling Median	Rolling 90th percentile
Five Day Biochemical Oxygen Demand (BOD_5)	10	25
Total Suspended Solids (TSS)	10	25
Total Kjeldahl Nitrogen	20	40
Total Phosphorus	15	30

For compliance purposes, the rolling median and 90 percentile concentrations shall be calculated in accordance with Schedule 1 (**attached**).

6 The concentration of Escherichia coli bacteria in the treated wastewater, as measured at NRC sampling site 105944 (Russell Sewage @ Plant after UV), shall not exceed:

(a) A rolling median of 50 per 100 millilitres; nor

(b) A maximum of 1,000 per 100 millilitres in any single sample.

For compliance purposes, the rolling median shall be calculated in accordance with Schedule 1 (**attached**).

7 There shall be no ponding or surface runoff of treated wastewater caused by the borehole disposal activity.

8 The exercise of this consent shall not cause land instability within or adjacent to the borehole disposal areas or on adjacent properties. The Consent Holder shall monitor groundwater levels in accordance with Schedule 1 (**attached**). For compliance purposes, a written assessment report prepared by a suitably qualified and experienced person on the land instability risk within each of the bore disposal areas shall be forwarded to the Northland Regional Council's Monitoring Manager by 31 May each year. Unless otherwise agreed in writing by the Northland Regional Council's Monitoring Manager, this report shall compare the groundwater level monitoring results for each observation bore with pre-set groundwater trigger levels, which shall be stated in the report, to determine whether or not a calculated slope "factor of safety" of 1.3 or greater is consistently achieved.

Advice Note: *The trigger levels for each groundwater observation bore and piezometer stated within the Riley Consultants report entitled "Engineering Review of the Sewerage Disposal System", dated 13 June 2006, shall be used unless an adjustment to these is warranted to more effectively achieve the purpose of this condition.*

9 Within three months of the commencement date of this consent, the Consent Holder shall forward to the Northland Regional Council's Monitoring Manager a programme for two-yearly monitoring and reporting of the infiltration efficiency (soakage rate) within each of the disposal bore areas A, B and C, as shown on the **attached** Riley Consultants drawing entitled "*Far North District Council Wastewater Treatment and Disposal, Russell Road, Russell – Location of Observation Bores and Piezometers*", No. 96173-6-1, Date: 27 November 2012. The monitoring programme shall be sufficiently detailed to enable the detection and quantification of any reduction in infiltration efficiency in any individual group of bores within each disposal area over the term of this consent. The Consent Holder shall provide a copy of the two-yearly monitoring report to the Northland Regional Council's Monitoring Manager by 31 May.

10 The Consent Holder shall submit to the Northland Regional Council's Monitoring Manager, an annual programme of works that are proposed to be undertaken to investigate and minimise stormwater infiltration and groundwater inflows into the sewerage reticulation system.

11 The Consent Holder shall submit a written report to the Northland Regional Council's Monitoring Manager by the 31 July each year that provides details of the outcome of any infiltration and inflow investigation works undertaken in accordance with the programme required to be prepared in accordance with Condition 10.

12 Safe and easy access to NRC Sampling Site 105944 (Russell Sewage @ Plant after UV) and to all observation bores and piezometers shall be provided for consent compliance and audit monitoring purposes.

AUT.008339.02.03 DISCHARGE OF CONTAMINANTS TO AIR

13 There shall be no discharge of contaminants to air at or beyond the legal boundary of Sec 1 SO 310696 Blk I Russell SD, which in the opinion of an enforcement officer of the Northland Regional Council is noxious, toxic, dangerous, offensive or objectionable to such an extent that it has, or is likely to have, a more than minor adverse effect on the environment.

GENERAL CONDITIONS

14 The Consent Holder shall monitor the exercise of these consents in accordance with Schedule 1 (**attached**). Changes may be made to Schedule 1 with the written approval of the Northland Regional Council's Monitoring Manager.

15 The Consent Holder shall keep and maintain a written record of all servicing and maintenance carried out on the wastewater treatment and bore disposal system, and forward a copy of this record to the Northland Regional Council's Monitoring Manager by the 31 May each year, and also upon request by that manager.

16 As a minimum, the operation and maintenance of the wastewater treatment and disposal system shall be carried out in accordance with the most recent version of the Management Plan for the system, but also always subject to the conditions of these consents. The Management Plan shall include, but not be limited to, the following:

(a) A schedule, including frequencies, of regular inspection, servicing, and maintenance items to be carried out on the treatment and disposal systems.

(b) Contingency measures for unauthorised discharges.

Changes may be made at any time to the Management Plan in consultation with the Northland Regional Council's Monitoring Manager. A copy of the amended Management Plan shall be provided to the Northland Regional Council within one month of it becoming operative and shall be deemed to be the most recent version for compliance purposes.

17 The Consent Holder shall, for the purposes of adequately monitoring the consent as required under Section 35 of the Act, on becoming aware of any contaminant associated with the Consent Holder's operations escaping otherwise than in conformity with this consent:

(a) Immediately take such action, or execute such work as may be necessary, to stop and/or contain such escape; and

(b) Immediately notify the Council by telephone of an escape of contaminant; and

(c) Take all reasonable steps to remedy or mitigate any adverse effects on the environment resulting from the escape; and

(d) Report to the Council's Monitoring Manager in writing within one week on the cause of the escape of the contaminant and the steps taken or being taken to effectively control or prevent such escape.

With regard to telephone notification, during the Council's opening hours the Council's assigned monitoring officer for these consents shall be contacted. If that person cannot be spoken to directly, or it is outside of the Council's opening hours, then the Environmental Emergency Hotline shall be contacted.

18 The Consent Holder shall pay reasonable costs of all testing of water and shellfish product that may be required by the Authorised Health Protection Officer in cases where a shellfish growing area has been closed by the Authorised Health Protection Officer due to a sewage spill from any part of the Russell wastewater treatment plant or borehole disposal system.

19 The Northland Regional Council may, in accordance with Section 128 of the Resource Management Act 1991, serve notice on the Consent Holder of its intention to review the conditions of these consents:

(a) Annually during the month of November for any one or more of the following purposes:

(i) To deal with any adverse effects on the environment that may arise from the exercise of the consent following assessment of the results of the monitoring of the consent and/or as a result of the Regional Council's monitoring of the state of the environment, or

(ii) To require the adoption of the best practicable option to remove or reduce any adverse effect on the environment; or

(iii) To change existing, or impose new limits on conditions relating to the quality of the discharges and/or compliance standards to be met in the receiving waters.

(b) Within three months of formally receiving a written report that is required by these consents.

The Consent Holder shall meet all reasonable costs of any such review.

EXPIRY DATE: **30 April 2024**

These consents is granted this Second day of September 2013 under delegated authority from the Council by:

S J Savill
Consents Programme Manager – Water and Waste

SCHEDULE 1

MONITORING PROGRAMME

The Consent Holder, or its authorised agent, shall undertake the following monitoring:

1 WASTEWATER VOLUMES

The Consent Holder shall keep a written record of the daily, midnight to midnight, volume of treated wastewater discharged to the disposal bores using the meter required by Condition 3.

The Consent Holder shall also keep a written record of the total volume of treated wastewater discharged to each individual disposal borehole group every month.

The Consent Holder shall forward copies of these records monthly to the Northland Regional Council and also immediately upon written request.

2 TREATED WASTEWATER QUALITY

The following sampling and analyses shall be undertaken on at least one occasion each fortnight unless Clause 2.1 applies.

During each sampling occasion, a composite* wastewater sample shall be collected at NRC Sampling Site 105944 (Russell Sewage @ Plant after UV).

The composite wastewater sample shall be analysed for the following:

Determinand
Escherichia coli
5 day Biochemical Oxygen Demand
Total Suspended Solids
Total Kjeldahl Nitrogen
Total Phosphorus

Temperature, pH and dissolved oxygen concentration shall be recorded in the wastewater samples using an appropriate meter, and in accordance with standard procedures.

Any significant odours at the site are also to be noted and recorded in the monitoring report.

**A sample made up of equal volumes from three samples taken at least one minute apart during the same sampling event.*

2.1 Sampling frequency reduction

The fortnightly monitoring frequency may be reduced to a monthly frequency if after any 12 consecutive month period:

(a) the fortnightly monitoring has been consistently undertaken; and

(b) the monitoring results demonstrate that the treated wastewater quality has fully complied with the discharge limits set out in Conditions 5 and 6.

At the discretion of the Northland Regional Council's Monitoring Manager, the requirement for fortnightly monitoring may be reinstated if there is any subsequent non-compliance with the discharge limits set out in Conditions 5 and 6.

3 COMPLIANCE WITH CONDITIONS 5 & 6

3.1 Median Values

The median values for the determinands listed in Conditions 5 and 6 shall be "rolling" 12 month values calculated each month using, as a minimum, the results from the samples collected in accordance with Section 2 of this schedule and any samples collected by the Regional Council.

3.2 90th Percentile Values

For compliance with Condition 5, the 90th percentile values for the listed determinands shall be "rolling" 12 month values calculated each month using, as a minimum, the results from the samples collected in accordance with Section 2 of this schedule and any samples collected by the Regional Council.

4 GROUNDWATER QUALITY

The following sampling and analyses shall be undertaken on at least one occasion every three months unless Clause 4.1 applies.

During each sampling occasion, a separate water sample shall be collected from each of the following observation bores as shown on the **attached** Riley Consultants drawing entitled "*Far North District Council Wastewater Treatment and Disposal, Russell Road, Russell – Location of Observation Bores and Piezometers*"; No. 96173-6-1; Date: 27 November 2012:

Area A: Observation Bores 2 and 6

Area B: Observation Bores 8, 9, 11, and 13

Area C: Observation Bore 15

The separate water samples shall be analysed for the following:

Determinand
Faecal coliforms
Total Kjeldahl Nitrogen
Total Phosphorus

Any significant odours at the bore disposal sites shall also be noted and recorded in the monitoring report.

4.1 Sampling frequency reduction

The three monthly monitoring frequency may be reduced to a six monthly frequency if after three consecutive years:

(a) the three monthly monitoring has been consistently undertaken; and

(b) the monitoring demonstrates that there has been no statistically significant upward trend in any of the three determinands specified.

At the discretion of the Northland Regional Council's Monitoring Manager, the requirement for three monthly monitoring may be reinstated if there is any subsequent statistically significant upward trend in any of the three determinands specified.

5 GROUNDWATER LEVELS

The monitoring and recording of the groundwater level in all observation bores and piezometers shown on the **attached** Riley Consultants drawing entitled "*Far North District Council Wastewater Treatment and Disposal, Russell Road, Russell – Location of Observation Bores and Piezometers*"; No. 96173-6-1; Date: 27 November 2012, shall be undertaken on at least one occasion each calendar month and following any rainfall event exceeding 45 millimetres per day. The required monitoring after rainfall events may be modified with the written agreement of the Northland Regional Council Monitoring Manager, subject to written technical evidence being provided to justify the change proposed.

6 SEEPAGE

There shall be an annual visual assessment of the location and extent of any surface seepage or wet zones occurring between the disposal bores and the adjacent, lower-lying streams and wetland. Any seepage zones detected shall be recorded photographically and the location accurately determined using GPS. The extent of the seepage shall also recorded using GPS and/or mapped in sufficient detail to allow an assessment of any change in seepage extent over time.

The presence of any visible groundwater outflow or ponding shall also be recorded.

7 NON-COMPLIANCE

Any non-compliance with the conditions of this consent as determined by the monitoring undertaken in accordance with this schedule shall be immediately reported to the Regional Council's Monitoring Manager.

8 COLLECTION OF SAMPLES

All samples shall be collected using standard procedures and in appropriate laboratory supplied containers.

All samples collected as part of this monitoring programme shall be transported in accordance with standard procedures and under chain of custody to the laboratory.

All samples taken shall be analysed at a laboratory with registered quality assurance procedures[#], and all analyses are to be undertaken using standard methods, where applicable.

[#] *Registered Quality Assurance Procedures are procedures which ensure that the laboratory meets recognised management practices as would include registrations such as ISO 9000, ISO Guide 25, Ministry of Health Accreditation.*

9 REPORTING

The Consent Holder shall forward a report to the Regional Council's Monitoring Manager by the 15th of each month for the preceding calendar month that provides the following:

(a) The wastewater volumes required by Section 1 of this schedule;

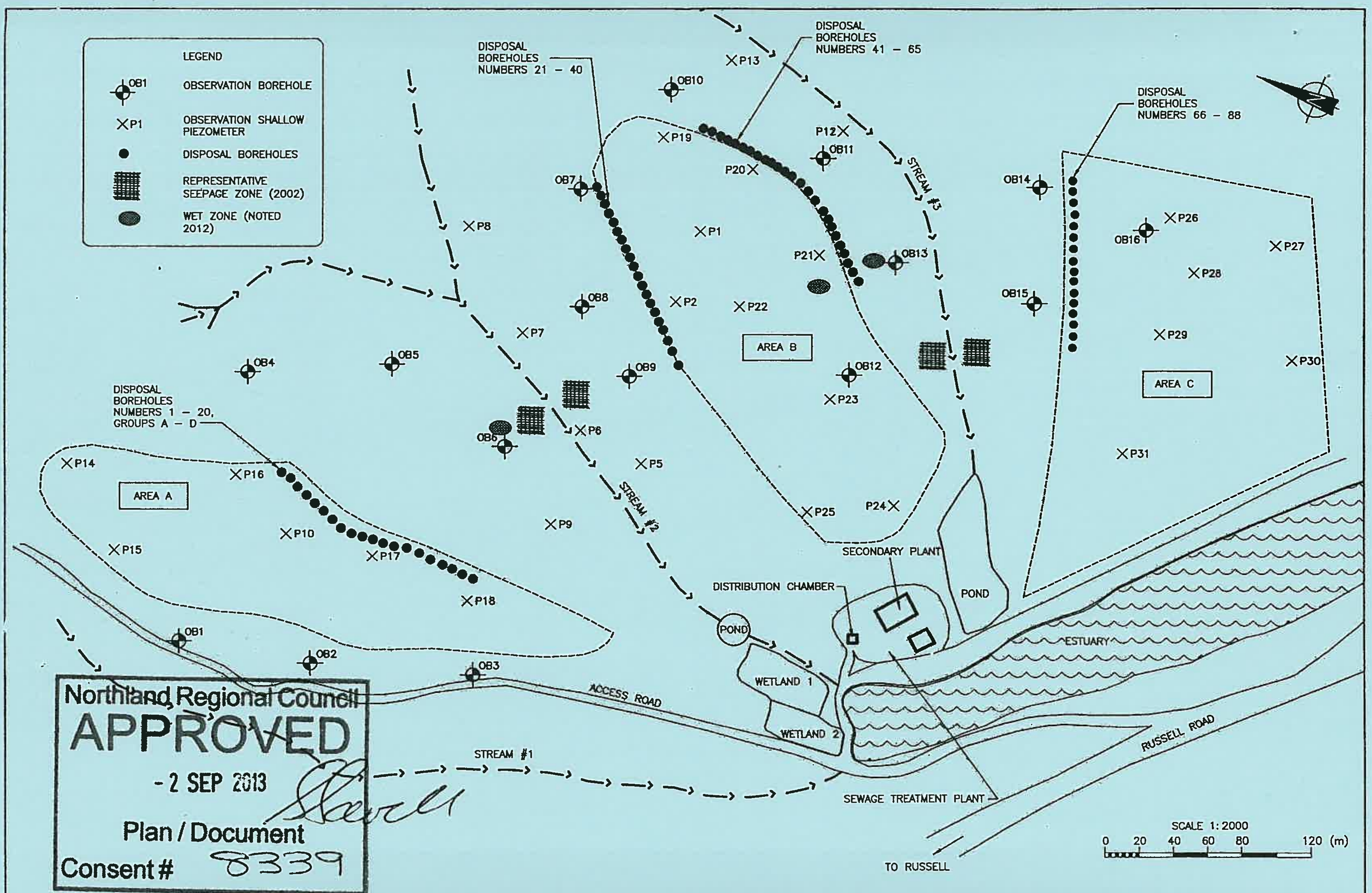
(b) Monitoring results of Section 2 of this schedule;

(c) Assessment of compliance with Conditions 5 and 6 in accordance with Section 3 of this schedule;

(d) If there is a non-compliance with Conditions 5 and 6, reasons for the non-compliances and any measures undertaken to prevent further non-compliance for that reason.

All required numerical monitoring results shall be provided in a Microsoft Excel spreadsheet, or otherwise an alternative format agreed to beforehand with the Regional Council.

The Consent Holder shall also prepare and forward an annual report to the Regional Council's Monitoring Manager by 31 May each year that provides a summary of monitoring results for Sections 4, 5 and 6 of this schedule.



Northland Regional Council
APPROVED
- 2 SEP 2013
Plan / Document
Consent # 8339

0	FIRST ISSUE			
REV	DESCRIPTION	BY	DATE	

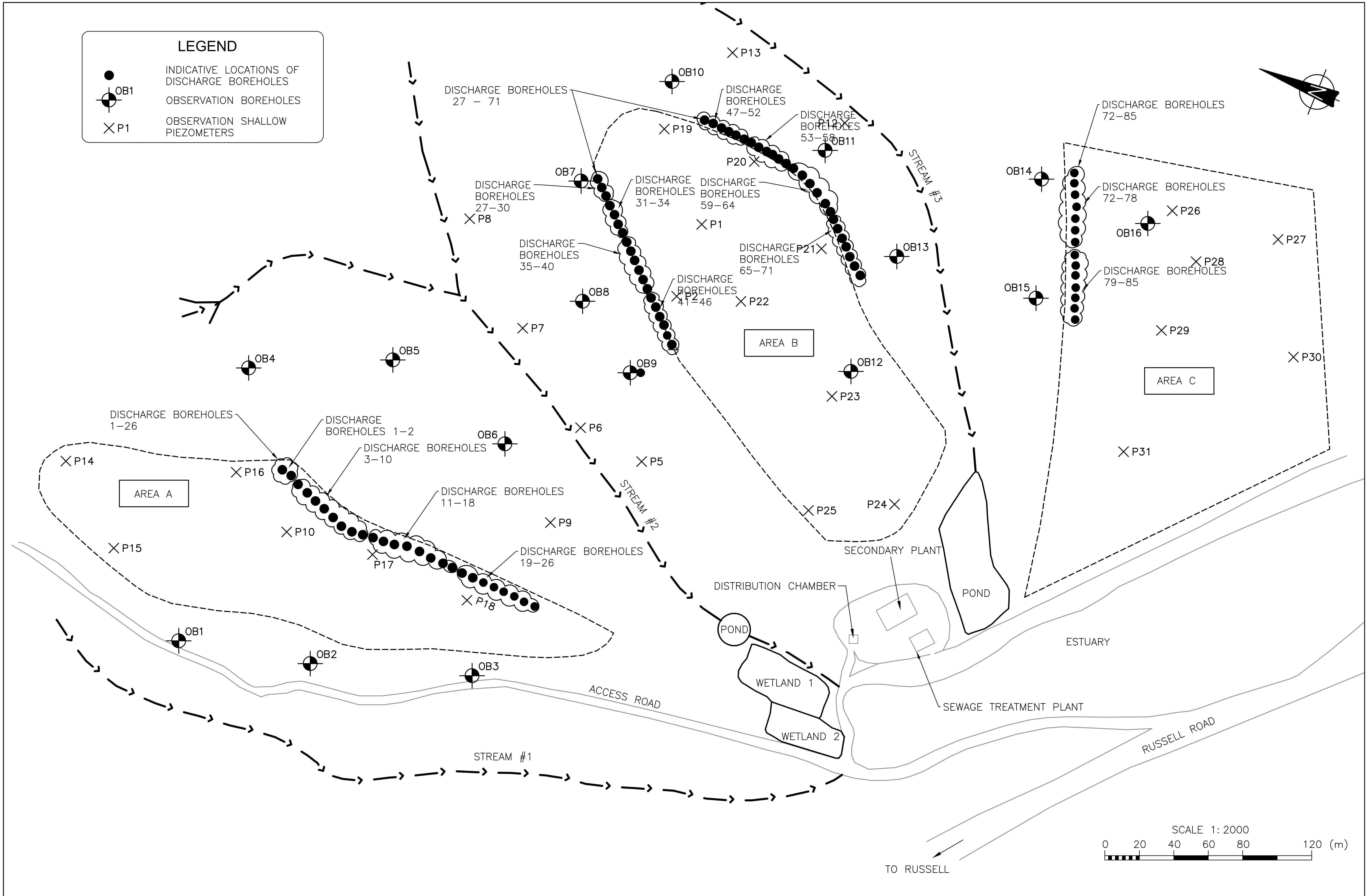
DESIGN SP | CHECKED
DRAWN KD | CHECKED
DATE DRAWN NOV 2012
APPROVED FOR ISSUE:
DATE: 27/11/12

RILEY CONSULTANTS
P.O.BOX 100 253
N.S.M.C.
AUCKLAND
TEL. 09-4897872
FAX. 09-4897873

TITLE FAR NORTH DISTRICT COUNCIL - RUSSEL WASTEWATER TREATMENT AND DISPOSAL
RUSSELL ROAD, RUSSELL
LOCATION OF OBSERVATION BORES AND PIEZOMETERS

CADFILE 96173-6-1
SCALES (A3) 1:2000
DRAWING No. 96173-6-1
REV. 0

Appendix B: Review of Piezometer Monitoring Results



2	MONITORING BORES ADDED	GB	5.09.19	DESIGN SP	CHECKED SLP	APPROVED FOR ISSUE: B BLACK
1	FIRST ISSUE	WY	11.10.17	DRAWN WY	CHECKED JM	DATE: 13/09/19
REV	DESCRIPTION	BY	DATE	DATE DRAWN OCT 2017		

RILEY CONSULTANTS
P.O.BOX 100 253
N.S.M.C.
AUCKLAND
TEL. 09–4897872
FAX. 09–4897873

TITLE
FAR NORTH DISTRICT COUNCIL
RUSSELL WASTEWATER DISPOSAL SCHEME
INDICATIVE LOCATION OF DISCHARGE BOREHOLES

CADFILE 150449–1
SCALES (A3) 1:2000
DRAWING No. 150449-1
REV. 2

Appendix F: Ecological Effects Assessment

Russell Wastewater Treatment Plant - Ecology

Prepared for

Far North District Council

November 2023

PATTLE DELAMORE PARTNERS LTD
Level 5, PDP House
235 Broadway, Newmarket, Auckland 1023
PO Box 9528, Auckland 1149, New Zealand

Tel +64 9 **523 6900**
Web www.pdp.co.nz

solutions for your environment

Quality Control Sheet

TITLE	Russell Wastewater Treatment Plant - Ecology
CLIENT	Far North District Council
ISSUE DATE	21 November 2023
JOB REFERENCE	A03576827

Revision History

REV	Date	Status/Purpose	Prepared By	Reviewed by	Approved
1	21/11/23	Final	Petra Wedlake Tom Hewitt	Alvar Koning	Mark Bellingham

DOCUMENT CONTRIBUTORS

Prepared by

SIGNATURE

Petra Wedlake

pp

Tom Hewitt

Reviewed by

SIGNATURE

Alvar Koning

Approved by

Mark Bellingham

Limitations:

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Far North District Council and others (not directly contracted by PDP for the work), including Northland Regional Council, EIA Ltd, and Wilderlab NZ Ltd. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This report has been prepared by PDP on the specific instructions of Far North District Council for the limited purposes described in the report. PDP accepts no liability if the report 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.

Executive Summary

Far North District Council (FNDC) owns and operates the existing Kororāreka/Russell Wastewater Treatment Plant (KR-WWTP) located on Russell Whakapara Road, Russell. FNDC engaged Pattle Delamore Partners Limited (PDP) to undertake stream and wetland ecological assessments at the KR-WWTP site to support resource consent applications.

The scope of this assessment included a desktop review of information relating to the current ecological value of the site and vicinity, vegetation habitat mapping and confirmation of the extent of naturel inland wetland areas onsite, stream ecological assessments for tributaries including assessments of habitat quality, benthic macroinvertebrate and fish fauna communities, and physico-chemical water quality.

Field assessments were undertaken between 27-28 September 2023. Several areas of wetland were identified on site at the lower reaches of each of the stream gullies. Wetland survey plots were established across the area to map the extent of wetland habitat on site. In total, five areas of wetland habitat were identified and included areas dominated by raupō (*Typha orientalis)*, Carex, and exotic herbs. Habitat values within the raupō areas were high and provide significant indigenous avifauna habitat.

When compared to the NRC Proposed Regional Plan water quality standards, physico-chemical water quality results did not exceed respective guideline values for dissolved oxygen (DO), temperature and pH. When compared to the partial control site, electrical conductivity (EC) had increased, and DO had decreased in the receiving environment. While the decline in DO may be in response to bacterial respiration within the wetland environment, the increase in EC may be attributable to the KR-WWTP. This increase may be related to the elevated nitrogen concentrations, particularly nitrate nitrogen and ammoniacal nitrogen, which were identified by PDP during groundwater and surface water assessments (PDP, 2023).

Macroinvertebrate community index (MCI) scores for upstream sites were indicative of ‘fair’ to ‘excellent’ water quality (Stark & Maxted, 2007), while the equivalent qualitative MCI (QMCI) scores are considered either ‘good’ or ‘excellent’. In contrast, both MCI and QMCI for the receiving environment were reflective of probable severe pollution and fell below the National Policy for Freshwater Management (NPS-FM 2020) national bottom-line for both metrics. Overall, differences in community composition between upstream sites and the receiving environment were largely attributed to habitat availability rather than water quality.

eDNA samples returned a total of 27 different taxon groups across monitoring sites, which included two avifauna (North Island weka, *Galliralus australis*, and pūkeko, *Porphyrio melanotus*), and ten fish fauna rank sequences. Results indicated the presence of five native freshwater fish species across all four sites, including two species with a conservation status of 'At Risk' (Dunn et al. 2017). The apparent absence of species from the receiving environment could be attributed to a number of factors including habitat suitability, distance between sampling sites, eDNA longevity, and the migratory cycles of identified species. As such, further monitoring would aid interpretation of results and understanding of fish community composition. Based on the Taxon-Independent Community Index (TICI) value (Wilkinson et al. *in prep*), Stream 1, Stream 2 and the receiving environment were considered in 'good' stream condition, while Stream 3 was 'average'. These results will provide a useful baseline for future comparison.

Based on available data, PDP has assessed the adverse effects of the KR-WWTP discharge on the receiving environment and existing ecological values as **low** overall. PDP has also provided recommendations for ongoing ecological monitoring in relation to the KR-WWTP, including pest species monitoring of wetland areas, eDNA and macroinvertebrate sampling, as well as investigation into any potential fish passage barriers.

Table of Contents

Table of Figures

Table of Tables

Appendices

1.0 Introduction

Far North District Council (FNDC) owns and operates the existing Kororāreka/Russell Wastewater Treatment Plant (KR-WWTP) located on Russell Whakapara Road, Russell. FNDC currently hold two existing resource consents for the KR-WWTP as follows:

- AUT.008339.01.03 to discharge treated wastewater, including Russell Landfill leachate, to ground via disposal boreholes; and
- AUT.008339.02.03, to discharge contaminants to air (primarily odour) from the treatment plant and borehole disposal areas.

Both consents expire on 30 April 2024, and FNDC is seeking replacement consents to allow for the continued operation of the KR-WWTP.

Pattle Delamore Partners Limited (PDP) has been engaged to undertake stream and wetland ecological assessments at the KR-WWTP site to support resource consent applications. Specifically, this included delineating areas of natural inland wetland, determining stream and wetland ecological values and assessing likely ecological impacts associated with the treated wastewater discharge.

1.1 Project Scope

The scope of PDP's ecological assessment for the KR-WWTP included the following:

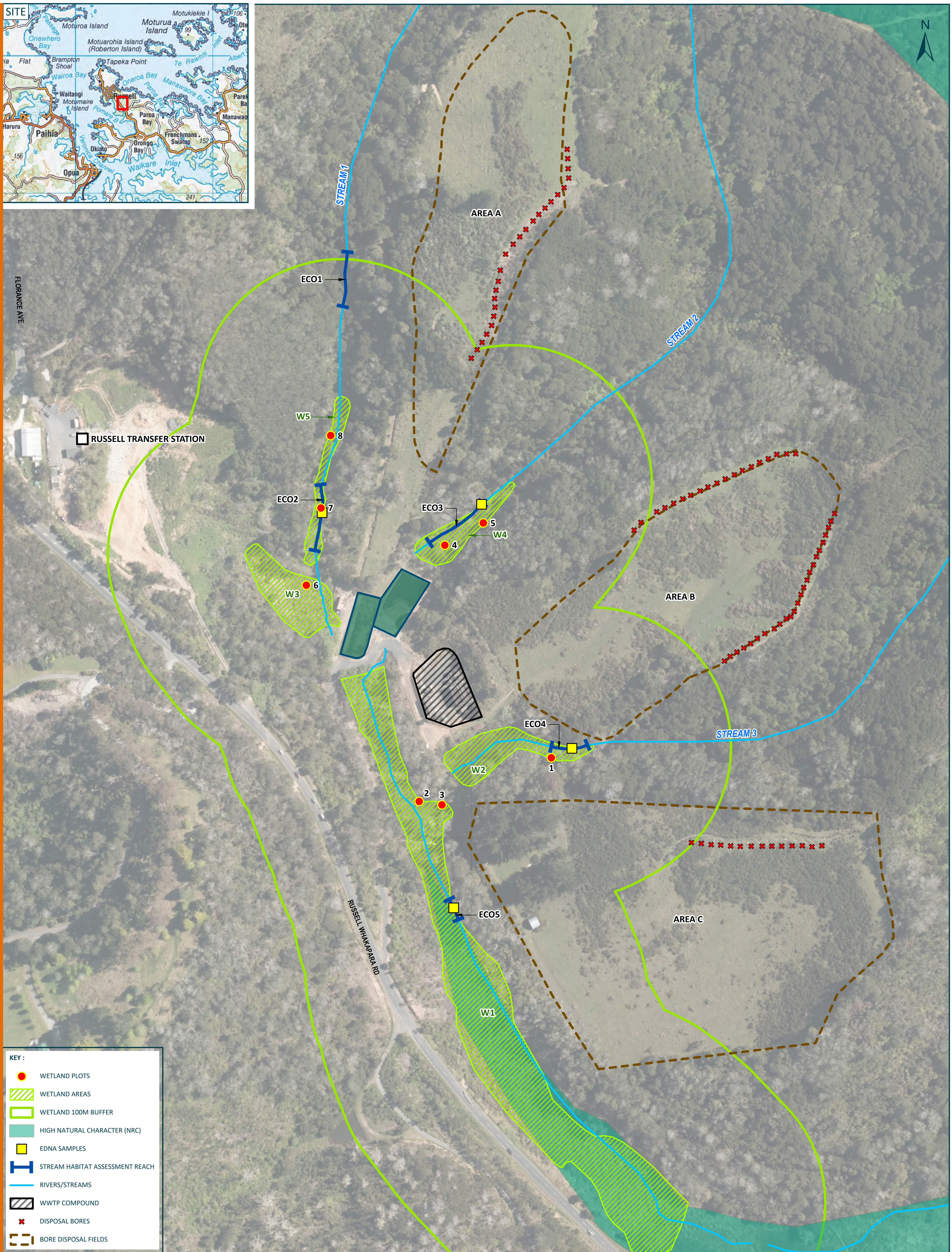
- Undertake a Desktop Review of existing information relating to the KR-WWTP, including previous compliance reports, and Assessment of Environmental Effects (AEEs), as well as publicly available data pertaining to freshwater, estuarine and wetland habitats within the catchment.
- Vegetation habitat mapping and confirmation of the extent of natural inland wetland areas (currently mapped by Northland Regional Council, NRC) to confirm consenting requirements under the National Environmental Standards for Freshwater (NES-F) 2020.
- Complete stream ecological assessments for tributaries bordering the KR-WWTP wastewater distribution fields, including, where possible, assessments of habitat quality, macrophyte and periphyton cover, benthic macroinvertebrate and fish fauna communities, and physico-chemical water quality.
- Prepare a technical report to support resource consent applications, identify potential impacts from the current discharge and provide recommendations for improvements or habitat restoration, if required.

2.0 Site Description

The KR-WWTP and associated bore disposal field are located approximately 1.5 km southeast of the Kororāreka/Russell township. The KR-WWTP receives wastewater from the Kororāreka/Russell and Tapeka Point communities in addition to small quantities of leachate from the adjacent closed landfill.

The KR-WWTP consists of a sewage treatment plant compound with two sequencing batch reactor (SBR) tanks. Two constructed ponds are situated to the north of treatment compound. Treated wastewater is discharged into ground via bore injection over 85 bores split across a series of ridgelines surrounding the KR-WWTP to the north and northeast of the site. Three small unnamed tributaries drain these areas, eventually discharging into a natural wetland located to the south of the WWTP.

The location of the KR-WWTP and the associated bore disposal field used for treated wastewater discharge to ground are provided in Figure 1.



SCALE : 1:2,500 (A3)

NO.	REVISION	DATE	BY
C	FINAL	NOV 23	TK
B	ISSUED FOR REVIEW	NOV 23	TK
A	ISSUED FOR REVIEW	OCT 23	JR

SOURCE:
1. AERIAL IMAGERY (FLOWN 2021-2022) SOURCED FROM THE LINZ DATA SERVICE HTTPS://DATA.LINZ.GOVT.NZ/ AND LICENCED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.
2. CADASTRAL/TOPOGRAPHICAL INFORMATION AND INSET DERIVED FROM LINZ DATA.
3. NATURAL CHARACTER OVERLAY DERIVED FROM NORTHLAND REGIONAL COUNCIL. RETRIEVED (19 OCT 23) FROM: HTTPS://LOCALMAPS.NRC.GOVT.NZ/LOCALMAPSVIEWER/?MAP=F75EF7386F8F49D5BF4B0B89305D48E7

CLIENT

Far North District Council
Te Kaunihera o Tai Tokerau ki te Raki

FIGURE

FIG 1: KORORĀREKA/ RUSSELL WASTEWATER TREATMENT PLANT LOCATION

PROJECT

KR-WWTP - ECOLOGY

A03576827.aprx - A03576828GIS001

3.0 Relevant Wetland Definitions

The following definitions were used to determine the presence or absence of wetlands on site.

RMA 1991:

Wetlands *are areas that are intermittently or permanently saturated by water and support natural ecosystems of plants and animals adapted to wet conditions.*

NPS-FM 2020:

*A **'natural inland wetland'** means a wetland (as defined in the Act) that is not:*

a) *in the coastal marine area,*
b) *a deliberately constructed wetland, other than a wetland constructed to offset impacts on, or to restore, an existing or former natural inland wetland, or*
c) *a wetland that has developed in or around a deliberately constructed water body, since the construction of the water body, or*
d) *A geothermal wetland; or*
e) *A wetland that:*
    i. *is within an area of pasture used for grazing; and*
    ii. *has vegetation cover comprising more than 50% exotic pasture species (as identified in the National List of Exotic Pasture Species using the Pasture Exclusion Assessment Methodology (see clause 1.8)); unless*
    iii. *is a location of a habitat of a threatened species identified under clause 3.8 of the National Policy Statement, in which case the exclusion in (e) does not apply.*

4.0 Methods

4.1 Desktop Review

PDP undertook an initial desktop review of existing information relating to the current ecological values of the KR-WWTP and surrounding area. This included a review of the following information sources:

- Previous KR-WWTP compliance reports and AEEs;
- NRC map resources including the Proposed Regional Plan;
- Manaaki Whenua Landcare and Ministry for the Environment (MfE) map resources;

- Recent and historical aerial and satellite imagery;
- Topographical maps and land surface contours;
- The NZ Freshwater Fish Database (NZFFD) to identify recorded fish assemblages within the catchment and infer likely species presence at the site; and,
- Photographs from previous site visits.

4.2 Field Assessments

All field assessments were undertaken by PDP between 27-28 September 2023. A total of 1.5 mm of rain was recorded in the 48 hours prior to the visit (NRC monitoring site 'Veronica Channel at Ōpua Wharf'). Light rain occurred during site visits on 27 September.

4.2.1 Wetland Identification

Wetlands are areas that are intermittently or permanently saturated by water and support natural ecosystems of plants and animals adapted to wet conditions. This is based on the Resource Management Act (RMA; 1991) term for '**wetland**'.

The Ministry for the Environment (MfE) National Policy Statement for Freshwater Management 2020 (NPS-FM, 2020) definition of a '**natural wetland**' is a wetland (as defined in the Act) that is not:

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

b) A geothermal wetland; or

c) Any area of improved pasture that, at the commencement date, is dominated by (that is more than 50 % of) exotic pasture species and is subject to temporary rain-derived water pooling.

A '**natural inland wetland**' is a wetland that is not located in the coastal marine area and includes both freshwater and inland saline wetlands in the Coastal Environment[1].

4.2.2 Wetland Desktop Review

Hydrological indicators of wetland presence are often visible in aerial imagery. These include surface water, sparsely vegetated concave surfaces, inundation, and soil saturation (MfE, 2021). Indicators such as geomorphic position can be assessed remotely using other desktop methods and studies of topography. Areas of low lying hydrophytic vegetation along stream reaches can also be discerned from aerial imagery. These features can be used to assess the likely presence of wetlands which can then be verified on site.

[1] NPS-FM as amended in December 2022 and operative 9 January 2023

4.2.3 Wetland Field Methods

Areas suspected of containing wetlands were assessed in the field as per standard wetland delineation protocols for Aotearoa New Zealand, based on the presence or absence of hydrophytic vegetation outlined in the MfE wetland delineation protocols (2020).

Hydrological conditions and hydric soil properties were also assessed as per the Wetland Delineation Hydrology Tool for Aotearoa New Zealand (MfE, 2021) and the Hydric Soils Field Identification Guide (Fraser *et al*. 2018). Areas containing more than 50% cover of pasture species were excluded from the definition of 'natural inland wetland'. Pasture species used in this assessment are those listed in the National list of exotic pasture species (MfE, 2022).

Clarkson (2014) assesses the presence of wetlands based on the presence of hydrophytic plants (plants adapted to wet conditions). Under this classification, all species found in wetlands are assigned an indicator status depending on the likelihood of them occurring within areas of wetland. These categories are:

- **OBL: Obligate**. Almost always is a hydrophyte, rarely in uplands (estimated probability > 99 % occurrence in wetlands);
- **FACW: Facultative Wetland**. Usually as a hydrophyte but occasionally found in uplands (estimated probability 67-99 % occurrence in wetlands);
- **FAC: Facultative**. Commonly occurs as either a hydrophyte but occasionally found in uplands (estimated probability 34-66 % occurrence in wetlands);
- **FACU: Facultative Upland**. Occasionally is a hydrophyte but usually occurs in uplands (estimated probability 1-33 % occurrence in wetlands); and,
- **UPL: Obligate Upland**. Rarely is a hydrophyte, almost always in uplands (estimated probability <1 % occurrence in wetlands).

4.2.4 Ecological Values Assessment

The ecological values associated with each of the wetland areas identified on site have been assessed according to the methodologies outlined in the Environmental Institute for Australia and New Zealand (EIANZ) Ecological Impact Assessment (EcIA) guidelines for use in Aotearoa New Zealand (Roper-Lindsay et al, 2018). In this method, areas of habitat are assessed based on several parameters including representativeness, rarity/distinctiveness, diversity and pattern, and ecological context.

4.2.5 Surface Water Quality

To aide interpretation of ecological data, in-situ measurements of physico-chemical water quality parameters including dissolved oxygen (DO), electrical conductivity (EC), pH, salinity, temperature, and turbidity were collected using a calibrated YSI ProDSS handheld meter.

4.2.6 Stream Habitat Assessment

Qualitative and semi-quantitative habitat assessments were carried out in conjunction with KR-WWTP monitoring locations following the Waikato Regional Council (WRC) semi-quantitative and qualitative stream habitat assessment methodology (Collier and Kelly, 2005). These are standard habitat assessment methods published by WRC which are commonly applied to wadeable streams across Aotearoa New Zealand. The WRC habitat assessments characterise the reach-scale aquatic habitat using observations of stream hydraulic conditions, channel and riparian features, stream-bottom substrata, instream plant cover and presence of organic material.

Beginning at the downstream end of the reach, the entire reach was visually assessed from the bankside. Reach-scale scores were allocated based on the following parameters: riparian vegetative zone width, vegetative protection, bank stability, channel sinuosity or frequency of riffles, channel alteration, sediment deposition, pool variability or velocity/depth regimes, abundance and diversity of habitat, and presence of periphyton. The average score across these parameters was used to generate a qualitative summary of habitat quality at the reach scale (i.e., ‘Poor’ to ‘Optimal’).

Where assessments were unable to be carried out in their entirety, due to lack of access for example, assessments were modified and undertaken to the extent practicable. Stream habitat assessment locations and approximate length of habitat assessed are presented in Table 1

Table 1: Stream Habitat Assessment Locations

Site	Description	Assessment Reach
ECO1	Partial control site, Stream 1	50 m
ECO2	Impact site downstream of bores, Stream 1	50 m
ECO3	Impact site downstream of bores, Stream 2	50 m
ECO4	Impact site downstream of bores, Stream 3	25 m
ECO5	Ultimate impact site, downstream of confluence of Tributaries and prior to discharge to wetland/estuary.	10 m

4.2.7 Benthic Macroinvertebrates

At each stream site, composite benthic macroinvertebrate samples were collected using a kick-net (500 µm mesh) in accordance with the National Environmental Monitoring Standard (NEMS) for collection and processing of macroinvertebrate samples from rivers and streams – collection method for semi-quantitative kick-net sampling (NEMS, 2020). This method targets all suitable macroinvertebrate mesohabitats available, in proportions equal to their presence across each monitoring reach.

Sampling involved the disturbance of available habitat including streambed substrate, bank margins, and accumulated debris, sampling a total area of between approximately 0.6-0.9 m^2. Note that due to the lack of access to the stream at ECO4 and ECO5, sampling area was reduced, between approximately 0.3-0.6 m^2.

Samples were preserved in 70% ethanol in the field and processed in the laboratory by Environmental Impact Assessments Ltd, under appropriate chain of custody. Analysis and identification followed Protocol P200 (200 fixed count with scan for rare taxa).

Biological indices used to assess the stream health included:

- **Macroinvertebrate Community Index (MCI) and Quantitative Macroinvertebrate Community Index (QMCI)** (Stark & Maxted, 2004) – a presence/absence-based measurement which describes the 'health of the stream' based on individual taxa scores between 1 and 10 (tolerant or sensitive to organic enrichment respectively).
- **EPT** – a measure of the relative abundance of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisfly) taxa, the major pollution sensitive taxonomic groups within macroinvertebrate communities, providing insight into water and habitat quality conditions.
- **Taxonomic richness** – a measure of the number of different macroinvertebrate taxa present in each sample.

Stream health can be inferred from MCI-sb and QMCI-sb scores using Table 2.

4.2.8 eDNA

Environmental DNA (eDNA) sampling was conducted to gain understanding of species distribution in relation to the KR-WWTP. Sampling requires that 1 litre of water is pushed through a syringe into a laboratory supplied filter. Samples were sent to Wilderlab NZ Limited for analysis. Sample locations are identified in Figure 1.

In addition to taxon presence/absence, stream health can also be inferred from Wilderlab eDNA results through the **Taxon-Independent Community Index** (TICI; Wilkinson et al. *in prep*). The TICI stream classification and associated values are provided in Table 3. The TICI is an experimental tool in development for the interpretation of Wilderlab eDNA data which works similarly to the MCI, except tolerance values have been assigned to DNA sequences from across the tree of life, instead of only invertebrate taxa.

Table 2: Benthic Macroinvertebrate Indices and Guideline Limits

Source	Classification	Description	MCI	QMCI
Stark and Maxted (2007) 'Quality Class' [1]	Excellent	Clean water	>119	>6.00
	Good	Doubtful quality or possible mild pollution	100 - 119	5.00 - 5.99
	Fair	Probable moderate pollution	80 - 99	4.00 - 4.99
	Poor	Probable severe pollution	<80	<4.00
NPS-FM 2020 NOF [2,3]	Attribute Band A	Pristine conditions with almost no organic pollution or nutrient enrichment	≥130	≥6.5
	Attribute Band B	Mild organic pollution or nutrient enrichment	≥110 - <130	≥5.5 - <6.5
	Attribute Band C	Moderate organic pollution or nutrient enrichment	≥90 - <110	≥4.5 - <5.5
	Attribute Band D	Severe organic pollution or nutrient enrichment	<90	<4.5

Notes:

1. *Quality class interpretations derived from Stark and Maxted (2007).*
2. *NOF refers to the National Policy Statement for Freshwater (NPS-FM 2020) National Objectives Framework (MfE, 2023).*
3. *Attribute Band D falls below the National Bottom Line of the NPS-FM 2020.*

Table 3: Stream Condition Index – Taxon-Independent Community Index

Classification	TICI Value[1]
Pristine	>120
Excellent	110 - 120
Good	100 - 110
Average	90 - 100
Poor	80 - 90
Very Poor	<80

Notes:

1. *Taxon-Independent Community Index interpretations from Wilkinson et al. in prep.*

5.0 Desktop Review

5.1 Landcover and Land Use

Land surrounding the KR-WWTP is maintained as a mix of mānuka (*Leptospermum scoparium*) and/or kānuka (*Kunzea ericoides)* scrub in the ridges and gullies, and high producing exotic grassland and herbaceous freshwater vegetation along flat areas of the site around the plant (Manaaki Whenua, 2020).

The land has been mostly vegetated since at least the early 1950's when the earliest aerial imagery is available. The existing treatment plant was established in the early 2000's where a series of deep bores were established in the surrounding hills. Areas of vegetation have been cleared in the vicinity of the bores leaving an area of open pasture, most recently filled in with gorse (*Ulex europaeus)*.

5.2 Catchment

Three small unnamed headwater stream tributaries are present on site, identified as Stream 1, Stream 2 and Stream 3, respectfully (Figure 1). The streams flow through vegetated gullies toward the KR-WWTP and are maintained via culverts and pipes beneath associated infrastructure for convergence to the south of the plant in the unnamed receiving environment stream. The unnamed receiving environment stream is characterised by the River Environment Classification (REC) as having 'warm, wet hill' origins. Shortly thereafter, flow is discharged into the Uruti Bay estuary.

5.3 Ecological Context

The KR-WWTP lies within the Whangaruru Ecological District (ED), which contains a high diversity of vegetation types at inland, coastal and island sites (Booth, 2005). One of the most important features is the relative abundance of pōhutukawa (*Metrosideros excelsa*) coastal forest, which is a nationally rare forest type. Other nationally important habitat types include swamp forest, freshwater wetlands, and estuarine systems.

The most common vegetation types in the Whangaruru ED are secondary forest dominated by tōtara (*Podocarpus totara)*, taraire (*Beilschmiedia taraire*), or tōwai (*Pterophylla sylvicola*), and kānuka/mānuka shrubland. Raupō (*Typha orientalis*) reedland is the most common freshwater wetland type, with oioi (*Apodasmia similis*) saltmarsh and mangrove (*Avicennia marina subsp. Australasica*) shrubland common in the numerous estuaries within the district.

5.4 Wetlands

A large area of wetland has been identified in the southern portion of the site which is contiguous with saltmarsh and brackish wetlands in the Uruti Bay estuary. This includes areas of high natural character identified in the Proposed Northland Regional Plan (NRP, 2019).

5.5 Freshwater Fish Records

As of September 2023, there were no NZFFD records available in the vicinity of the KR-WWTP.

6.0 Assessment Results

6.1 Wetlands

A site visit was undertaken between 27-28 September 2023 to assess and delineate the extent of 'natural inland wetland' within a 100 m buffer of the KR-WWTP.

Five areas of wetland habitat were identified in the lower lying portions of the site alongside streams and in the base of gullies, this included areas within 100 m of the bores. The location of these wetlands relative to the bores is provided in Figure 1. The KR-WWTP wetlands identified on site include both indigenous and exotic dominant wetlands habitats with potential habitat for indigenous avifauna.

Full wetland plot data is provided in Appendix A, with representative photographs in Appendix B.

6.1.1 Wetland 1

Wetland 1 is located to the south of the treatment plant and is a contiguous with a larger area shown as Saltmarsh and Mangrove in Northland Regional Council Maps. This area includes areas mapped in the Northland Regional Policy Statement High Natural Character area overlays. Wetland 1 is dominated by raupō (OBL) and other hydrophytic plant species such as water cress (*Nasturtium officinale,* OBL). Occasional species include *Carex maorica* (OBL), Yorkshire fog (*Holcus lanatus*, FAC), pampas (*Cortaderia selloana,* FAC), and woolly nightshade (*Solanum mauritanium,* no rating). The wetland is flanked by native trees including kānuka (*Kunzea robusta,* FACU), tī kōuka (cabbage tree, *Cordyline australis,* FAC), tree ferns (*Cyathea* spp. FACU), and māpou (*Myrsine australis,* FACU).

Ecological values of this wetland are considered to be high due to the presence of extensive raupō reeds which are of high habitat value for indigenous fauna such as the matuku-hūrepo (Australian Bittern, *Botaurus poiciloptilus,* Threatened-Nationally Critical), pūweto (spotless crake, *Porzana tabuensis*, At-Risk Declining) and mātātā (North Island fernbird, *Poodytes punctatus,* At-Risk Declining). Overall ecological values associated with Wetland 1 are assessed as **high**.

6.1.2 Wetland 2

Wetland 2 surrounds the lower reaches of the gully in the vicinity of ECO4. This area of habitat is characterised by a canopy of exotic black wattle (*Acacia mearnsii,* UPL) and indigenous shrubs over an understorey of mostly rautahi (*Carex geminata,* FACW) with occasional swamp kiokio (*Parablechnum minus,* FACW), watercress (*Nasturtium officinale*, OBL) and swamp millet (*Isachne globosa,* OBL). Other recorded species include māpou, rough tree fern (*Dicksonia squarrosa,* FACU), tī koūka (FAC), kānuka (FACU), woolly nightshade (no rating). A pond is also present in the downstream limit of the wetland fringed by swamp millet. Habitat values associated with Wetland 2 are considered **moderate**.

6.1.3 Wetland 3

Wetland 3 is formed above the accessway in the northern portion of the site. This wetland is characterised by a dominant stand of raupō (OBL) fringed by exotic species such as pampas (*Cortaderia selloana,* FAC), woolly nightshade (*Solanum mauritanium,* no rating), and gorse (FACU). Although small this area also provides potential habitat for indigenous birds including mātātā and matuku-hūrepo. Overall, Wetland 3 has **high** ecological value.

6.1.4 Wetland 4

Wetland 4 is formed around the base of a gully in the vicinity of ECO3. A stream flows through this wetland forming a pond at the downstream extent. Hydrophytic vegetation comprising predominantly raupō and Yorkshire fog are abundant in the lower reaches of the gully. Other occasional species include lotus (*Lotus pedunculatus,* FAC), starwort (*Callitriche stagnalis,* OBL), creeping buttercup (*Rannunculus repens,* FAC), soft rush (*Juncus effusus,* FACW), rautahi (FACW), swamp millet (OBL), and jointed twig rush (*Machaerina articulata,* OBL). Overall habitat values associated with Wetland 4 are **moderate**.

6.1.5 Wetland 5

Wetland 5 is located along a stream in the vicinity of ECO2. This habitat was dominated by Mexican devil (*Ageratina adenophora,* FAC) along with occasional cabbage tree (*Cordyline australis,* FAC), and mamaku (*Cyathea medullaris,* FACU). Vegetation plots established in this wetland comprised predominantly facultative wetland plants that may indicate either wetland or upland conditions. Soil and hydrology assessments were therefore undertaken revealing the presence of adequate wetland hydrology including surface water (1A), high groundwater (1B), soil saturation (1C), and pale low chroma soils (10YR5/2). Overall habitat values associated with Wetland 5 are **moderate**.

6.1.6 Other Vegetation

Surrounding each of the wetlands are areas of indigenous and exotic vegetation including areas of forest. Exotic species such as black wattle, radiata pine, tree privet, gorse, ginger (*Hedychium gardnerianum*), and woolly nightshade are frequent in the lower portions of each of the gullies immediately adjacent to the treatment plant. In the upper reaches of these gullies are areas dominated by a tall tree canopy and indigenous species such as kānuka, tī koūka, pūriri (*Vitex lucens*), kohekohe (*Dysoxylum spectabile*), supplejack (*Ripogonum scandens*), kawakawa (*Piper excelsum*), hangehange (*Geniostoma ligustrifolium*), and tawa (*Beilschmieda tawa*).

6.1.7 Wetland Ecological Values

Ecological values associated with each of the wetlands are outlined in Table 4. These habitats include a mix of indigenous and exotic dominated wetlands of which the most abundant plant species is raupō. Wetland 1 and Wetland 3 are are of particular value due to the dominance of indigenous plant species. Parts of Wetland 1 are also included within a High Natural Character area overlay in the Northland Regional Policy Statement.

Table 4: Ecological Values Assessment for Habitat Types[1]

Habitat Type	Criteria	Ecological Value
W1 & W3	**Representativeness –** Predominantly indigenous vegetation.	High
	Rarity/distinctiveness – Wetlands are a threatened habitat type with less than 10 % overall remaining.	High
	Diversity and Pattern – low diversity of indigenous plants.	Low
	Ecological Context – Forms part of the Uruti and Pomare Bay estuary and areas of High Natural Character. Habitat for indigenous fauna.	High
	Overall Ecological Value	**High**
W2, W4 & W5	**Representativeness –** Mix of indigenous and exotic plant species.	Moderate
	Rarity/distinctiveness – Wetlands are a threatened habitat type with less than 10 % of the original cover remaining. As such all areas of wetland habitat are considered valuable.	High
	Diversity and Pattern – Low diversity of indigenous wetland plants.	Low
	Ecological Context – Forms part of a network of wetlands surrounding the WWTP.	Moderate
	Overall Ecological Value	**Moderate**

Notes:
1. *Assessed according to the EIANZ guidelines (Roper-Lindsay et al, 2018).*

6.2 Avifauna

Incidental observations of birds recorded during assessments are presented in Table 5 below. Records also include two species, the weka (*Galliralus australis*) and the pūkeko (*Porphyrio melanotus*), which were returned in eDNA sampling results.

The mātātā (North Island fernbird, *Poodytes punctatus*), Australasian bittern (*Botaurus poiciloptilus*) and pūweto (spotless crake, *Porzana tabuensis tabuensis*) could also be expected in this area but were not observed during assessments. The mātātā and pūweto have the conservation status ‘At Risk – Declining’, while the Australasian bittern is considered ‘At Risk – Nationally Critical’ (Robertson et al. 2021).

Table 5: KR-WWTP Avifauna Observations

Common Name	Species Name	Conservation Status[1]	Likelihood of Presence
Myna	*Acridotheres tristis*	Introduced	Observed
Kahu/Swamp harrier	*Circus approximans*	Not Threatened	Observed
Chaffinch	*Fringilla coelebs*	Introduced	Observed
Weka	*Galliralus australis*	At Risk – Relict	eDNA
Riroriro	*Gerygone igata*	Not Threatened	Observed
Kererū	*Hemiphaga novaeseelandiae*	Not Threatened	Observed
Swallow	*Hirundo neoxena*	Not Threatened	Observed
House sparrow	*Passer domesticus*	Introduced	Observed
Pheasant	*Phasianus colchius*	Introduced	Observed
Eastern Rosella	*Platycercus eximius*	Introduced	Observed
Pūkeko	*Porphyrio melanotus*	Not Threatened	Observed, eDNA
Tūī	*Prosthemadera novaeseelandiae*	Not Threatened	Observed
Piwakawaka	*Rhipidura fulginosa*	Not Threatened	Observed
Kōtare	*Todripamphus sanctus*	Not Threatened	Observed
Blackbird	*Turdus merula*	Introduced	Observed
Song thrush	*Turdus philomelos*	Introduced	Observed
Tauhou/Silvereye	*Zosterops lateralis*	Not Threatened	Observed

Notes:

1. *Conservation status from Roberston et al., 2021.*

6.3 Surface Water Quality

In-situ surface water quality measurements were collected at KR-WWTP ecological monitoring locations during sampling between 27-28 September 2023. A summary of the results is presented below (Table 6).

When compared to the partial control site, ECO1, electrical conductivityDO concentrations had decreased from 10.03 mg/L to 6.31 mg/L at ECO5. EC was also elevated for downstream sites compared to the partial control, increasing from 233.1 µS/cm at ECO1 to 364.6 µS/cm at ECO5. The highest EC concentration was recorded at ECO4 (457.1 µS/cm). Temperature appears to have been influenced by the timing of sampling (i.e. lower in the morning, higher in the afternoon), rather than indicative of any upstream-downstream trend. Salinity results for ECO5 were consistent with upstream sites, indicating that ECO5 is not tidally influenced.

When compared to the NRC Proposed Regional Plan Table 22: Water quality standards for ecosystem health in rivers, results did not fall below the minimum standards for ‘other rivers’ for DO (≥ 4.0 mg/L for the 1-day minimum) and were below the maximum temperature standard (≤ 24 °C). pH results were within the range of acceptable values (6.0-9.0).

Table 6: Surface Water Quality Results – KR-WWTP Sites

Parameter	ECO1	ECO2	ECO3	ECO4	ECO5
Dissolved Oxygen (mg/L)	10.03	9.48	9.38	8.85	6.31
Electrical Conductivity (µS/cm)	233.1	296.2	390.7	457.1	364.6
pH (pH units)	6.72	6.47	6.79	6.45	6.59
Salinity (ppt)	0.11	0.14	0.19	0.22	0.18
Temperature (°C)	13.9	13.3	14.8	14.6	15.1
Turbidity (FNU)	7.06	6.15	6.28	6.43	2.97

DO levels within receiving environments are affected by a number of factors including temperature, pH and salinity. The reduction in DO from ECO1 to ECO2, ECO3, and ECO4 measurements is considered minimal, and are of a level that is sufficient to support most aquatic organisms. Given the location of ECO5 along the edge of the Wetland 1 with considerable fine material accumulation noted during assessments (Section 6.4.5), increased rates of organic decomposition and a subsequent decrease in DO may be the cause of low DO levels recorded in the receiving environment.

Elevated EC is caused by a wide range of factors but in this case could potentially be related to the elevated nutrient ions in surface water, identified by PDP (PDP, 2023). More detail on the KR-WWTP surface water quality can be found in the PDP report *Kororāreka Russell WWTP – GW and SW Effects Assessment*.

6.4 Stream Habitat Assessment

Stream habitat assessments were conducted between 27-28 September 2023. A summary of the habitat assessment results is presented below (Table 7) and are presented in full in Appendix C. Descriptions of each reach are provided in the following subsections.

6.4.1 ECO1

ECO1 is located along Stream 1 to the north of the KR-WWTP, flowing through a steep gully that drains north-south. The ECO1 reach had a wetted width between 0.7-1.2 m, generally widening with distance downstream of the ECO1 sampling reach. Narrow sections of flow were also observed in the mid-reach, associated with debris dams and large substrate deposits on edges. Measured stream depth was typically less than 0.2 m.

Stream 1 was hard bottomed along this section, with cobbles identified as the most dominant riverbed substrate (40 % cover). Moderate silt build up was noted within pooled areas. Macrophytes were not observed, however, mosses and lichens covered approximately 20 % of bed substrate material along the reach. Periphyton was not visible, and surfaces were generally rough to the touch.

Located within a forested gully, a riparian vegetation buffer of at least 10 m was maintained along both sides of the ECO1 stream reach, providing a high level of shade. Well established native forest included patē (*Schefflera digitata*), pūriri, kohekohe, supplejack, kawakawa, hangehange, and tree ferns (*Dicksonia* spp). Ginger was also relatively common along stream edges. As a result, large woody material and organic inputs were common, particularly along the mid-reach. Fine organic deposits and sediments were minimal and limited to edges and backwaters.

The ECO1 reach scored a total of 163.5 out of a possible 180 (average score = 18.2), which is considered 'Optimal'.

6.4.2 ECO2

ECO2 is located to the south of ECO1, flowing through the base of the Stream 1 gully and associated Wetland 5. ECO2 is a narrow, shallow channel, with wetted width < 0.4 m and stream depth < 0.1 m. This was a section of soft bottomed stream, with silt and sand sized substrates dominant. As ECO2 flows along the edge of Wetland 5, stream flow was contained within a defined channel however, lacked established banks for assessment. Macrophytes, filamentous algae and periphyton were not observed.

A riparian vegetation buffer of at least 10 m was maintained along this section of stream, providing a relatively high level of shade. The upper 30-35 m of the reach flows through mixed native and exotic vegetation including tī kōuka, mamaku, kānuka, and black wattle. The lower 10-15 m of the ECO2 reach flows beneath overhanging Wetland 5 vegetation including raupō. As such, woody debris and organic material deposits were observed in the upper 30-35 m of the reach but were not observed beneath Wetland 5 vegetation in the lower reach.

The ECO3 reach scored a total of 120.5 out of a possible 160 (average score = 15.1) which is considered 'Optimal'.

6.4.3 ECO3

ECO3 is located along Stream 2 to the northeast of the KR-WWTP. The stream flows through the base of the Stream 2 gully and associated Wetland 4. ECO3 is a narrow soft bottomed channel less than 1.2 m wide, with maximum stream depth at 0.2 m. As ECO3 flows along the edge of Wetland 4, stream flow was contained within a defined channel dominated by silt-sized particles, but which lacked established banks for assessment. Macrophytes, filamentous algae and periphyton were not observed.

A riparian vegetation buffer of at least 10 m was maintained along this section of Stream 2. In the mid-to-lower reach, riparian vegetation cover was dominated by raupō, with sparse canopy cover consisting of tree ferns. Woody vegetation was confined to the banks of the upper reach and included exotic species such as black wattle, gorse, and woolly nightshade. Woody and organic material inputs were minimal, and generally limited to upper areas.

The ECO3 reach scored a total of 117 out of a possible 160 (average score = 14.6) which is considered 'Sub-optimal'.

6.4.4 ECO4

ECO4 is located along Stream 3, immediately southeast of the KR-WWTP. The stream flows through the base of the Stream 3 gully and associated Wetland 2. Access to a full 50 m reach in this location was not possible and assessments were undertaken to the extent practicable, along a 25 m section of Stream 3. Stream habitat scores were unable to be allocated for a number of habitat parameters and given the lack of data, ECO4 has not been given an overall habitat quality score.

The ECO4 reach had a wetted width of less than 1.0 m and depth of less than 0.2 m. ECO4 is a soft bottomed stream, with observed channel areas dominated by silt. Similar to ECO2 and ECO3, ECO4 stream flow was contained within a defined channel which lacked established banks for assessment. Macrophytes, filamentous algae and periphyton were not observed.

The riparian vegetation buffer was at least 10 m along both banks, however, canopy cover was sparse due to numerous fallen trees. Riparian vegetation along both stream banks included native shrub species including rautahi, swamp kiokio and watercress. Canopy vegetation was relatively sparse, dominated by black wattle. A number of trees had fallen in this lower gully area, causing much of the access difficulties at this location. Woody debris and organic material of all sizes was observed. As for other wetland associated reaches, the stream lacked established banks for assessment.

6.4.5 ECO5

ECO5 is located downstream of the confluence of Tributaries 1, 2 and 3, along the eastern edge of Wetland 1. Access to a full 50 m in this location was not possible and assessments were undertaken to the extent practicable, along a 10 m section of stream. Stream habitat scores were unable to be allocated for a number of habitat parameters and given the lack of data, ECO5 has not been given an overall habitat quality score.

The ECO5 reach had a wetted width of less than 1.0 m and depth of less than 0.2 m. ECO5 was soft bottomed, with observed channel areas dominated by silt and accumulated fine sediment. Stream flow was contained within a defined channel which lacked established banks for assessment. Macrophytes were observed within the channel, including watercress and *Ludwigia palustris*.

The riparian vegetation buffer was at least 10 m along both banks, largely consistent of Wetland 1 raupō. Native trees including kānuka were within the riparian zone along the TLB, with fallen branches contributing to woody debris within the stream. As for other wetland associated reaches, the stream lacked established banks for assessment.

Table 7: Stream Habitat Assessment Results Summary – KR-WWTP Sites

Parameter[1,2]	ECO1	ECO2	ECO3	ECO4	ECO5
1. Riparian Vegetative Zone Width	20	18	18	18	18
2. Vegetative Protection	19	16.5	14	14.5	15.5
3. Bank Stability	17.5	N/A	N/A	N/A	N/A
4. Channel Sinuosity	18[3]	15	15	N/A	N/A
5. Channel Alteration	20	19	19	19	N/A
6. Sediment Deposition	16	18	17	N/A	N/A
7. Pool Variability	16[4]	10	9	N/A	N/A
8. Abundance and Diversity of Habitat	18	14	15	13	N/A
9. Periphyton	19	10	10	10	N/A
Average Score	**18.2**	**15.1**	**14.6**	**N/A**	**N/A**
Category	**Optimal**	**Optimal**	**Sub-optimal**	**N/A**	**N/A**

Notes:

1. *Wadeable soft-bottom stream habitat parameter.*
2. *N/A applied to habitat parameter scores where insufficient data was able to be collected.*
3. *Hard-bottom stream equivalent score for habitat parameter 'Frequency of Riffles'.*
4. *Hard-bottom stream equivalent score for habitat parameter 'Velocity/Depth Regimes'.*

6.5 Benthic Macroinvertebrates

Benthic macroinvertebrate surveys were carried out along surveyed stream reaches associated with ECO1, ECO2, ECO3, ECO4 and ECO5 (Table 1). As previously mentioned (Section 4.2.5), total sampling area was reduced for ECO4 and ECO5 due to a lack of access. A summary of macroinvertebrate metrics for the KR-WWTP is provided in Table 7 below, and full macroinvertebrate results are included in Appendix D.

A total of 42 taxa were recorded across all surveyed reaches, 11 of which were EPT taxa (four Ephemeroptera, seven Trichoptera). With the exception of ECO5, sites had high % EPT scores, with ECO4 scoring the highest at 58 %. The *Zephlebia* mayfly was identified in abundance at ECO1 and ECO3, constituting more than half of the sampled individuals at each site. The *Zephlebia* mayfly was also the most common taxa for ECO2 and ECO4, but present in lower abundances than at ECO1 and ECO3. In contrast, crustacea were the most common taxa at ECO5, with only four EPT individuals identified.

MCI scores for ECO1, ECO2, ECO3, and ECO4 indicate ‘fair’ to ‘excellent’ water quality (Stark & Maxted, 2007), while the equivalent QMCI scores are considered either ‘good’ or ‘excellent’. Despite having the greatest taxa richness (23), ECO5 scored poorly for all other metrics. Both MCI and QMCI for ECO5 were reflective of ‘poor’ water quality (Stark & Maxted, 2007), and were consistent with the respective NPS-FM 2020 Attribute Band D categories. As such, MCI and QMCI results for ECO5 do not meet the NPS-FM 2020 national bottom-line.

As the ultimate receiving environment for the KR-WWTP treated wastewater discharge, benthic macroinvertebrate results, in isolation, appear to suggest an upstream-downstream decline in water quality. While low macroinvertebrate metrics are indicative of severe pollution or nutrient enrichment, this is more likely to be attributed to the difference in habitat available for sampling at ECO5 when compared to upstream sites. ECO5 is located along the edge of Wetland 1, with considerable fine material accumulation noted during assessments. Fine sediments are not ideal habitat for sensitive EPT taxa and it appears that these are largely absent from the ECO5 sample, in favour of more generalist taxa including crustacea.

6.6 eDNA

6.6.1 Stream Condition

eDNA samples were collected from a single point along stream reaches associated with ECO2, ECO3, ECO4 and ECO5 (Figure 1). A summary of stream health, as indicated by the TICI, is provided in Table 9, with a visualisation of full eDNA results included in Appendix E.

A total of 27 different taxon groups were represented by KR-WWTP eDNA samples. Bacteria was by far the most common (139 rank sequences signalled), followed by plants (92). Cattle were identified at ECO3, while the black rat or hinamoki (*Rattus rattus*) were identified in all samples except for ECO4. Weka were signalled at ECO3 and the receiving environment ECO5, with pūkeko found at ECO4. There were also 10 freshwater fish rank sequences identified, which are explored further in Section 11.2.

Based on the TICI value, ECO2, ECO3, and ECO5 were considered in 'good' stream condition, while ECO4 was 'average'. These results will provide a useful baseline for future comparison.

6.6.2 Freshwater Fish Fauna

eDNA results indicated the presence of six species of freshwater fish (Table 10), with a visualisation of full eDNA results provided in Appendix E.

Five different native freshwater fish species were identified from KR-WWTP samples. Of these, the longfin eel (*Anguilla dieffenbachii*) has a conservation status of 'At Risk – Declining', while the giant kokōpu (*Galaxias argenteus*) is 'At Risk – Naturally Uncommon' (Dunn et al. 2017).

All five fish species were identified in the ECO3 sample, and three were identified at ECO4, however only two species were signalled in the furthest downstream environment ECO5, the shortfin eel (*Anguilla australis*) and banded kokōpu (*Galaxias fasciatus*). These upstream-downstream differences may reflect a number of factors, including the ECO5 habitat suitability for identified species, distance between sampling sites, eDNA longevity, and the migratory cycles of these species.

eDNA signals decrease with distance from source and transport distances are positively related to stream velocity and morphology (e.g. Wilcox et al. 2016). These slow-moving near headwater streams drain to ponds before eventual discharge to the receiving environment. It is possible eDNA from fish communities located in the upstream areas may have deteriorated by the time it reached ECO5, or had settled out of suspension and not transferred to the receiving environment (e.g. Turner et al. 2014; Buxton et al. 2018).

While habitat preference and suitability may contribute to the absence of certain species from ECO2, ECO4 and ECO5, migratory cycles of identified species may also be a factor in these results. For example, sampling coincided with peak migration of juvenile banded kokōpu upstream between September and October but was outside the upstream migration periods of the giant kokōpu, shortfin eel or longfin eel (NIWA, 2014). It is also possible that upstream-downstream connectivity is impacted by fish passage barriers, and upstream communities represent populations cut off from downstream areas. Any impediment to fish passage i.e. between ECO4 and ECO5, should be investigated further.

Table 8: Summary of Macroinvertebrate Community Indices – KR-WWTP

Location	Number of Individuals[1]	Taxa Richness	% EPT Taxa	MCI	Stark & Maxted Quality Class - MCI	NPS-FM 2020 Attribute Band - MCI	QMCI	Stark & Maxted Quality Class – QMCI	NPS-FM 2020 Attribute Band – QMCI
ECO1[2]	205	19	42.1	113.7	Good	B	6.6	Excellent	A
ECO2	204	18	44.4	120.4	Excellent	B	7.2	Excellent	A
ECO3	210	19	55.2	109.6	Good	C	7.1	Excellent	A
ECO4	188	17	58.0	96.5	Fair	C	5.3	Good	C
ECO5	214	23	8.7	86.1	Poor	D	3.7	Poor	D

Notes:
1. *Number of individuals under P200 (200 fixed count with scan for rare taxa).*
2. *ECO1 is a hard-bottomed site while remaining sites are considered soft-bottomed.*
3. *Shaded values do not meet NPS-FM 2020 national bottom-line.*

Table 9: Summary of eDNA Stream Condition – KR-WWTP

Location	TICI Value	Wilkinson et al. Stream Condition – TICI	TICI Reliability[1]
ECO2	107.84	Good	Average
ECO3	109.80	Good	High
ECO4	98.72	Average	Average
ECO5	108.03	Good	Average

Notes:
1. *The reliability/robustness of the score as determined by the number of composite tolerance values included in its calculation.*

Table 10: Fish eDNA Results – KR-WWTP

Common Name	Species Name	Conservation Status[1]	ECO2/ Stream 1	ECO3/ Stream 2	ECO4/ Stream 3	ECO5/ Receiving
Shortfin eel	*Anguilla australis*	Not Threatened	X	X	X	X
Longfin eel	*Anguilla dieffenbachii*	At Risk – Declining	-	X	-	-
Banded kokōpu	*Galaxias fasciatus*	Not Threatened	X	X	X	X
Giant kokōpu	*Galaxias argenteus*	At Risk – Naturally Uncommon	-	X	-	-
Redfin bully	*Gobiomorphus huttoni*	Not Threatened	-	X	X	-

Notes:
1. *Conservation status from Dunn et al., 2017.*

7.0 Assessment of Discharge on Existing Ecological Values

Physico-chemical water quality results indicated an upstream-downstream increase in EC which may be attributable to the KR-WWTP. This increase may be related to the elevated nitrogen concentrations, particularly nitrate nitrogen and ammoniacal nitrogen, which were identified by PDP during groundwater and surface water assessments (PDP, 2023).

Wetlands onsite are dominated by predominantly tolerant wetland plant species such as raupō with frequent exotic herbs and indigenous rushes and sedges. Increased nutrient levels from discharges may have an effect on pest plant growth in wetlands and can lead to reduced indigenous plant diversity (Sorrell, 2012). Increased nutrient levels will generally increase the growth rate of species such as raupō which can outcompete other native plant species and increase the production of leaf litter. This can result in greater rates of decomposition leading to increased nutrient levels within the water column.

There was no substantial evidence to suggest that discharges from the KR-WWTP are impacting significantly on wetlands at the site through for instance the nuisance growth of algae or excessive growth of raupō or exotic pest plants. Vegetation communities were more or less as expected for their position in the landscape. Exotic pest plants were prevalent in some areas however this community was consistent with what would be expected given the level of disturbance and modification of the surrounding landscape and does not appear to be primarily a consequence of increased nutrient levels from the KR-WWTP discharge.

Effects of the discharge on the hydrological functioning of the wetland are expected based on the locations of the bores as these are hydrologically linked to the wetlands through surface water flow. This may result in a small changes in the water levels and hydrological functioning of the wetland however this could not be quantified based on the site visit. Overall, the impact of discharges on the wetlands are considered to be **low**.

In isolation, benthic macroinvertebrate survey results appear to suggest an upstream-downstream decline in water quality, with ‘poor’ quality macroinvertebrate communities identified at the site compared to upstream communities which were dominated by pollution sensitive macroinvertebrate taxa. When results are considered in the wider context, differences in community composition between upstream sites and the receiving environment are more likely attributed to habitat availability, with upstream sites offering increased habitat diversity.

eDNA results indicated the presence of five native freshwater fish species across all four sites, including two species with a conservation status of 'At Risk' (Dunn et al. 2017). All five fish fauna were identified as present along Stream 2 but were absent from the receiving environment. This could be attributed to a number of factors, including water quality, but are more likely in this case due to a combination of habitat suitability, eDNA longevity in the KR-WWTP surface water environment, and the migratory cycles of identified species. TICI values calculated using eDNA results did not suggest any upstream-downstream decline in stream condition.

Based on available data, the current KR-WWTP discharge is assessed as having a **low** ecological effect on the receiving environment and existing ecological values.

8.0 Recommendations

PDP recommends the following ongoing ecological monitoring:

- Annual pest plant control and ongoing monitoring of wetland plant composition and weed abundance to maintain the wetland ecological values, particularly within Wetland 1.
  - Monitoring in the form of a walkover of each of the wetlands with notes taken on location and abundance of pest plant species. Ongoing monitoring will also be required to detect any changes in wetland condition as a result of any future changes in nutrient discharge or water levels.
- Monitoring of benthic macroinvertebrates and eDNA at ECO1-ECO4, with eDNA only at ECO5.
  - Sampling should be undertaken in November/December and May/June, following periods of low rainfall, to coincide with migration peaks of species identified at the site.
  - Change over time to be considered on a site-by-site basis, rather than for the purposes of an upstream-downstream comparison.
- Surface water quality monitoring at ecological monitoring sites to allow for better interpretation of ecological monitoring results and understanding of the receiving environment water quality.

9.0 Conclusions

Several areas of wetland were identified on site at the lower reaches of each of the stream gullies. Wetland survey plots were established across the area to map the extent of wetland habitat on site. In total, five areas of wetland habitat were identified and included areas dominated by raupō, carex, and exotic herbs. Habitat values within the raupō areas were high and provide significant indigenous avifauna habitat.

Applicable physico-chemical water quality parameters were within the range of acceptable values for surface water when compared to the NRC Proposed Regional Plan guidelines, however, results indicated an upstream-downstream change in EC which may be attributable to the KR-WWTP. Benthic macroinvertebrate survey results did not appear to have been influenced by any change in water quality, with differences in community composition between upstream sites and the receiving environment largely attributed to habitat availability.

eDNA results indicated the presence of five native freshwater fish species across all four sites, including two species with a conservation status of 'At Risk' (Dunn et al. 2017). The apparent absence of species from the receiving environment could be attributed to a number of factors. As such, further monitoring would aide interpretation of results and understanding of community composition.

Based on available data, PDP has assessed the effect of the KR-WWTP discharge on the receiving environment and existing ecological values as **low** overall. PDP has also provided recommendations for ongoing ecological monitoring in relation to the KR-WWTP, including pest species monitoring of wetland areas, eDNA and macroinvertebrate sampling, as well as investigation into any potential fish passage barriers.

10.0 References

Booth, A. (2005). *Natural areas of Whangaruru Ecological District: Reconnaissance Survey Report for the Protected Natural Areas Programme*. Publishing Team, Department of Conservation.

Buxton, A. S., Groombridge, J. J., & Griffiths, R. A. (2018). Seasonal variation in environmental DNA detection in sediment and water samples. *PLoS One, 13*(1), e0191737.

Collier, K. & Kelly, J. (2005). Regional guidelines for ecological assessments of freshwater environments. Macroinvertebrate sampling in wadable streams. *Environment Waikato Technical Report TR2005/02*.

Dunn, N. R., Allibone, R. M., Closs, G., Crow, S., David, B. O., Goodman, J., ... & Rolfe, J. R. (2018). *Conservation status of New Zealand freshwater fishes.* Publishing Team, Department of Conservation.

Manaaki Whenua (2020). *Landcover Database Version 5*. Available at: https://lris.scinfo.org.nz/layer/104400-lcdb-v50-land-cover-databaseversion-50-mainland-new-zealand/

Ministry for the Environment (MfE). (2023). *National Policy for Freshwater Management 2020*, Amended February 2023. Publishing Team, Ministry for the Environment.

National Environmental Monitoring Standards. (2020a). *Sampling, measuring, processing and archiving of discrete river water quality data.* Publishing Team, Ministry for the Environment.

National Environmental Monitoring Standards. (2020b). *Collection and processing of macroinvertebrate samples from rivers and streams.* Publishing Team, Ministry for the Environment.

NIWA. (2014). *Freshwater Fish Spawning and Migration Periods.* Prepared for the Ministry for Primary Industries. NIWA, Hamilton, NZ.

Northland Regional Council (NRC). (2019, May). Proposed Northland Regional Plan – Decisions Version. Available at: https://nrcgis.maps.arcgis.com/apps/webappviewer/index.html?id=a8e411843cc749d3af8eab5a7b26f196

Pattle Delamore Partners Limited. (PDP). (2023). *Kororāreka Russell WWTP – GW and SW Effects Assessment*.

Robertson, H, A., Baird, K, A., Elliott, G, P., Hitchmough, R, A., McArthur, N, J., Makan, T., Miskelly, C, M., O'Donnell, J, C., Sagar, P, M., Scofield, P R., Taylor, G, A., & Michel P. (2021). Conservation status of birds in Aotearoa New Zealand, 2021. *New Zealand Threat Classification Series 36.* Department of Conservation, Wellington, 47p.

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

Sorrell, B. (2012). Nutrients. In M. Peters, & B. Clarkson (Eds.), *Wetland restoration: a handbook for New Zealand freshwater systems*. Manaaki Whenua Press, Landcare Research.

Turner, C. R., Uy, K. L., & Everhart, R. C. (2015). Fish environmental DNA is more concentrated in aquatic sediments than surface water. *Biological Conservation, 183*, 93-102.

Wilcox, T. M., McKelvey, K, S., Young, M. K., Sepulveda, A. J., Shepard, B. B., Jane, S. F., Whiteley, A. R., Lowe, W. H., & Schwartz, M. K. (2016). Understanding environmental DNA detection probabilities: A case study using a stream-dwelling char Salvelinus fontinalis. *Biological Conservation 194*: 209-216.

Wilkinson, S. P., Gault, A. A., Welsh, S., Smith, J., David, B., Hicks, A., Fake, D., Suren, A., Bunce, M., Lust, B., Shaffer, M. R. (manuscript in prep). *A robust taxon-independent community index (TICI) for freshwater ecological health assessment*.

Appendix A: Wetland Plot Data – KR-WWTP

Table A-1: Wetland Plots and Vegetation Classification – KR-WWTP

Plot	Improved Pasture (%)	Rapid Test	Dominance Test (%)	Prevalence Index Test (%)	Classification
1	No (0)	Fail	Fail (50)	Uncertain (3.42)	Uncertain
2	No (8.55)	Pass	Pass (100)	Pass (1.26)	Hydrophytic vegetation
2	No (45.83)	Fail	Pass (100)	Pass (2.21)	Hydrophytic vegetation
4	No (47.37)	Fail	Pass (100)	Pass (2)	Hydrophytic vegetation
5	No (15.79)	Fail	Pass (66.67)	Pass (1.89)	Hydrophytic vegetation
6	No (0)	Pass	Pass (100)	Pass (1)	Hydrophytic vegetation
7	No (4.35)	Fail	Fail (66.67)	Uncertain (2.87)	Uncertain
8	No (14.29)	Fail	Pass (62.5)	Uncertain (2.62)	Hydrophytic vegetation

Table A-2: Hydric Soil Indicators and Resulting Classification – KR-WWTP				
Plot	**Pale Low Chroma Soils (depth)**	**High Water Table (depth)**	**Pan Restricting Layer (depth)**	**Classification**
1	Yes (10-20 cm)	Yes (cm)	n/a	Hydric soil
2		n/a	n/a	n/a
2		n/a	n/a	n/a
4		n/a	n/a	n/a
5		n/a	n/a	n/a
6		n/a	n/a	n/a
7	Yes (10-20 cm)	Yes (15 cm)	Yes (30 cm)	Hydric soil
8		n/a	n/a	n/a

Table A-3: Hydrological Indicators – KR-WWTP			
Plot	**Primary Indicators**	**Secondary Indicators**	**Classification**
1	1C - Soil saturation < 30cm 3C - Reduced iron -		Wetland Hydrology
2			n/a
2			n/a
4			n/a
5			n/a
6			n/a
7	1A - Surface water 1B - Groundwater < 30 cm 1C - Soil saturation < 30 cm	4B - Geomorphic position	Wetland Hydrology
8			n/a

Appendix B: Photograph Log

Photograph 1: Wetland 1 features abundant raupō and watercress.

Photograph 2: *Carex maorica* and watercress within Wetland 1.

Photograph 3: Abundant rautahi beneath a canopy of black wattle, Wetland 2.

Photograph 4: Pond at the lower end of the Wetland 2.

Photograph 5: Raupō is abundant within Wetland 3.

Photograph 6: Pond at the lower end of Wetland 4.

Photograph 7: Raupō within Wetland 4.

Photograph 8: Mexican devil is abundant in Wetland 5.

Photograph 9: Mid-reach at ECO1 (Stream 1).

Photograph 10: Mid-reach at ECO2 (Stream 1).

Photograph 11: Upper reach at ECO3 (Stream 2).

Photograph 12: Upper reach at ECO4 (Stream 3).

Photograph 13: eDNA sampling point at ECO5 (receiving environment).

Appendix C: Summary Habitat Assessment Data

Table B-1: Summary Habitat Assessment Data – KR-WWTP

	ECO1	ECO2	ECO3	ECO4	ECO5
Date/ Time	**28/09/2023 10:45 am**	**28/09/2023 9:30 am**	**27/09/2023 2:00 pm**	**27/09/2023 12:30 pm**	**27/09/2023 4:00 pm**
Reach Scale Habitat Quality – Average Score	**18.2**	**15.1**	**14.6**	**N/A**	**N/A**
Habitat Category	**Optimal**	**Optimal**	**Sub-optimal**	**N/A**	**N/A**
Channel and Riparian Features					
Canopy cover	Significantly shaded	Significantly shaded	Partly shaded	Partly shaded	Partly shaded
Riparian Vegetation	Native trees, native shrub	Native trees and shrub, exotic trees, reeds	Exotic trees, reeds	Native shrub, exotic trees	Reeds
Channel width (m) [1]	2.0-4.0	-	-	-	-
Wetted width (m)	0.7-1.2	<0.4	<1.2	<1.0	<1.0
Depth (m)	<0.2	<0.1	<0.2	0.5	<0.2
Stream-Bottom Substrata					
Compaction	Moderately packed with some overlap	Mostly a loose assortment with little overlap	Mostly a loose assortment with little overlap	Loose assortment easily moved	Loose assortment easily moved
Embeddedness	5-25	<5	<5	<5	<5
Large wood (% cover)	5-25	<5	<5	5-25	5-25
Coarse detritus (% cover)	26-50	5-25	<5	5-25	5-25
Fine organic deposits (% cover)	5-25	5-25	5-25	5-25	51-75
Bedrock (% cover)	-	-	-	-	-
Boulder (% cover)	10	-	-	-	-
Cobble (% cover)	40	-	-	-	-
Gravel (% cover)	30	10	10	10	-
Sand (% cover)	5	30	15	10	5
Silt (% cover)	15	60	70	70	95
Clay (% cover)	-	-	-	10	-
Filamentous/thick mat periphyton (% cover)	<5	<5	<5	<5	<5
Macrophytes (% cover)	<5	<5	<5	<5	5-25
Mosses/liverworts (% cover)	5-25	<5	<5	<5	<5
Invertebrate Sampling					
Macroinvertebrate habitat types sampled [2]	Stones – 90% Wood – 10%	Mid-channel – 100%	Mid-channel – 100%	Mid-channel – 100%	Mid-channel – 100%

Notes:
1. *Channel width not measured/estimated for ECO2, ECO3, ECO4 or ECO5 due to connectivity to adjacent wetland habitats.*
2. *Macroinvertebrate sampling undertaken for ECO2, ECO3, ECO4 and ECO5 was limited to a kick/jab approach targeting the mid-channel substrate and any associated organic material including root mats, due to lack of defined edge habitat, macrophytes, and large substrate types.*

Appendix D: Benthic Macroinvertebrate Sampling Results

Table D-1: Macroinvertebrates Results -KR-WWTP

Taxa	MCI-HB Score	MCI-SB[1] Score	ECO1[2]	ECO2	ECO3	ECO4	ECO5
Mayfly *Coloburiscus*	**9**	**8.1**	8	5	-	-	-
Mayfly *Neozephlebia*	**7**	**7.6**	-	22	-	-	-
Mayfly *Tepakia*	**8**	**7.6**	-	2	-	-	-
Mayfly *Zephlebia*	**7**	**8.8**	123	55	108	45	-
Caddisfly *Aoteapsyche*	**4**	**6**	6	-	-	1	-
Caddisfly *Hudsonema*	**6**	**6.5**	2	-	-	-	-
Caddisfly *Oeconesidae*	**9**	**6.4**	3	15	-	21	-
Caddisfly *Polyplectropus*	**8**	**8.1**	12	-	-	-	3
Caddisfly *Psilochorema*	**8**	**7.8**	-	2	1	-	1
Caddisfly *Pycnocentria*	**7**	**6.8**	1	20	1	-	-
Caddisfly *Triplectides*	**5**	**5.7**	2	2	6	42	-
Bug *Microvelia*	**5**	**4.6**	-	-	-	1	-
Dobsonfly *Archichauliodes*	**7**	**7.3**	6	-	-	-	-
Beetle *Ptilodactylidae*	**8**	**7.1**	-	22	31	-	-
Beetle *Scirtidae*	**8**	**6.4**	-	-	1	-	3
True Fly *Austrosimulium*	**3**	**3.9**	-	-	-	1	-
True Fly *Ceratopogonidae*	**3**	**6.2**	-	5	2	-	3
True Fly *Corynoneura*	**2**	**1.7**	-	-	-	-	3
True Fly *Harrisius*	**6**	**4.7**	1	-	-	-	-
True Fly *Hexatomini*	**5**	**6.7**	1	-	5	2	1
True Fly *Muscidae*	**3**	**1.6**	-	-	-	-	1
True Fly *Orthocladiinae*	**2**	**3.2**	2	1	1	1	2
True Fly *Paradixa*	**4**	**8.5**	1	-	-	-	-
True Fly *Paralimnophila*	**6**	**7.4**	2	2	-	-	1
True Fly *Polypedilum*	**3**	**8.0**	-	-	1	4	
True Fly *Psychodidae*	**1**	**6.1**	-	-	-	-	1
True Fly *Tanypodinae*	**5**	**6.5**	25	33	3	-	3
True Fly *Tanytarsini*	**3**	**4.5**	-	-		-	2
True Fly *Zelandotipula*	**6**	**3.6**	-	-	2	-	-
Collembola	**6**	**5.3**	2	-	4	-	-
Crustacea *Ostracoda*	**3**	**1.9**	-	-	-	18	65
Crustacea *Paracalliope*	**5**	**5.5**	-	1	-	-	45
Crustacea *Paratya*	**5**	**3.6**	-	-	-	-	48
Crustacea *Talitridae*	**5**	**5**	-	-	-	1	-
Mites (Acari)	**5**	**5.2**	-	14	9	3	9
Spiders *Dolomedes*	**5**	**6.2**	2	-	2	1	-
Mollusc *Lymnaeidae*	**3**	**1.2**	-	-	-	-	1
Mollusc *Potamopyrgus*	**4**	**2.1**	4	-	6	27	7
Mollusc *Sphaeriidae*	**3**	**2.9**	2	1	7	9	2
Oligochaetes	**1**	**3.8**	-	1	11	-	6
Hirudinea (Leeches)	**3**	**1.2**	-	-	-	-	2
Nemertea	**3**	**1.8**	-	1	9	9	1
Summary Statistics							
Number of Taxa			19	18	19	17	23
EPT Value			8	8	4	4	2
Number of Individuals			205	204	210	188	214
% EPT (taxa number)			42.11	44.44	55.24	57.98	8.7
Sum of recorded scores			108	108.4	104.1	82	99
MCI Value			**113.68**	**120.4**	**109.6**	**96.47**	**86.09**
Sum of abundance load			1351	1472.4	1480.8	1000.1	785.4
QMCI Value			**6.59**	**7.22**	**7.05**	**5.32**	**3.67**

Notes:
1. *Where taxon MCI values are not available for soft-bottomed streams, the value of the previous order is given as a proxy following Stark and Maxted (2007).*
2. *ECO1 is a hard-bottomed site while remaining sites are considered soft-bottomed.*

Appendix E: eDNA Sampling Results

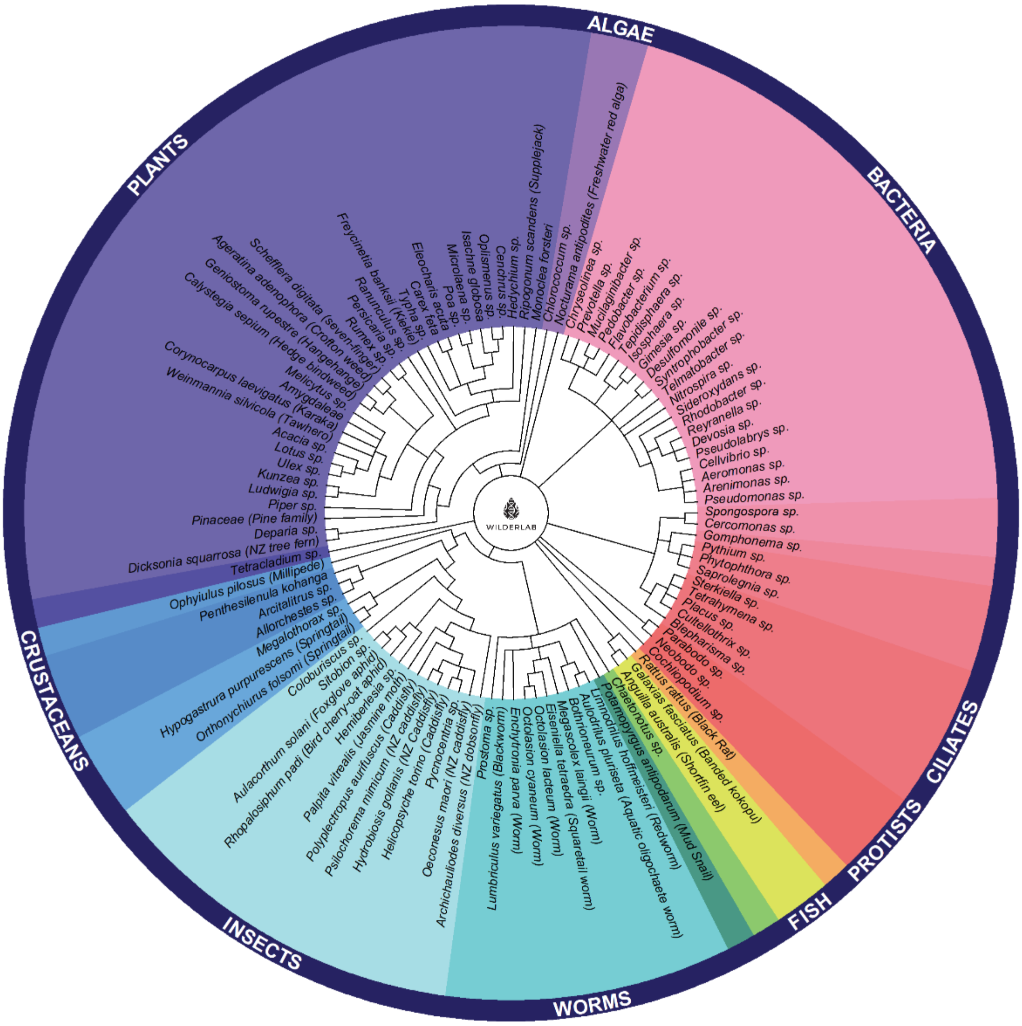


Figure E-1: ECO2 eDNA results.

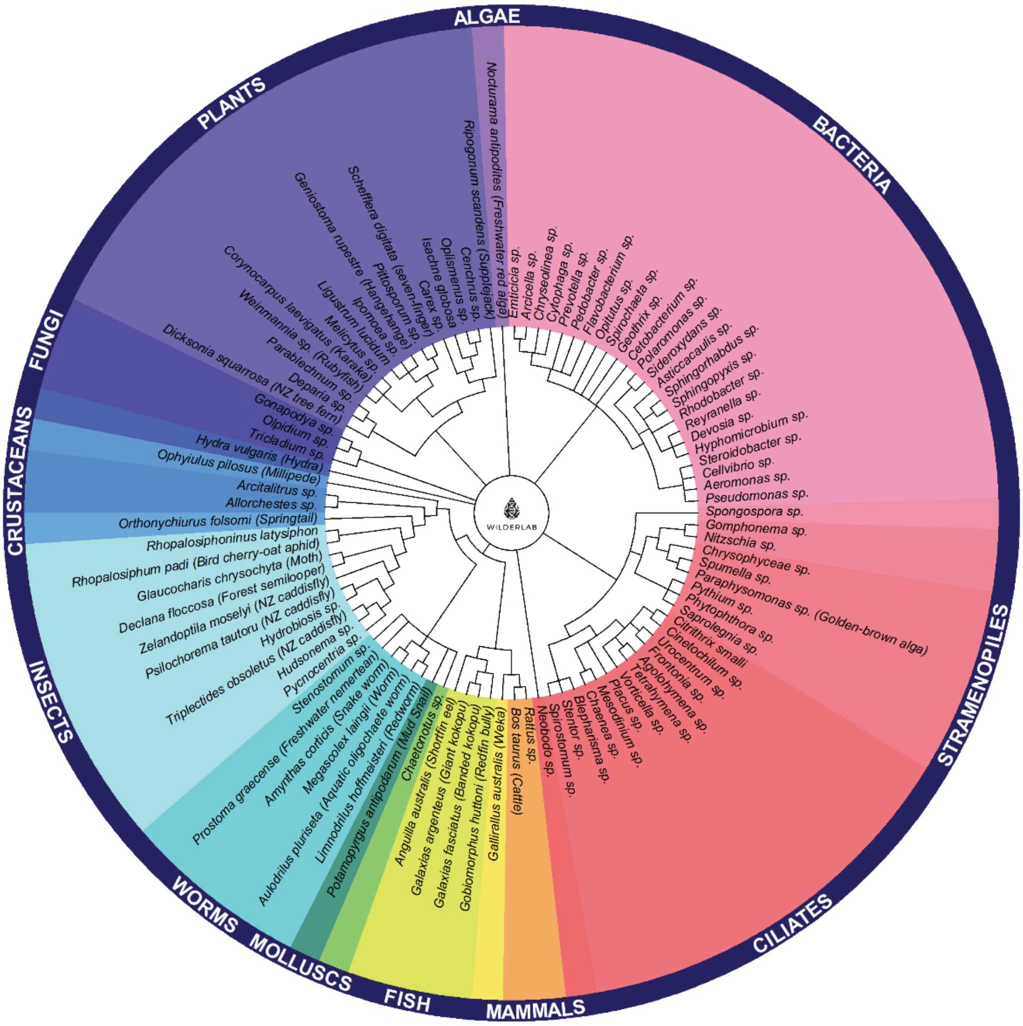


Figure E-2: ECO3 eDNA results.

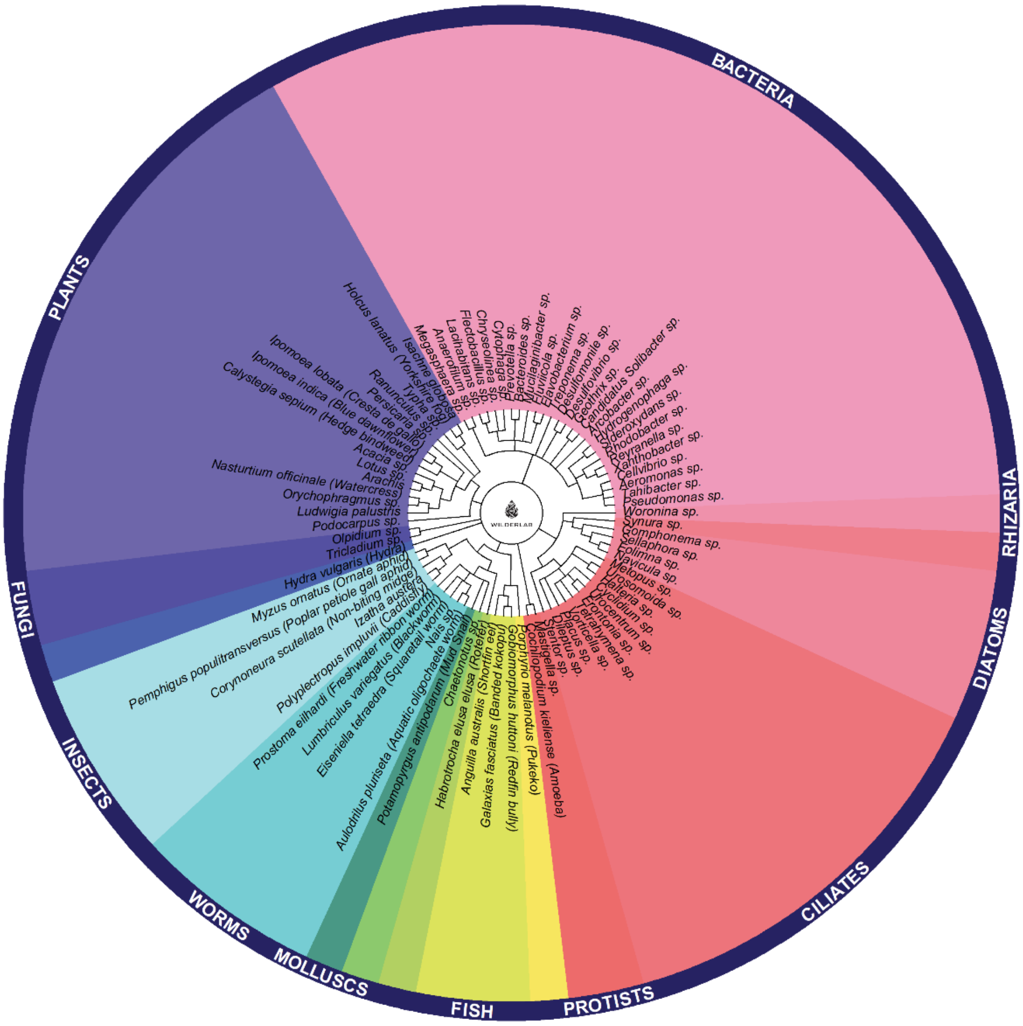


Figure E-3: ECO4 eDNA results.

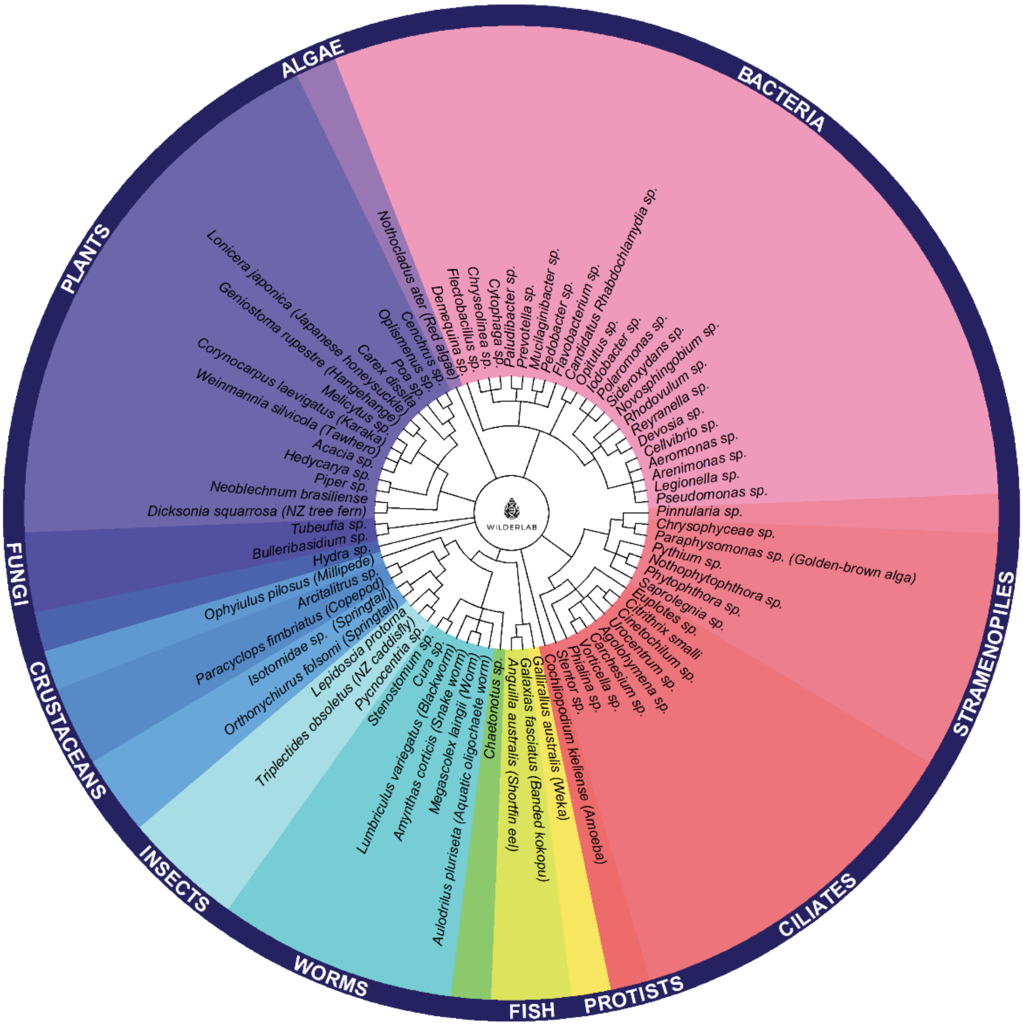


Figure E-4: ECO5 eDNA results.

Appendix G: Flood and Coastal Hazard Assessment

Russell Wastewater Treatment Plant – Coastal and Flood Hazards

Prepared for

Far North District Council

September 2023

PATTLE DELAMORE PARTNERS LTD
South British House, Level 2
35 Grey Street, Tauranga 3110
PO Box 13274, Tauranga 3141, New Zealand

Tel +64 7 **985 6440**
Web www.pdp.co.nz

Quality Control Sheet

TITLE	Russell Wastewater Treatment Plant – Coastal and Flood Hazards
CLIENT	Far North District Council
VERSION	Final
ISSUE DATE	20 September 2023
JOB REFERENCE	A03576827
SOURCE FILE(S)	A03576827R001_Flood_Coastal_Final.docx

DOCUMENT CONTRIBUTORS

Prepared by

SIGNATURE

Florence Dowson

Reviewed by

SIGNATURE

Phil Hook

Approved by

Hayden Easton

Limitations:

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Far North District Council and others (not directly contracted by PDP for the work), including Northland Regional Council, Tonkin and Taylor, Water Technology and NIWA. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This report has been prepared by PDP on the specific instructions of Far North District Council for the limited purposes described in the report. PDP accepts no liability if the report 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.

Executive Summary

Far North District Council (FNDC) owns and operates the existing Kororāreka/ Russell Wastewater Treatment Plant (KR-WWTP). FNDC currently hold two resource consents for the KR-WWTP, both of which expire on 30 April 2024. As such, FNDC are seeking replacement consents to allow the continued operation of the KR-WWTP. This report discusses the coastal and flood hazards associated with the continued operation of the KR-WWTP.

The KR-WWTP has not been identified as being at risk from either coastal inundation or coastal erosion based on Northland Regional Council (NRC) coastal hazard modelling. However, the KR-WWTP has been identified in the yellow tsunami inundation zone. This zone is evacuated in response to a 3 – 5 m wave threat and is the worst-case scenario with a 2,500-year return period. Review of the tsunami modelling indicates that there is minimal coastal inundation predicted north-west of the KR-WWTP and as such, it is assumed the risk of tsunami wave inundation is low at the KR-WWTP. Furthermore, given the maximum consent duration that can be sought for the KR-WWTP is 35 years, the exposure of the site to a tsunami of a magnitude large enough to cause inundation is considered to be limited within this consent timeframe.

Interrogation of NRC flood hazard maps produced for 10-year, 50-year and 100-year plus climate change flood events indicates that the main sewage treatment compound is not predicted to be inundated by flood water in any of the modelled scenarios. However, the two constructed ponds located to the north of the main compound are predicted to potentially be impacted by the 100-year plus climate change annual recurrence interval (ARI) flood scenario. It has been determined that the region wide flood modelling likely did not incorporate the bund height of these ponds given the model outputs and the 5 m grid resolution used for the model. Therefore, flood hazards are not considered a risk for the site. It is recommended that regular, yearly monitoring of the pond bunds occurs to ensure their integrity.

Table of Contents

Table of Figures

1.0 Introduction

Far North District Council (FNDC) owns and operates the existing Kororāreka/ Russell Wastewater Treatment Plant (KR-WWTP) located on Russell Whakapara Road, Russell. FNDC currently hold two existing resource consents for the KR-WWTP as follows:

- AUT.008339.01.03 to discharge treated wastewater, including Russell Landfill leachate, to ground via disposal boreholes; and
- AUT.008339.02.03, to discharge contaminants to air (primarily odour) from the treatment plant and borehole disposal areas.

Both consents expire on 30 April 2024, and FNDC is seeking replacement consents to allow for the continued operation of the KR-WWTP. FNDC are required to demonstrate under Section F.1.10 of the Proposed Regional Plan for Northland:

- The risks and impacts of natural hazard events (including the influence of climate change) on people, communities, property, natural systems, infrastructure and the regional economy are minimised by:
  - (3) Avoiding inappropriate new development in 100-year flood hazard areas and coastal hazard areas, and
  - (6) Promoting long-term strategies that reduce the risk of natural hazards impacting on people, communities and natural systems.

While the KR-WWTP is not a new development, it is still considered appropriate to assess whether the KR-WWTP will be inundated by a 100-year (with climate change) Average Recurrence Interval (ARI) flood event. Furthermore, in general municipal WWTP's are essential network utilities and services, and as such, the effects of potential natural hazards impacting on the essential community infrastructure needs to be understood and reduced in line with the regional plan.

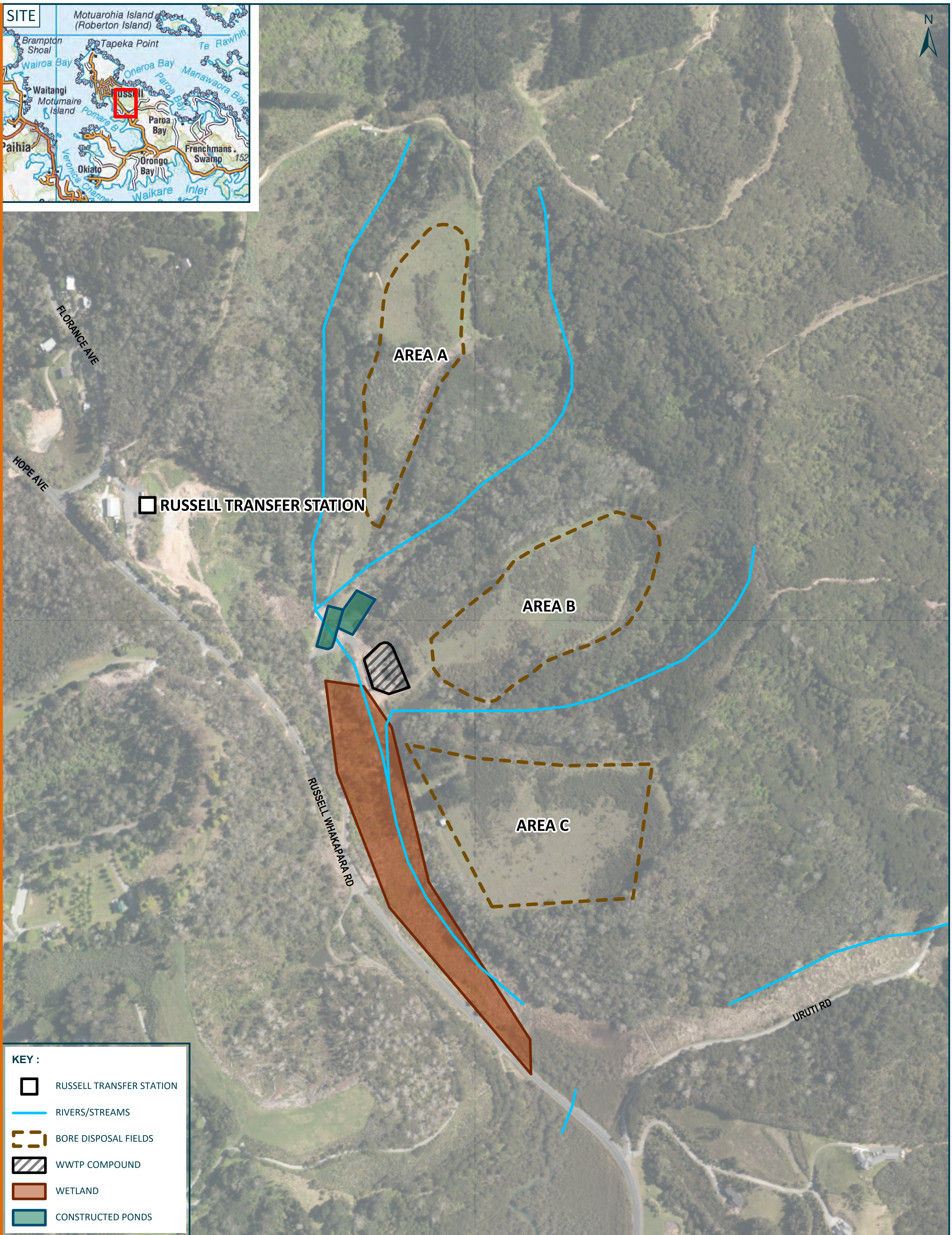
Pattle Delamore Partners Limited (PDP) has been engaged by FNDC to undertake a coastal and flood hazard assessment to support the consent applications associated with the continued operation of the KR-WWTP.

2.0 Site Description

The KR-WWTP and associated bore disposal field are located approximately 1.5 km southeast of the Kororāreka/Russell township. The KR-WWTP site itself is situated on a reasonably flat parcel of land. The land to the northeast of the WWTP is relatively steep and consists of a series of three ridgelines and associated valleys. The bore disposal fields are located along these ridgelines. Three small unnamed streams drain these ridgelines, flowing from the northeast to southwest and discharge into a natural wetland located to the southwest of the WWTP. The KR-WWTP is located east of Matauwhi Bay.

The KR-WWTP receives wastewater from the Kororāreka/Russell and Tapeka Point communities in addition to small quantities of leachate from the adjacent closed landfill. The closed landfill is located approximately 300 m northwest of the WWTP site. Treated wastewater is discharged into ground via bore injection over 85 bores split across the three ridgelines previously mentioned.

Figure 1 presents the location of the KR-WWTP and the associated bore disposal field used for treated wastewater discharge to ground. The WWTP consists of a sewage treatment plant compound with two sequencing batch reactor (SBR) tanks. Two constructed ponds are situated to the north of treatment compound. These ponds are both bunded.



pdp

0 50 100
METRES

SCALE : 1:5,500 (A4)

THIS DRAWING REMAINS THE PROPERTY OF PATTLE DELAMORE PARTNERS LTD AND MAY NOT BE REPRODUCED OR ALTERED WITHOUT WRITTEN PERMISSION. NO LIABILITY SHALL BE ACCEPTED FOR UNAUTHORISED USE OF THE DRAWING.

SOURCE:
1. AERIAL IMAGERY (FLOWN 2015) SOURCED FROM THE LINZ DATA SERVICE www.linz.govt.nz/ AND LICENCED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.
2. CADASTRAL/TOPOGRAPHICAL INFORMATION AND INSET DERIVED FROM LINZ DATA.
3. WETLANDS SOURCED FROM LINZ/FNDC.
4. PONDS AND COMPOUND DIGITISED FROM AERIAL IMAGERY.
5. RIVERS/STREAMS SOURCED FROM LINZ AND PDP.
6. BORE DISPOSAL FIELDS DERIVED FROM SCHEMATIC PROVIDED TO PDP.

NO.	REVISION	DATE	BY
A	ISSUED FOR REVIEW	SEP 23	TK

CLIENT
Far North District Council

FIGURE
FIGURE 1: KORORĀREKA/ RUSSELL WASTEWATER TREATMENT PLANT LOCATION MAP

PROJECT
RUSSELL WWTP RECONSENTING

3.0 Previous/ Historic Studies

Review of the previous assessment of environmental effects (AEE) document prepared to support the 2013 consent application does not present any information associated with flood or coastal hazards.

4.0 Methodology

The following sections outline the methodology used to undertake coastal and flood hazard assessments associated with the operation of the KR-WWTP. The Northland Regional Council (NRC) coastal, tsunami and flood hazard maps were interrogated to assess whether the KR-WWTP was at risk of either coastal or flood hazards.

4.1 Coastal Hazard Methodology

Coastal hazards can be separated into three key areas including coastal inundation, coastal erosion and tsunami waves. The following sections outline the modelling approaches used to assess each hazard.

4.1.1 Inundation

Coastal inundation is the flooding of normally dry land from coastal water predominantly due to storm events which is often temporary and reverses once the storm has passed. However, sea level rise can increase the frequency of these inundation events and cause permanent inundation in some areas (Auckland Council, 2021).

Tonkin and Taylor Limited (T+T) undertook regional coastal inundation modelling to assess coastal inundation levels across the Northland region (Tonkin and Taylor, 2021). The modelling combined the above processes along with water level, storm surge, wave processes and sea level rise to model the total inundation level under storm conditions at Mean High Water Springs (MHWS).

The closest modelled representative output location to the KR-WWTP is Kororāreka Bay which is defined as a sheltered environment. As such, T+T used the following equation to calculate the static inundation of the bay:

Extreme Static Water Level (maximum inundation water level) = Storm Tide + Wave Set Up + Sea Level Rise

It is noted that the representative output location results are typically representative for a section of shoreline and as such, the Kororāreka Bay location is considered representative of coastal inundation along the nearby section of coastline. Therefore, the results for this location are relevant to Matauwhi Bay which is approximately 1.2 km southeast of Kororāreka Bay and the closest bay to KR-WWTP.

The results of the modelling produced coastal hazard maps across the Northland region for specific inundation scenarios, including the following:

- Coastal Flood Hazard Zone 0 (CFHZ0) = Present-day 100-year ARI
- CFHZ1 = 2080 50-year ARI + 0.6 m sea level rise (SLR)
- CFHZ2 = 2130 100-year ARI + 1.2 m SLR
- CFHZ3 = 2130 100-year ARI + 1.5 m SLR

These maps have been interrogated to assess the coastal inundation risk associated with the operation of the KR-WWTP.

4.1.2 Erosion

Coastal erosion is the removal of material that has formed the land (e.g. rocks, soil and/or sand) due to natural coastal processes resulting in an inland movement of the coastline position over time. Coastal erosion is caused by multiple factors such as wave energy, sediment availability, land use and sea level rise (Auckland Council, 2021).

T+T were engaged to update NRC's coastal erosion hazard zones (CEHZ) for 44 sites across the Northland region (Tonkin and Taylor, 2020). Dependent on the type of processes controlling change along different coastal areas, two major coast types were defined which determined the expressions used to calculate coastal erosion distances. These two major coast types were:

- Beaches and coastal terraces comprising unconsolidated sediments;
- Consolidated cliff coasts.

The closest coastal erosion assessment site to KR-WWTP is Long Beach, Oneroa Bay which is located to the east of Kororāreka/ Russell Township and on the eastern side of the peninsula. It is assumed that the unconsolidated shoreline equation was used to assess the coastal erosion hazards for this site:

$$\textit{Coastal Erosion Hazard Zone} = ST + DS + (LT \times T) + SL$$

- ST is the short-term changes in horizontal shoreline position in metres.
- DS is the dune stability allowance. This is the horizontal distance from the base of the eroded dune to the dune crest at a stable angle of repose in metres.
- LT is the long-term rate of horizontal coastline movement in metres per year.
- T is the timeframe in years.
- SL is the horizontal coastline retreat due to increased mean sea level in metres.

These parameters were used to define areas at risk of coastal erosion including sea level rise scenarios using a risk-based approach.

Three CEHZ were produced from the modelling, including:

- Coastal Erosion Hazard Zone 1 (CEHZ1) = an area 'likely' at risk of costal erosion over the next 50-years (66% probability of occurrence).
- CEHZ2 = an area 'potentially' at risk of coastal erosion over the next 100-years (5% probability of occurrence).
- CEHZ3 = an area 'potentially' at risk of costal erosion over the next 100-years (5% probability of occurrence), including a rapid sea level rise scenario (NRC, 2023).

These scenarios were incorporated into the coastal erosion hazard map for the 44 sites assessed by T+T.

4.1.3 Tsunami

Tsunami are waves caused by a large displacement of ocean water, due to earthquakes at tectonic plate boundaries or volcanic eruptions (NIWA, 2010). Tsunami waves can cause inundation at the coast and therefore are considered a hazard to the WWTP.

There are a range of potential tsunami sources in the Northland region that include several local and distant fault systems and underwater landslides (NIWA, 2010). Tsunami hazard scenarios were defined by NIWA (2010), to model maximum wave heights affecting Northland for two of the significant scenarios. These scenarios were:

- Remote source: South American tsunami event. The return period is 50-100 years and represents the most probable tsunami risk in the next 100 years.
- Local/Regional source: Tonga Kermadec event. The return period of these events are 500-2,000 years and represent a worst-case scenario.

Tsunami propagation to the Northland coastline was assessed at 15 specific locations using a computer model (NIWA, 2010). Using this information, NRC have mapped four tsunami evacuation zones in relation to tsunami hazards. These zones include:

- Shore/ Red Zone: this zone must be evacuated in response to a 0.2 – 1 m wave height but flooding of land near the shore is not expected.
- Orange Inundation Zone: this zone matches the 3 – 5m threat level warning and is to be evacuated in the event of either the 1 – 3m, or 3 – 5 m threat level warning being issued (area inundated by a tsunami with a 500-year return period).

- Yellow Inundation Zone: this zone should also be evacuated in an official warning for larger than a 3 – 5 m threat level (2,500-year return period) or in the case of a natural or informal warning where the potential wave height is unknown.
- Safe/ Green Zone (NRC, 2023).

4.2 Flood Hazard Methodology

To characterise the flood hazard to KR-WWTP, the NRC region wide flood hazard maps were interrogated to identify if the KR-WWTP was predicted to be inundated. The flood hazard maps were produced from flood modelling completed by Water Technology (2021) to assess the riverine flood hazard zones across the Northland region. TUFLOW modelling software was used which routes the overland flow over a topographic surface and produces outputs of flood extent, depth, velocity, and flood hazards (depth x velocity). The resolution of the modelling was resampled to a 5 m Digital Elevation Model DEM (DEM) (Water Technology, 2021).

The modelling was completed for four storm durations (1-hour, 6-hour, 12-hour, 24-hour) and for multiple ARIs (10-year, 50-year and 100-year ARI) and incorporated climate change projection scenarios up to the year 2100 (including Representative Concentration Pathways (RCPs) 4.5, 6 and 8.5). RCPs are different greenhouse gas emission (GHG) scenarios and are published in the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report. RCP 4.5, 6 and 8.5 represent a different range of global mean temperature increases over the 21st century (IPCC, 2023).

Due to the nature of the catchment the critical event duration varied throughout the catchment (e.g. headwaters vs the lower catchment areas). As a result, an enveloped storm incorporating the peak intensities from all four storm durations was created as the critical storm event (Water Technology, 2021).

Three flood hazard zones have been defined by NRC on the flood hazard maps:

- River Flood Hazard Zone 1: 10-year flood extent - an area with a 10% chance of flooding annually;
- River Flood Hazard Zone 2: 50-year flood extent – an area with a 2% chance of flooding annually;
- River Flood Hazard Zone 3: 100 year flood extent – an area with a 1% chance of flooding annually with the inclusion of potential climate change impact (NRC, 2023).

5.0 Coastal Hazard Assessment

5.1 Coastal Flood Hazard Zones - Inundation

Interrogation of the NRC CFHZ indicate that there is no risk under any of the storm and sea level rise scenarios of the KR-WWTP being inundated by sea water.

5.2 Coastal Erosion Hazard Zones

Interrogation of the coastal erosion hazard map produced from the T+T 2020 report indicates that the KR-WWTP is not located in any of the defined CEHZ zones.

5.3 Tsunami Inundation

The KR-WWTP is located in the yellow inundation zone. This zone is evacuated in response to a 3-5 m wave threat and is the worst-case scenario with a 2,500-year return period. As such, large tsunami waves potentially pose a risk to the KR-WWTP.

Maps of inundation depth and maximum current speed were produced for Kororāreka/Russell township by NIWA (2010). The KR-WWTP location is not included in the model extent for the Kororāreka/Russell township tsunami modelling. Therefore, it is not possible to assess the risk from tsunami inundation further. However, it is noted that under the worst-case scenario modelled in the NIWA (2010) report, a moment magnitude[1] (M_w) 9.0 earthquake originating in the Tonga-Kermadec subduction zone at MHWS + 50 cm, there is minimal coastal inundation predicted along the coast to the north-west of the KR-WWTP. It is, therefore, assumed that the risk of tsunami wave inundation at the KR-WWTP is low (Figure 2). Furthermore, given the maximum consent duration that can be sought for the KR-WWTP is 35 years, the exposure of the site to a tsunami of a magnitude large enough to cause inundation is considered to be limited within this timeframe.

[1] The moment magnitude scale provides an estimate of earthquake size valid over the complete range of mangnitudes (USGS, 2023).

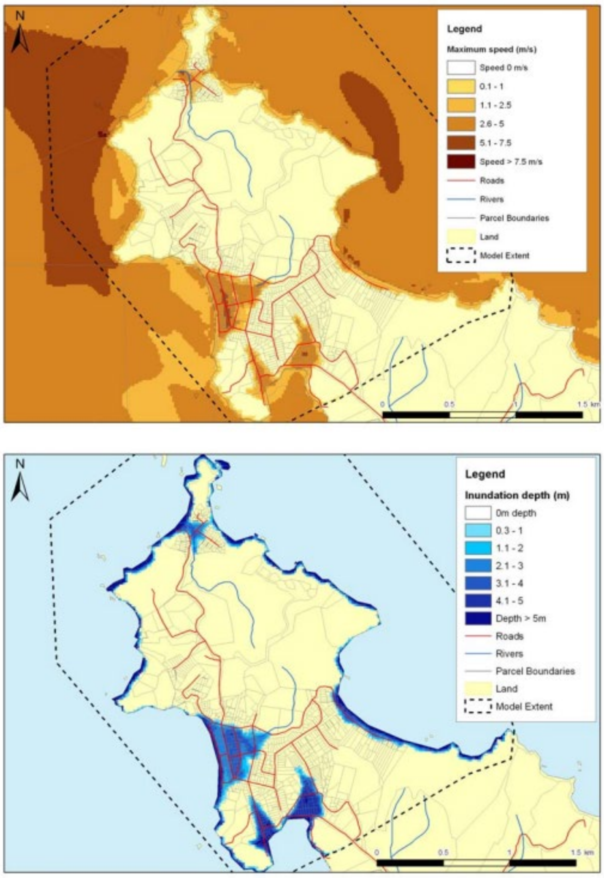
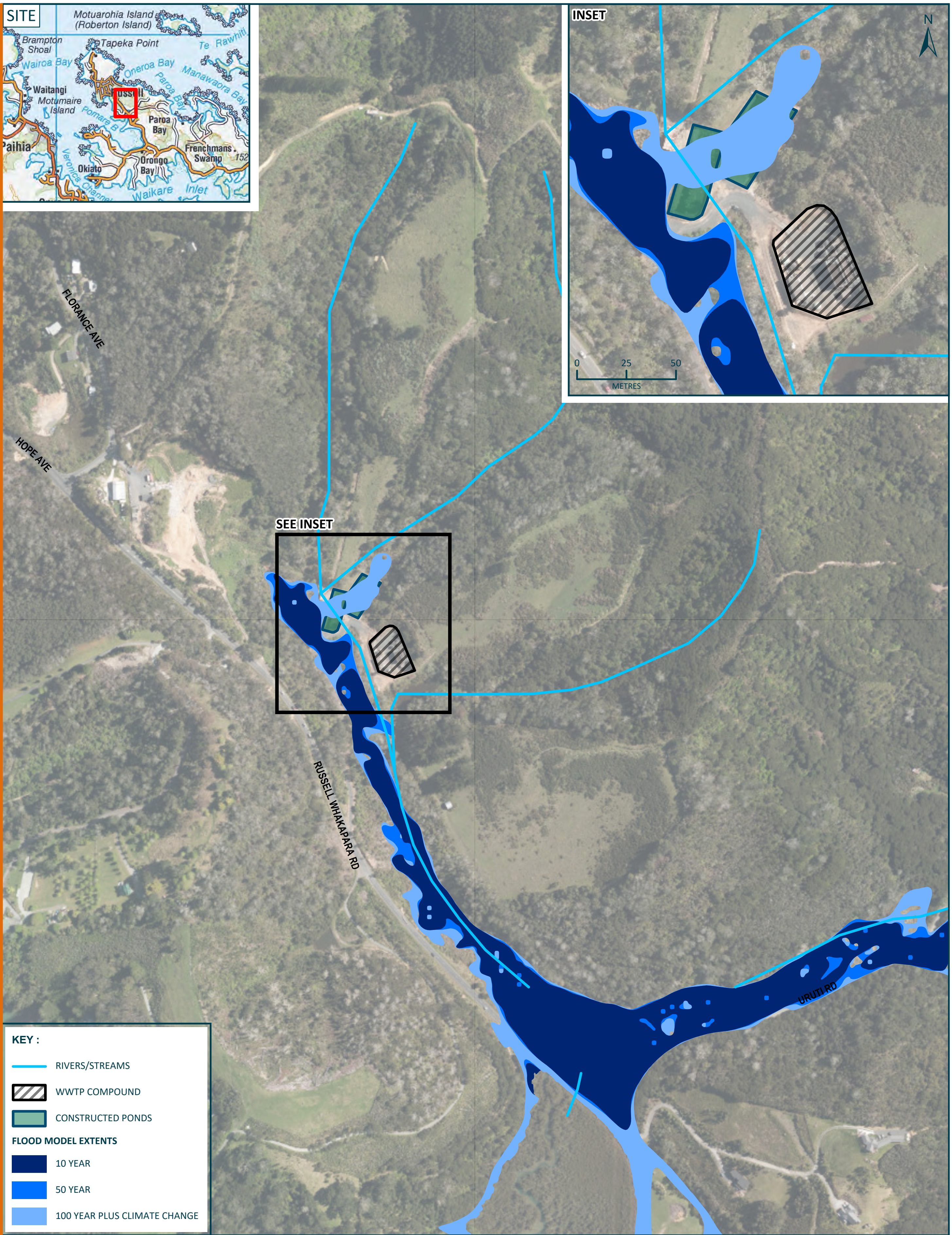


Figure 2: Kororāreka/ Russell maximum inundation speed (upper) and depth (lower) plots for M_w9.0 Tonga-Kermadec subduction zone scenario at MHWS + 50 cm (to extent of LIDAR) (from NIWA, 2010).

6.0 Flood Hazard Assessment

To assess the flood hazard of the KR-WWTP, the NRC flood hazard maps were interrogated. It is evident from these maps that the main sewage treatment compound is not predicted to be inundated by flood water in any of the modelled scenarios (10-year, 50-year, or 100-year plus climate change ARI). However, the two constructed ponds located to the north of the main compound are predicted to potentially be impacted by the 100-year plus climate change ARI flood scenario (Figure 3).



0 50 100

METRES

SCALE : 1:5,500 (A4)

SOURCE:
1. AERIAL IMAGERY (FLOWN 2015) SOURCED FROM THE LINZ DATA SERVICE www.linz.govt.nz/ AND LICENCED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.
2. CADASTRAL/TOPOGRAPHICAL INFORMATION AND INSET DERIVED FROM LINZ DATA.
3. WETLANDS SOURCED FROM LINZ/FNDC.
4. PONDS AND COMPOUND DIGITISED FROM AERIAL IMAGERY.
5. RIVERS/STREAMS SOURCED FROM LINZ AND PDP.
6. BORE DISPOSAL FIELDS DERIVED FROM SCHEMATIC PROVIDED TO PDP.

NO.	REVISION	DATE	BY
A	ISSUED FOR REVIEW	SEP 23	TK

CLIENT

Far North District Council

FIGURE

FIGURE 3: NORTHLAND REGIONAL COUNCIL FLOOD HAZARD MAP FOR KORORĀREKA/ RUSSELL WASTEWATER TREATMENT PLANT

PROJECT

RUSSELL WWTP RECONSENTING

A site visit to the KR-WWTP undertaken on 6th September 2023 indicated that the constructed ponds are bunded approximately 1 -1.5 m above ground level (Figure 4). It is likely that the region wide flood modelling did not accurately represent these bunds. This is further supported by the regional modelling output at the KR-WWTP.

The modelling completed by Water Technology used a region wide model to estimate potential locations susceptible to inundation from different flood scenarios. The region wide model used a 5 m grid resolution to predict cells where flooding may occur. It is evident from the inset map in Figure 3 that the model has in a couple of instances picked up higher ground heights around the constructed ponds and has subsequently incorporated this into the model. Three small squares which are modelled as not flooding indicate the sections of the model which have incorporated higher elevations. As such, it is not anticipated that the KR-WWTP will flood under a 100-year plus climate change flood scenario as the inundation predicted from the region wide modelling likely does not incorporate the additional bund heights of the constructed ponds on site.

Figure 4: Photos of constructed pond bunds at KR-WWTP (photos taken 6th Sept 2023)

7.0 Monitoring Requirements

To ensure the bund is fit for purpose over time, a visual assessment of the structural integrity of the bund should be undertaken yearly. This will ensure the bund remains stable and will identify any potential issues which can be remedied (e.g. land subsidence). No further monitoring is recommended at present given the low risk of coastal and flood hazards to site.

8.0 Conclusion

The NRC hazard mapping indicates that the KR-WWTP is not at risk from coastal inundation or erosion hazards. However, the KR-WWTP is in the yellow tsunami inundation zone which is potentially at risk from inundation from a 3 – 5 m wave threat level with a 2,500-year return period. As such, the risk from tsunami inundation is considered limited given the maximum consent duration that can be sought is 35 years.

The NRC hazard maps suggest that the KR-WWTP is not at risk of flood inundation under a 10-year and 50-year ARI flood scenario. However, the constructed ponds to the north of the main compound are shown to potentially be inundated under a 100-year plus climate change scenario. It has been determined that the region wide flood modelling likely did not incorporate the bund height of these ponds given the model outputs and the 5 m grid resolution used for the model. Therefore, flood hazards are not considered an issue for the site. It is recommended that regular, yearly monitoring of the bunds occurs to ensure the integrity of the bunds.

9.0 References

Auckland Council. (2021). Coastal Hazard Assessment in the Auckland Region GD10.

IPCC. (2023). Climate Change 2023: Synthesis Report. Contributing of Working Groups I, II, and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, 184 pp. doi: 10.59327/IPCC/AR6-9789291691647.

NIWA. (2010). Northland Regional Council Tsunami Modelling Study 3. Report prepared for Northland Regional Council.

NRC. (2023). Natural Hazards Map. https://nrcgis.maps.arcgis.com/apps/webappviewer/index.html?id=81b958563a2c40ec89f2f60efc99b13b. [accessed: 6 Sept 2023].

Tonkin and Taylor. (2020). Coastal Erosion Hazard Assessment for Selected Sites 2019-2020. Report prepared for Northland Regional Council.

Tonkin and Taylor Ltd. (2021). Coastal Flood Hazard Assessment for Northland Region 2019-2020. Report prepared for Northland Regional Council.

USGS. (2023). Earthquake Hazards Programme. https://www.usgs.gov/glossary/earthquake-hazards-program#M. [accessed: 15 September 2023].

Water Technology. (2021). Design Modelling: Bay of Islands Coast Catchment (M07). Report prepared for Northland Regional Council.

Appendix H: Qualitative Microbial Risk Assessment

QUANTITATIVE MICROBIAL RISK ASSESSMENT (QMRA): RUSSELL WASTEWATER TREATMENT PLANT

OCTOBER 2023

PREPARED FOR:	**Pattle Delamore Partners (PDP)**
CLIENT REPORT No:	**CSC23019**
PREPARED BY:	**Peter Cressey, Risk Assessment, Food and Social Systems Group**
REVIEWED BY:	**Dr Beverley Horn, Risk Assessment, Food and Social Systems Group**

ACKNOWLEDGEMENTS

The author wishes to acknowledge the Ministry of Health as owner of the copyright and funders of the 2008-2009 Adult Nutrition Survey and to thank them for access to food consumption information (24-hour dietary recall) from this survey.

Manager

Daniel Bohnen

Manager, Risk Assessment, Food and Social Systems Group

Reviewer

Dr Beverley Horn

Senior Scientist, Risk Assessment, Food and Social Systems Group

Author

Peter Cressey

Senior Leader, Risk Assessment, Food and Social Systems Group

DISCLAIMER

CONTENTS

TABLES AND FIGURES

Tables

Figures

EXECUTIVE SUMMARY

This QMRA considers risks to human health from the discharge of wastewater from the Russell WWTP into Uruiti Bay. These receiving waters will also be impacted by other, mainly diffuse, sources of contamination. These other sources are not considered in the current QMRA.

Risks were considered for primary contact recreation (swimming) and consumption of raw shellfish harvested within the affected area. Risks were assessed at a surrogate location, where the treated wastewater emerges from the groundwater system and makes its way via small streams to Uruiti Bay. Risks were compared to the risk levels for microbiological assessment categories (MACs) in the *Microbiological water quality guidelines for marine and freshwater recreational areas*. The MACs for marine recreational waters were considered most relevant in the current situation. While the MACs are not directly applicable to risks associated with shellfish consumption, the risk cut-offs for the MACs were used generically to classify risks associated with voluntary recreational activities.

Risks associated with swimming in and consumption of raw shellfish, from the affected marine environment, would be less than 1% (equivalent to a MAC 'A') with a 5 $\log_{10}$ reduction in viral concentrations. Viral concentration reduction will occur through the operation of the Russell WWTP and through dilution of treated wastewater in Uruiti Bay. While the former is not explicitly known, the wastewater treatment processes in place (secondary plus UV treatment) are likely to result in at least a 4 $\log_{10}$ viral reduction. Dilution in Uruiti Bay is likely to result in at least an additional 3 $\log_{10}$ reduction in viral concentrations. In combination, the reductions in viral concentration between the influent to the Russell WWTP and points of likely recreational contact are likely to be sufficient to reduce risks of viral illness to a negligible level.

This assessment has taken a conservative approach at a number of points, and it is expected that risks, for the majority of the time, will be lower than those estimated in the current QMRA.

1. INTRODUCTION

1.1 BACKGROUND

The Far North District Council (FNDC) is preparing technical documents to support a resource consent application for discharge of wastewater to ground via disposal boreholes from the Russell wastewater treatment plant (WWTP). The existing resource consent (AUT.008339.01.03) authorising the discharge of treated wastewater to disposal boreholes expires on 30 April 2024. Pattle Delamore Partners (PDP) have been contracted to assist FNDC with preparation for the resource consent re-application and have subcontracted the Institute of Environmental Science and Research (ESR) to carry out a quantitative microbial risk assessment (QMRA).

The Russell WWTP is located approximately one kilometre southeast of Russell township, between Florance Avenue and Uruiti Road. The WWTP treats wastewater from the Russell and Tapeka Point communities, as well as a small volume of leachate from the Russell landfill.[1] The treatment process includes rotary screens, activated sludge treatment through two sequencing batch reactors (SBRs), rock filters, sand filters and UV disinfection (Trojan UV 3000 PTP) (Harrison Grierson, 2017). UV-treated wastewater is then disposed of to one of three borehole areas (A, B and C) located on the hills adjacent to the WWTP.

The groundwater system accessed by the disposal boreholes emerges into several small streams that flow into Uruti Bay, a branch of Pomare Bay. From a risk perspective, it should also be noted that oysters are farmed in Orongo Bay, to the south of Uruti Bay (Phil Hook, PDP, personal communication).

FNDC require a technical assessment which reports on the likely risk of the discharge to public health.

1.2 CURRENT ASSESSMENT

Based on other recent New Zealand QMRAs, the technical assessment will consider the risks associated with norovirus in discharged wastewater. Norovirus has consistently been the pathogen representing the greatest human health risks in recent QMRAs. The assessment includes two components:

- Review of available information on norovirus removal by the processes in place at the Russell WWTP.
- Estimation of the risk of illness due to norovirus from primary contact recreation (swimming) and consumption of raw kaimoana (shellfish) at locations chosen as surrogates for Uruti/Orongo/Pomare Bay.

[1] https://www.fndc.govt.nz/Our-services/Wastewater-and-stormwater/Wastewater/Wastewater-treatment-plants/Russell-Wastewater-Treatment-Plant Accessed 4 September 2023

2. METHODS

Quantitative Microbial Risk Assessment (QMRA) consists of four basic steps:

1. Hazard identification. Selection of the hazard(s). For microbial risk assessments the hazard(s) will be bacterial, viral or protozoan human pathogens
2. Exposure assessment. Estimation of exposure to the pathogen(s) at selected sites through selected human activities
3. Hazard characterisation. Characterisation of the dose-response relationship for the pathogen(s)
4. Risk characterisation. Characterisation and communication of the health risks.

QMRA uses statistical distributions (parametric or non-parametric) for the inputs to the assessment and combines these distributions using Monte Carlo simulation modelling. Modelling involves repeated sampling from the distributions and means that any plausible 'what-if' scenario will be included within the analysis. This approach is particularly useful, as the majority of the risk is caused by combinations of inputs toward the upper extremes of the input distributions, the combined effects of which are unlikely to be detected when using averages.

2.1 HAZARD IDENTIFICATION

Based on previous New Zealand wastewater discharge QMRAs, the current study only considered risks associated with norovirus, as the likely 'worst case' microbial pathogen.

Risks associated with wastewater-contaminated water include two types of infection and illness:

- Gastrointestinal disease, due to:
    - ingestion of water during recreational water-contact, and
    - consumption of raw shellfish, gastropod or finfish flesh.
- Respiratory ailments, due to inhalation of aerosols formed during contact recreation, such as water skiing, surfing or by nearby breaking waves.

Noroviruses have only been associated with gastrointestinal disease. Risks of gastrointestinal disease due to primary contact recreation (swimming) and consumption of raw shellfish were considered.

2.2 EXPOSURE ASSESSMENT

Exposure refers to the dose of some agent that is ingested, absorbed or inhaled during a specified period. For microbial pathogens, adverse health effects usually occur in an acute time frame and are generally considered to be due to a single exposure event. In the current QMRA, the exposure event considered is a single day of water-contact recreation in wastewater-affected water or a single meal of raw shellfish.

2.2.1 Selection of assessment sites

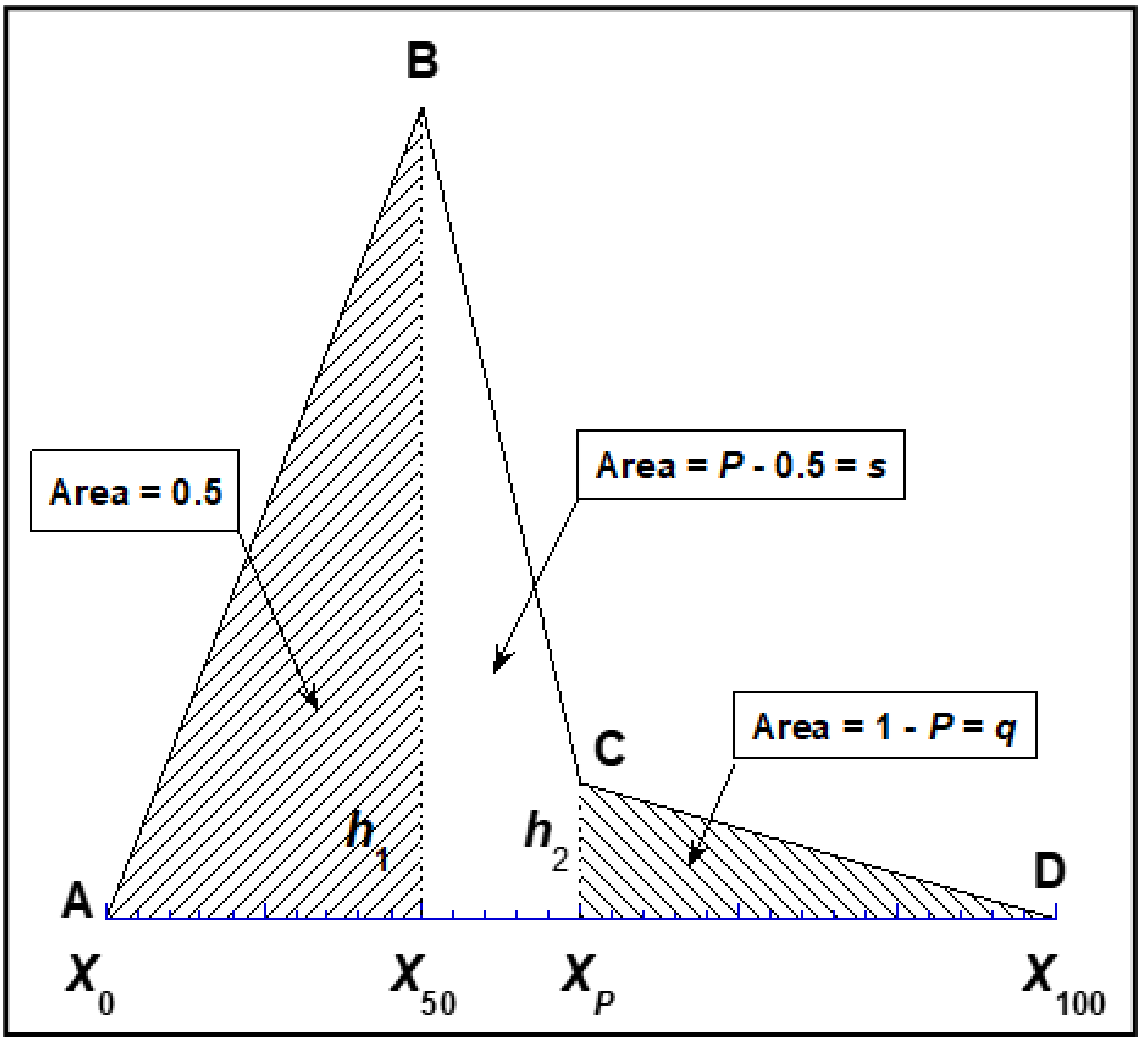
The viral concentrations at the sites of interest are a function of the viral concentration of discharged wastewater, dilution between the point of discharge and the site of interest and viral inactivation during the period between discharge and reaching the site of interest. The viral concentration of discharge wastewater is a function of the viral concentration of WWTP influent and the reductions in viral concentrations achieved by the WWTP.

There are uncertainties concerning the rate at which treated wastewater disposed of to the discharge bores will enter the small streams, the dilution in those streams and the subsequent dilution in Uruti/Orongo/Pomare Bay. Consequently, the current QMRA will consider risks associated with the wastewater as it discharges from the groundwater system. This approach provides a highly conservative surrogate for risks associated with the impact of discharged wastewater on recreational sites within Uruti/Orongo/Pomare Bay.

2.2.2 Viral concentrations in receiving waters

Viral influent concentrations used in the current QMRA

Recent QMRAs carried out in New Zealand have used 'standardised' viral concentrations for influent (Cressey and Armstrong, 2020; McBride, 2016; McBride and Hudson, 2016; Oldman and Dada, 2020). This approach models the viral concentrations as a custom 'hockey-stick' distribution, defined by minimum, median and maximum viral concentration. The term hockey-stick comes from the fact that the custom distribution has a break at the 95th percentile and an extended triangular right-hand tail. The general form of the hockey stick distribution is shown in Figure 1.



Reproduced from McBride et al. (2013)

Figure 1. General form of the custom hockey stick distribution

In the absence of specific information on the influent to the Russell WWTP, this approach was used for the current QMRA. The rationale for this approach is that, while the distribution of viral concentrations in influent from a small community are likely to be more variable day-to-day than for a large community, over time the distribution will be similar.

Both norovirus GI and GII are infectious to humans. However, results from analyses of New Zealand wastewaters suggest that GI concentrations are typically at least one order of magnitude less than GII concentrations (Cressey and Armstrong, 2020).

Based on the complete body of New Zealand data and the review of Eftim *et al*. (2017), the concentration of norovirus GII was modelled with a median of 1.0E+5 genome copies/L (5.0 $\log_{10}$ genome copies/L), with a minimum and maximum of 100 and 3.0E+7 genome copies/L and a 95th percentile of 1.9E+5 genome copies/L. This distribution of norovirus concentrations is the same as used previously for QMRAs in the Far North region (Cressey, 2020; Cressey and Armstrong, 2020).

Table 1 provides summary statistics from relevant New Zealand and international studies on the norovirus content of raw wastewater.

Table 1. Literature information on the norovirus content of raw wastewater

Country	Details	Norovirus content ($\log_{10}$ gc/L)	Reference
New Zealand	New Plymouth WWTP influent	GII 5.7 and 5.6 GI 3.7 and 4.1	(NPDC, 2022)
Australia	Two WWTPs in Sydney	GI + GII WWTP A Mean 4.9 Range 3.2-6.2 WWTP B Mean 5.0 Range 3.0-6.4	(Ahmed *et al.*, 2022)
Chile	Influent to rural WWTPs	GII Mean 4.8 Range 4.0-6.3	(Plaza-Garrido *et al.*, 2023)
China	Raw wastewater from three WWTPs in Nanjing	GII 5.4-5.9 GI 3.9-4.1	(Liu *et al.*, 2021)
Japan	Hinaga WWTP influent	GI 5.4-5.7 GII 6.6-6.9	(Malla *et al.*, 2022)
Spain	Influent from four WWTPs in the Valencia regions	GI Mean 4.8 Range 3.2-6.0 GII Mean 5.3 Range 4.0-6.6	(Cuevas-Ferrando *et al.*, 2022)
UK	Influent from five WWTPs	GII Geometric mean 4.2 Range 1.7-6.8	(Palfrey *et al.*, 2011)
Sweden	Influent from Rya WWTP in Gothenberg	GII 4.0-8.3 GI 6.5-9.3	(Wang *et al.*, 2020)

gc: genome copies

Although some very high norovirus concentrations were reported in the Swedish study summarised in Table 1, the remaining studies are largely consistent and support the currently used distribution of norovirus concentrations for raw wastewater.

Viral removal at the WWTP

Little specific information is available on the removal of viruses by wastewater treatment processes in New Zealand. While some sources report on the viral content of influent and effluent from the same plant (McBride, 2016; Norquay, 2017; TDC, 2020), no attempt has been made to account for the time it takes the wastewater to progress through the plant and comparisons are not strictly comparing the same wastewater.

A limited number of studies have considered viral removal during wastewater treatment processes. Studies on removal of norovirus through secondary wastewater treatment have reported log reductions in the range from no significant removal to removal of greater than 3 $\log_{10}$ (Campos *et al.*, 2016; Cuevas-Ferrando *et al.*, 2022; El-Senousy and Abou-Elela, 2017; Ito *et al.*, 2016; Lee *et al.*, 2019; Montazeri *et al.*, 2015; Plaza-Garrido *et al.*, 2023; Prado *et al.*, 2019; Qiu *et al.*, 2015; Simhon *et al.*, 2019; Symonds *et al.*, 2014; van den Berg *et al.*, 2005). The mean reduction across these studies is about 1.5 $\log_{10}$.

Prior to the previous renewal of the Russell WWTP resource consent in 2014, monitoring of the viral species F-RNA bacteriophage was carried out four times per year, to assess the performance of the Russell WWTP with respect to virus removal. F-RNA bacteriophage concentrations were determined in the influent wastewater and the effluent following UV treatment. F-RNA bacteriophage is a culturable virus, commonly present at high concentrations in human effluent. The fact that it is culturable makes it much easier to measure than enteric viruses such as norovirus. The mean (range) log reduction value (LRV) with respect to bacteriophage removal through the Russell WWTP was 5.5 (4.2-6.5) log.

While there is ongoing discussion as to appropriateness of F-RNA bacteriophage as a surrogate for norovirus, the study of Palfrey et al. (2011) reported reasonable agreement between F-RNA bacteriophage removal and norovirus removal across five WWTPs, with overall mean removal of F-RNA bacteriophage of 2.1 $\log_{10}$ and overall mean removal of norovirus of 1.5 $\log_{10}$. Good correlations between the concentrations of F-RNA bacteriophage and enteric viruses have been reported in receiving freshwater environments (Havelaar *et al.*, 1993). On the basis of available information, F-RNA bacteriophage should be considered a suitable indicator for the viral removal performance of the Russell WWTP.

While the degree of removal of enteric viruses by the Russell WWTP and UV treatment is unknown, it seems likely that this combination of treatments will result in viral removal rates greater than 3 $\log_{10}$ and probably greater than 4 $\log_{10}$. This is consistent with the performance of the WWTP for removal of F-RNA bacteriophage and literature information. Due to uncertainty in this aspect of the QMRA, the model was run for five viral reduction levels (1, 2, 3, 4 or 5 $\log_{10}$), to determine what level of viral reduction is required to achieve an acceptable level of swimming and shellfish consumption risk.

Groundwater attenuation of viruses

Although subsurface media act as natural filters and buffers that can mitigate microbial contamination, they vary widely in their ability to remove microbial contaminants. The study of Pang (2009) presents the theoretical basis for estimating microbial removal and summarises the results from field studies and large scale laboratory studies.

Microbial removal depends on the nature of the saturated zone (and the vadose zone, for surface application) and the distance between the point of microbial entry to the groundwater system and the point of water abstraction (Pang, 2009).

The subsurface media in the vicinity of the Russell WWTP disposal bores is fractured rock (greywacke) (Phil Hook, PDP, personal communication). Fractured rock offers a lower rate of microbial removal than most other media due to the relative rapid velocity of groundwater through this medium.

Based on the study of Pang (2009), Moore *et al.* (2010) estimated a mean removal rate (λ) for viruses through 'Karstic and fractured rock' of 0.0153 $\log_{10}$/m. In other words, the viral concentration will decrease by 1 $\log_{10}$ for every 65 m the groundwater moves through the subsurface medium. The uncertainty in this estimated removal rate was represented by a normal distribution with mean = 0.0153 and standard deviation = 0.0245.

Exact information on the distance of underground flow, from the disposal bores to the streams that receive the emerging groundwater, is not currently available. Site inspection suggests that an estimate of 60 m would be conservative, with the figure potentially closer to 100 m (Phil Hook, PDP, personal communication). To represent this uncertainty, the distance of underground flow was represented by a uniform distribution with limits of 60 and 100 m.

2.2.3 Exposure factors

For all exposure routes considered, the exposure dose is the simple product of the concentration of viruses in the exposure media (water or shellfish) and the ingested amount of the exposure media. Parameters defining the amount of water ingested are termed exposure factors. Relevant exposure factors are discussed and defined in the following sections.

<u>Primary contact recreation (swimming)</u>

Rate of water ingestion

The current QMRA considered risks associated with primary contact recreation downstream from the wastewater discharge point. In this context, the most likely form of primary contact recreation will be swimming.

No information is available on water ingestion during swimming in New Zealand. The most commonly used water ingestion information for environmental QMRAs was derived from a pilot swimming pool study in the USA (Dufour *et al.*, 2006). The volume of water ingested was estimated by measuring the concentration of the chlorine-stabilising chemical cyanuric acid in the urine of swimmers and in the pool water. Cyanuric acid passes through the human body without undergoing metabolic changes. The full study by the same research group has subsequently been published (Dufour *et al.*, 2017). Summary data from this study are included in Table 2.

Table 2. Water ingestion parameters from the swimming pool survey of Dufour et al. (2017)

Age group	Water intake description		Mean duration (minutes)
	Geometric mean (95%CI) (mL/hr)	Maximum (mL/hr)	
Children	23.9 (17-33)	153	95.9
Teenagers	23.7 (19-30)	287	55.8
Adults	12.4 (11-14)	333	50.3

While not included in the scientific paper, ESR have obtained the raw data from this study and, for all age groups, the minimum ingested volumes are about 1 mL or 0.6-1.2 mL/hr (Dr Alfred Dufour, USEPA, personal communication).

A search of the scientific literature did not identify any studies subsequent to the Dufour study on the amount of water ingested during primary contact recreation. The information from the Dufour study continues to be the best available.

The Dufour *et al*. (2017) study was carried out in swimming pools, while the current QMRA considers a marine recreational environment. Schets *et al.* (2011) compared self-reported volumes of water ingested during swimming in a swimming pool, in freshwater and in seawater. For children (<15 years), the highest amount of water was ingested during swimming in a pool (mean = 51 mL/event), compared to freshwater (37 mL/event) and seawater (31 mL/event). This suggests that the Dufour data may be conservative for water ingestion during marine swimming, which is appropriate for risk assessment.

Duration of contact recreation events

In the absence of New Zealand specific data, the study of Schets *et al.* (2011) provides the most applicable data for the current QMRA – actual measurements of the duration of swimming in freshwater or seawater. The current QMRA is concerned with swimming at seawater locations, as it was assumed that the 'small streams' receiving the post-groundwater wastewater would be too small for contact recreation. The study of Schets *et* al. (2011) also provides details of normal distributions fitted to the natural log of the distribution of swimming duration times. For seawater swimming, the parameterised distributions are normal ($\mu = 3.8, \sigma = 0.8$) for children, normal ($\mu = 3.2, \sigma = 0.94$) for adult females and normal ($\mu = 3.5, \sigma = 0.85$) for adult males. The units for these parameters are the natural log of minutes. For example, the mean of the distribution for children is $e^{3.8} = 44.7$ minutes.

While it could be argued that swimming habits may differ in New Zealand compared with the USA and the Netherlands, there is no evidence to support this argument.

Water ingestion – summary

Children spend more time in the water during contact recreation and ingest water at a higher mean rate than adults. Therefore, the current QMRA conservatively based risk estimates on children swimming in Uruti/Orongo/Pomare Bay. Water ingested was determined as the product of the ingestion rate and the recreation duration, with the ingestion rate represented by a beta pert distribution with minimum = 0.6 mL/hr, mean = 23.9 mL/hr and maximum = 153.3 mL/hr. The duration of exposure was represented by a distribution whose natural log was normally distributed with $\mu = 4.1$ and $\sigma = 0.8$. The exponential of this distribution is the duration of recreation in minutes.

As the normal distribution used for the duration of swimming events has no maximum (or minimum) value, there is potential for the combination of the distributions for water ingestion rate and swimming duration to produce an unrealistically high estimate of the amount of water ingested during swimming. Ingestion of up to 800 mL of water has been reported for competitive swimmers (Allen *et al.*, 1982) and this value was used as an upper limit on the amount of water ingested during any swimming event.

Shellfish consumption

Commercial oyster farming operations are present in Orongo Bay, immediately to the south of Uruti Bay. No information was available on recreational shellfish gathering locations (Phil Hook, PDP, personal communication).

Accumulation of viruses by shellfish

Bivalve molluscan shellfish feed by filtering large volumes of seawater. This means that they may bioaccumulate contaminants, including viral pathogens. QMRA involving shellfish consumption usually try to account for bioaccumulation of pathogen particles by the shellfish (McBride and Hudson, 2016). Limited information is available on the rate of virus accumulation by shellfish. Previous New Zealand viral QMRAs have used bioaccumulation factors (BAFs) derived by Burkhardt and Calci (2000) for the enteric virus surrogate, F+ coliphage in oysters (*Crassostrea virginica*). The bioaccumulation factor is the concentration of the organism in shellfish flesh, divided by the concentration in the surrounding water. The study of Burkhardt and Calci (2000) demonstrated that viral BAFs were highest during the autumn-winter (mean 49.9, standard deviation 7.4) and relatively modest in spring-summer (mean 2.9, standard deviation 0.5). Previous New Zealand QMRAs used the autumn-winter bioaccumulation figures as a conservative estimate of bioaccumulation by all shellfish of all viruses (McBride *et al.*, 2005; McBride, 2016; McBride and Hudson, 2016; McBride, 2014; URS New Zealand, 2013).

In the study of Burkhardt and Calci (2000) the period of high viral bioaccumulation occurred at seawater temperatures of approximately 15-20°C, with low viral bioaccumulation occurring at seawater temperatures >20°C. Average seawater temperatures in Northland vary between approximately 16 and 20°C (NIWA, 2013). On this basis, the approach used in previous New Zealand QMRAs of using cold season BAFs appears appropriate.

It should be noted that other studies on virus accumulation by bivalve shellfish have shown much lower rates of bioaccumulation. Amoroso *et al*. (2020) carried out accumulation studies for rotavirus in mussels (*Mytilus galloprovincialis*). Mussels accumulated rotavirus to approximately the same concentration as the surrounding water, but not to any greater concentration.

No specific information was found to enable estimation of BAFs for norovirus in shellfish.

Previous QMRAs have based the estimated viral content of shellfish on the instantaneous viral concentration of the water and application of the BAF discussed above. However, the viral content of shellfish is the product of processes of accumulation, retention and depuration. The available evidence suggests that viral levels in shellfish may reach a steady state, reflecting their mean exposure to the virus, rather than their instantaneous exposure (Dr Joanne Hewitt, ESR, personal communication). There is evidence that retention of norovirus in shellfish is mediated through binding to type-A like receptors in the shellfish gut (Tian *et al.*, 2007). This mechanism is likely to be cumulative, but saturable. To accommodate this approach to viral accumulation, the virus content of shellfish was calculated as 30-day running means. No evidence was found to suggest that recreational shellfish collection in New Zealand is other than a year-round activity.

Consumption of shellfish – serving size

The 2008/2009 New Zealand Adult Nutrition Survey collected detailed information on foods consumed by adult New Zealander (*n* = 4,721) during a 24-hour period (University of Otago and Ministry of Health, 2011). Analysis has been carried out of the reported serving sizes for specific foods, including bivalve shellfish (Cressey, 2013). The mean serving size for bivalve shellfish was 79.3 g, with a median of 65.5 g and a 95th percentile of 164 g. The distribution of serving sizes could be satisfactorily represented by a lognormal distribution with mean

82.7 g and standard deviation 73.4 g. The distribution of serving sizes was truncated at the highest reported shellfish serving size (375 g).

Viruses are inactivated by cooking. The QMRA is related to consumption of raw shellfish. It has been assumed that the distribution of serving sizes for raw shellfish is not substantially different to the distribution of all shellfish serving sizes.

2.3 DOSE-RESPONSE

The dose-response relationship is a mathematical description of the probability of infection (or illness) for a given exposure dose. Dose-response relationships are derived from clinical trials, in which volunteers receive known amounts of pathogen, or from the analysis of outbreaks of illness associated with a defined exposure to the pathogen. Dose-response relationships can be highly uncertain, as they are influenced not only by uncertainty in the source data, but also the choice of mathematical model. For comparability, the dose-response models used in the current QMRA are those most frequently used in New Zealand QMRAs.

Norovirus is associated with uncomplicated acute gastroenteritis. More effort has gone into characterising the dose-response relationship for norovirus than other viruses potentially transmitted through the environment. Based on human challenge experiments with the Norwalk strain, beta-binomial parameters were estimated, $\alpha = 0.040$ and $\beta = 0.055$ (Teunis *et al.*, 2008).

Viruses suspended in water can cluster into aggregates of varying sizes, depending on the ionic strength, pH, and properties of the viral protein coat or envelope. The study of Teunis *et al*. (2008) noted this phenomenon in their norovirus stock solutions and calculated a mean aggregate size of approximately 400 virus particles. Aggregation will tend to decrease the infectivity of viral solutions by effectively reducing the concentration of virus infectious units. For the current QMRA, it was assumed that noroviruses would be present in a disaggregated form.

The strength of the norovirus inoculum was determined by PCR, but using a different approach to that currently used in New Zealand for norovirus quantification. A dose harmonisation factor (18.5) has been derived to provide equivalence between the methods (McBride *et al.*, 2013).

The probability of illness, given infection, has been represented as a fixed proportion (0.6) (McBride *et al.*, 2013; Soller *et al.*, 2010). The reference study for the dose-response relationship indicated that the probability of illness, given infection, was a function of exposure dose (Teunis *et al.*, 2008). However, the association was quite weak and the fixed proportion used in QMRA was the mean probability across doses.

Teunis *et al*. (2008) identified that there was a proportion of the volunteer cohort who appeared to be resistant to infection, even at very high norovirus doses. It has been suggested that this resistance may be due to acquired immunity or genetic factors. This factor has been included in previous New Zealand QMRAs, assuming that the proportion of the New Zealand population susceptible to norovirus infection is the same as the proportion susceptible in the original volunteer study (74%) and this approach is used in the current QMRA.

2.4 RISK CHARACTERISATION: CONDUCTING THE QMRA

In order to adequately reflect limits to knowledge on key features of the risk assessment and inherent variability in the exposure events, Monte Carlo simulation modelling is used (Vose, 2008). In simpler models key input variables may be represented by a single number. However, input variables, such as viral concentrations, are known to be variable and, in most cases, uncertain. Simulation models 'sample' at random from input distributions, effectively addressing the complete range of possible 'what-if' scenarios. A summary of the input distributions used in the current study is shown in Table 3. Simulations were performed using the Excel plug-in @RISK (Palisade Corporation). The models were run for 100,000 iterations, with each iteration representing a potential swimming or shellfish consumption event. Results are presented as the Individual Illness Risk (IIR); the probability of an individual becoming ill from exposure to the specified virus from a single swimming event or a single meal of raw shellfish.

Table 3. Input variable and associated parameters used in the current QMRA

Input variable	Parameters	Distribution
Influent viral concentrations		
Norovirus (genome copies/L)	Minimum = 100 Median = 1E+5 95th percentile = 1.9E+5[a] Maximum = 3E+7	Custom hockey stick
Viral removal by WWTP	1, 2, 3 4 or 5 $\log_{10}$	
Viral inactivation during transit through groundwater system		
Inactivation rate (λ, $\log_{10}$/m)	Mean = 0.0153 Standard deviation = 0.0245	Normal
Distance of travel through groundwater system	Minimum = 60 m Maximum = 100 m	Uniform
Exposure factors		
Duration of swimming event (minutes)[b]	μ = 3.8, σ = 0.8	Normal. The result is the natural log of the duration
Water ingestion rate (mL/hr)[b]	Minimum = 0.6 Most likely = 23.9 Maximum = 153.3	Beta pert
Shellfish serving size (g)	μ = 82.7, σ = 73.4, truncated at 0 and 375	Lognormal
Shellfish bioaccumulation factor (BAF)	μ = 49.4, σ = 7.4, truncated at 1 and 100	Normal
Dose-response relationship		
Norovirus	α = 0.04, β = 0.055, P (ill | infection) = 0.6, P(susceptible) = 0.74 Dose harmonisation factor = 18.5	Beta binomial

[a] The 95th percentile break point for the custom hockey stick distribution was calculated according to the method of McBride et al. (2013)

[b] The distribution for the combination of the water ingestion rate and the duration of swimming was truncated at 800 mL for a single swimming event

The simulation analysis is reported as IIRs, which are an expression of the probability of illness resulting from a single exposure event. The *Microbiological water quality guidelines for marine and freshwater recreational areas* (MfE, 2003) similarly report microbiological assessment categories (MACs) in terms of estimated risk of gastrointestinal illness. The same MACs were used to classify the IIR estimates in the current study. Table 4 summarises the relevant aspects of the MACs.

Table 4. Microbiological assessment categories for primary human contact with marine recreational waters

Microbiological Assessment Category	Description
A	<1% GI illness risk
B	1-5% GI illness risk
C	5-10% GI illness risk
D	>10% GI illness risk

GI: gastrointestinal

No similar classification framework is available classifying the risks due to consumption of raw shellfish. However, as swimming and shellfish consumption are both voluntary recreational activities, the risk break points included in the recreational water guidelines were also applied to risks from raw shellfish consumption.

3. RESULTS AND DISCUSSION

3.1 PRIMARY CONTACT RECREATION

Outputs of QMRA modelling of norovirus illness risks associated with swimming in the environment affected by the Russell WWTP discharge, using the point of emergence from the groundwater system as a conservative surrogate for points in Uruti Bay, are summarised in Table 5.

Table 5. Individual Illness Risk (%) in the environs of the Russell WWTP discharge for gastrointestinal illness associated with norovirus from swimming

Location	Log_{10} norovirus removal by Russell WWTP[a]				
	1	**2**	**3**	**4**	5
Surrogate discharge point	8.4	3.3	0.82	0.20	0.028

[a] Shading indicates microbiological assessment categories, blue = A, green = B, yellow = C and red = D

At 2 log_{10} viral removal by the Russell WWTP, the risks of norovirus illness from discharge of effluent to Uruti Bay (surrogate) would equate to a B recreational water quality classification. At 3 log_{10} viral removal the risk would equate to an A water quality classification.

It should be reiterated that these risk estimates do not account for the further dilution of the discharge effluent as it enters Uruti Bay. While it is not possible to estimate the degree of dilution of effluent in Uruti Bay, hydrodynamic models for similar QMRAs with discharges almost directly into a marine environment report dilutions of at least 1000-fold (Armstrong, 2022; McBride, 2016; McBride and Hudson, 2016). If dilution of this magnitude occurred in Uruti Bay, a 2 log_{10} viral reduction through the Russell WWTP would be sufficient for risk of norovirus mediated illness from swimming in Uruti Bay to be reduced to <0.1%, below the risk level for an A water quality classification.

3.2 SHELLFISH CONSUMPTION

Outputs of QMRA modelling of norovirus illness risks associated with raw shellfish consumption of shellfish harvested from sites relevant to the Russell WWTP discharge are summarised in Table 6.

Table 6. Individual Illness Risk (%) in the environs of the Russell WWTP discharge for gastrointestinal illness associated with noroviruses from raw shellfish consumption

Location	Log_{10} norovirus removal by Russell WWTP[a]				
	1	**2**	**3**	**4**	5
Surrogate discharge point	25.4	23.6	21.5	15.8	2.6
Additional 1000-fold dilution	15.8	2.6	0.27	0.038	0.003

[a] Shading indicates microbiological assessment categories, blue = A, green = B, yellow = C and red = D

Due to the bioaccumulation of viruses by bivalve molluscan shellfish, the risks associated with this activity are higher than those associated with swimming at the same locations. At 5 log_{10} viral removal by the Russell WWTP, the risks of norovirus illness from discharge of effluent to Uruti Bay would equate to a risk level consistent with a B water quality classification. However, even at 4 log_{10} reduction in viral concentrations risk levels will be greater than 10% (D classification).

As for the risk associated with swimming, the risk estimates for the surrogate discharge point in Table 6 do not include consideration of viral reductions due to dilution in the marine environment. This is particularly relevant in the case of risks associated with raw shellfish consumption as the most likely location of shellfish that may be subject to contamination is Orongo Bay, around a headland from Uruti Bay. Inclusion of a nominal 1000-fold dilution of the treated wastewater substantially reduces the risk estimates to the point where a 3 $\log_{10}$ viral removal at the WWTP will equate to a risk level from consumption of raw shellfish equivalent to an A recreational water categorisation and a 2 $\log_{10}$ viral removal at the WWTP will equate to a B recreational water categorisation.

4. CONCLUSIONS

This QMRA considers risks to human health from the discharge of wastewater from the Russell WWTP into Uruiti Bay. These receiving waters will also be impacted by other, mainly diffuse, sources of contamination. These other sources are not considered in the current QMRA.

Risks were considered for primary contact recreation (swimming) and consumption of raw shellfish harvested within the affected area. Risks were assessed at a surrogate location, where the treated wastewater emerges from the groundwater system and makes its way via small streams to Uruiti Bay. Risks were compared to the risk levels for MACs in the *Microbiological water quality guidelines for marine and freshwater recreational areas*. The MACs for marine recreational waters were considered most relevant in the current situation. While the MACs are not directly applicable to risks associated with shellfish consumption, the risk cut-offs for the MACs were used generically to classify risks associated with voluntary recreational activities.

Risks associated with swimming in the affected marine environment would be less than 1% with a 5 $\log_{10}$ reduction in viral concentrations, while consumption of raw shellfish from the affected area would result in a 2.6% (1 in 40) risk of gastrointestinal illness. Viral concentration reduction will occur through the operation of the Russell WWTP and through dilution of treated wastewater in Uruiti Bay. While the former is not explicitly known, the wastewater treatment processes in place (secondary plus UV treatment) are likely to result in at least a 4 $\log_{10}$ viral reduction. Dilution in Uruiti Bay is likely to result in at least an addition 3 $\log_{10}$ reduction in viral concentrations. In combination, the reductions in viral concentration between the influent to the Russell WWTP and points of likely recreational contact are likely to be sufficient to reduce risks of viral illness to a negligible level.

This assessment has taken a conservative approach at a number of points, and it is expected that risks, for the majority of the time, will be lower than those estimated in the current QMRA.

REFERENECES

Ahmed W, Bivins A, Payyappat S, Cassidy M, Harrison N, Besley C. (2022) Distribution of human fecal marker genes and their association with pathogenic viruses in untreated wastewater determined using quantitative PCR. Water Research; 226: 119093.

Allen LM, Briggle TV, Pfaffenberger CD. (1982) Absorption and excretion of cyanuric acid in long-distance swimmers. Drug Metabolism Reviews; 13(3): 499-516.

Amoroso MG, Langellotti AL, Russo V, Martello A, Monini M, Di Bartolo I, Ianiro G, Di Concilio D, Galiero G, Fusco G. (2020) Accumulation and depuration kinetics of rotavirus in mussels experimentally contaminated. Food and Environmental Virology; 12(1): 48-57.

Armstrong B. (2022) Screening quantitative microbial risk assessment (QMRA): Hihi wastewater treatment plant. ESR Client Report CSC22007. Christchurch: Institute of Environmental Science and Research.

Burkhardt W, Calci KR. (2000) Selective accumulation may account for shellfish-associated viral illness. Applied and Environmental Microbiology; 66(4): 1375-1378.

Campos CJA, Avant J, Lowther J, Till D, Lees DN. (2016) Human norovirus in untreated sewage and effluents from primary, secondary and tertiary treatment processes. Water Research; 103: 224-232.

Cressey P. (2013) Food consumption data for risk assessments. ESR Client Report FW13008. Christchurch: Institute of Environmental Science and Research.

Cressey P. (2020) Screening quantitative microbial risk assessment (QMRA): Kaikohe wastewater treatment plant. ESR Client Report CSC21013. Christchurch: Institute of Environmental Science and Research.

Cressey P, Armstrong B. (2020) Quantitative microbial risk assessment (QMRA): East Coast (Taipa) wastewater treatment plant. ESR Client Report CSC20028. Christchurch: Institute of Environmental Science and Research.

Cuevas-Ferrando E, Pérez-Cataluña A, Falcó I, Randazzo W, Sánchez G. (2022) Monitoring human viral pathogens reveals potential hazard for treated wastewater discharge or reuse. Frontiers in Microbiology; 13: 836193.

Dufour AP, Evans O, Behymer TD, Cantu R. (2006) Water ingestion during swimming activities in a pool: a pilot study. Journal of Water and Health; 4(4): 425-430.

Dufour AP, Behymer TD, Cantu R, Magnuson M, Wymer LJ. (2017) Ingestion of swimming pool water by recreational swimmers. Journal of Water and Health; 15(3): 429-437.

Eftim SE, Hong T, Soller JA, Boehm AB, Warren I, Ichida AM, Nappier SP. (2017) Occurrence of norovirus in raw sewage – A systematic literature review and meta-analysis. Water Research; 111: 366-374.

El-Senousy WM, Abou-Elela SI. (2017) Assessment and evaluation of an integrated hybrid anaerobic-aerobic sewage treatment system for the removal of enteric viruses. Food and Environmental Virology; 9(3): 287-303.

Harrison Grierson. (2017) Russell WWTP O&M and management plan. O&M manual. Prepared for the Far North District Council. R001v1-AK141237-01-kkh-ich. Auckland: Harrison Grierson.

Havelaar AH, van Olphen M, Drost YC. (1993) F-specific RNA bacteriophages are adequate model organisms for enteric viruses in fresh water. Applied and Environmental Microbiology; 59(9): 2956-2962.

Ito T, Kato T, Hasegawa M, Katayama H, Ishii S, Okabe S, Sano D. (2016) Evaluation of virus reduction efficiency in wastewater treatment unit processes as a credit value in the multiple-barrier system for wastewater reclamation and reuse. Journal of Water and Health; 14(6): 879-889.

Lee S, Suwa M, Shigemura H. (2019) Occurrence and reduction of F-specific RNA bacteriophage genotypes as indicators of human norovirus at a wastewater treatment plant. Journal of Water and Health; 17(1): 50-62.

Liu P, Li ZH, Che ZF, Hu XR, Ying M, Ren HQ, Zhang XX. (2021) Prevalence of common enteric viruses in municipal wastewater treatment plants and their health risks arising from wastewater reuse. Blue-Green Systems; 3(1): 95-106.

Malla B, Thakali O, Shrestha S, Segawa T, Kitajima M, Haramoto E. (2022) Application of a high-throughput quantitative PCR system for simultaneous monitoring of SARS-CoV-2 variants and other pathogenic viruses in wastewater. Science of The Total Environment; 853: 158659.

McBride G, Moore J, Tipler C. (2005) Comparing human health risk outcomes for the proposed Christchurch City ocean outfall: A quantitative approach. NZWWA Conference, Auckland.

McBride G. (2016) Quantitative Microbial Risk Assessment for the discharge of treated wastewater: Proposed sub-regional wastewater treatment facility at Clarks Beach, South Manukau. NIWA Client Report No.: HAM2016-018. Hamilton: National Institute of Water and Atmospheric Research.

McBride G, Hudson N. (2016) Quantitative Microbial Risk Assessment for the discharge of treated wastewater: Snells Beach wastewater treatment plant. NIWA Client Report No.: HAM2016-038. Hamilton: National Institute of Water and Atmospheric Research.

McBride GB, Stott R, Miller W, Bambic D, Wuertz S. (2013) Discharge-based QMRA for estimation of public health risks from exposure to stormwater-borne pathogens in recreational waters in the United States. Water Research; 47(14): 5282-5297.

McBride GB. (2014) Water-related health risks analysis for the proposed Akaroa wastewater scheme. NIWA Client Report No.: HAM2014-030. Hamilton: National Institute of Water and Atmospheric Research.

MfE. (2003) Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas. ME Number: 474. Wellington: Ministry for the Environment.

Montazeri N, Goettert D, Achberger EC, Johnson CN, Prinyawiwatkul W, Janes ME. (2015) Pathogenic enteric viruses and microbial indicators during secondary treatment of municipal wastewater. Applied and Environmental Microbiology; 81(18): 6436-6445.

Moore C, Nokes C, Lowe B, Close M, Pang L, Smith V, Osbaldiston S. (2010) Guidelines for separation distances based on virus transport between on-site domestic wastewater systems and wells. ESR Client Report No. CSC1001. Christchurch: Institute of Environmental Science and Research.

NIWA. (2013) The climate and weather of Northland. 3rd Edition. Hamilton: National Institute of Water and Atmospheric Research (NIWA).

Norquay K. (2017) Rotorua wastewater treatment plant discharge public health risk assessment. Prepared for Rotorua Lakes Council. Dunedin: Stantec.

NPDC. (2022) NPDC New Plymouth WWTP. Monitoring Programme. Annual Report 2020-2021. Technical Report 2021-59. Stratford: Taranaki District Council.

Oldman JW, Dada AC. (2020) A Quantitative Microbial Risk Assessment of the Porirua WWTP discharge and receiving environment. DHI1901. Hamilton: Streamlined Environmental.

Palfrey R, Harman M, Moore R. (2011) Impact of Waste Water Treatments on Removal of Noroviruses from Sewage. R&D Technical Report WT0924/TR. London: Department for Environment Food and Rural Affairs.

Pang L. (2009) Microbial Removal Rates in Subsurface Media Estimated From Published Studies of Field Experiments and Large Intact Soil Cores. Journal of Environmental Quality; 38(4): 1531-1559.

Plaza-Garrido A, Ampuero M, Gaggero A, Villamar-Ayala CA. (2023) Norovirus, Hepatitis A and SARS-CoV-2 surveillance within Chilean rural wastewater treatment plants based on different biological treatment typologies. Science of The Total Environment; 863: 160685.

Prado T, Bruni AD, Barbosa MRF, Garcia SC, Moreno LZ, Sato MIZ. (2019) Noroviruses in raw sewage, secondary effluents and reclaimed water produced by sand-anthracite filters and membrane bioreactor/reverse osmosis system. Science of The Total Environment; 646: 427-437.

Qiu Y, Lee BE, Neumann N, Ashbolt N, Craik S, Maal-Bared R, Pang XL. (2015) Assessment of human virus removal during municipal wastewater treatment in Edmonton, Canada. Journal of Applied Microbiology; 119(6): 1729-1739.

Schets FM, Schijven JF, de Roda Husman AM. (2011) Exposure assessment for swimmers in bathing waters and swimming pools. Water Research; 45(7): 2392-2400.

Simhon A, Pileggi V, Flemming CA, Bicudo JR, Lai G, Manoharan M. (2019) Enteric viruses in municipal wastewater effluent before and after disinfection with chlorine and ultraviolet light. Journal of Water and Health; 17(5): 670-682.

Soller JA, Bartrand T, Ashbolt NJ, Ravenscroft J, Wade TJ. (2010) Estimating the primary etiologic agents in recreational freshwaters impacted by human sources of faecal contamination. Water Research; 44(16): 4736-4747.

Symonds EM, Verbyla ME, Lukasik JO, Kafle RC, Breitbart M, Mihelcic JR. (2014) A case study of enteric virus removal and insights into the associated risk of water reuse for two wastewater treatment pond systems in Bolivia. Water Research; 65: 257-270.

TDC. (2020) New Plymouth wastewater treatment plant. Marine outfall and sludge lagoon monitoring programme. Annual Report 2018-2019. Technical Report 2019-80. New Plymouth: Taranaki District Council.

Teunis PFM, Moe CL, Liu P, Miller SE, Lindesmith L, Baric RS, Le Pendu J, Calderon RL. (2008) Norwalk virus: How infectious is it? Journal of Medical Virology; 80(8): 1468-1476.

Tian P, Engelbrektson AL, Jiang X, Zhong WM, Mandrell RE. (2007) Norovirus recognizes histo-blood group antigens on gastrointestinal cells of clams, mussels, and oysters: A possible mechanism of bioaccumulation. Journal of Food Protection; 70(9): 2140-2147.

University of Otago and Ministry of Health. (2011) A focus on nutrition: Key findings of the 2008/09 New Zealand Adult Nutrition Survey. Wellington: Ministry of Health.

URS New Zealand. (2013) Assessment of Public Health Risks Associated with Rosedale WWTP Effluent Discharge. Auckland: URS New Zealand Ltd.

van den Berg H, Lodder W, van der Poel W, Vennema H, De Roda Husman AM. (2005) Genetic diversity of noroviruses in raw and treated sewage water. Research in Microbiology; 156(4): 532-540.

Vose D. (2008) Risk Analysis: A Quantitative Guide. Third Edition. Chichester: John Wiley and Sons.

Wang H, Neyvaldt J, Enache L, Sikora P, Mattsson A, Johansson A, Lindh M, Bergstedt O, Norder H. (2020) Variations among viruses in influent water and effluent water at a wastewater plant over one year as assessed by quantitative PCR and metagenomics. Applied and Environmental Microbiology; 86(24): e02073-02020.

Science for Communities

INSTITUTE OF ENVIRONMENTAL
SCIENCE AND RESEARCH LIMITED

Kenepuru Science Centre
34 Kenepuru Drive, Kenepuru, Porirua 5022
PO Box 50348, Porirua 5240
New Zealand
T: +64 4 914 0700 **F:** +64 4 914 0770

Mt Albert Science Centre
120 Mt Albert Road, Sandringham, Auckland 1025
Private Bag 92021, Auckland 1142
New Zealand
T: +64 9 815 3670 **F:** +64 9 849 6046

NCBID – Wallaceville
66 Ward Street, Wallaceville, Upper Hutt 5018
PO Box 40158, Upper Hutt 5140
New Zealand
T: +64 4 529 0600 **F:** +64 4 529 0601

Christchurch Science Centre
27 Creyke Road, Ilam, Christchurch 8041
PO Box 29181, Christchurch 8540
New Zealand
T: +64 3 351 6019 **F:** +64 3 351 0010

www.esr.cri.nz

Appendix I: Air Quality Effects Assessment

Russell Wastewater Treatment Plant – Air Quality Assessment

Prepared for

Far North District Council

December 2023

PATTLE DELAMORE PARTNERS LTD
Level 5, PDP House
235 Broadway, Newmarket, Auckland 1023
PO Box 9528, Auckland 1149, New Zealand

Tel +64 9 **523 6900**
Web www.pdp.co.nz

solutions for your environment

Quality Control Sheet

TITLE	Russell Wastewater Treatment Plant – Air Quality Assessment
CLIENT	Far North District Council
ISSUE DATE	18 December 2023
JOB REFERENCE	A03576827

Revision History

REV	Date	Status/Purpose	Prepared By	Reviewed by	Approved
1	20-10-2023	Draft	Jonathan Harland	Andrew Curtis	Andrew Curtis
2	1-11-2023	Final	Jonathan Harland	Andrew Curtis	Andrew Curtis
3	18-12-2023	Final v2	Jonathan Harland	Andrew Curtis	Andrew Curtis

DOCUMENT CONTRIBUTORS

Prepared by

SIGNATURE

Jonathan Harland

Reviewed and Approved by

SIGNATURE

Andrew Curtis

Limitations:

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Far North District Council. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This report has been prepared by PDP on the specific instructions of Far North District Council for the limited purposes described in the report. PDP accepts no liability if the report 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.

Table of Contents

Table of Figures

Table of Tables

1.0 Introduction

Far North District Council (FNDC) operates the Russell Wastewater Treatment Plant (WWTP) to the southeast of Kororāreka/Russell township for which it holds an air discharge consent (AUT.008339.02.03) from the Northland Regional Council (NRC). This consent is due to expire on 30 April 2024 and FNDC has engaged Pattle Delamore Partners Limited (PDP) to assess the odour discharges from the WWTP and prepare a technical assessment which can support an application for a new consent for the site.

FNDC is not proposing to make any changes to the site and therefore PDP has undertaken odour observations at the Russell WWTP and in the wider area to understand the current level of odour. Based on these observations as well as experience with other sites, PDP has prepared a FIDOL odour assessment, and the findings of this assessment are presented in the following sections of this report.

1.1 Site Description

The Russell WWTP is located approximately 1 kilometre to the southeast of Kororāreka/Russell township, on Russell Whakapara Road, between Florance Avenue and Uruti Road. The WWTP is located next to the Russell waste transfer station and the closed Russell landfill. The site and the surrounding terrain are undulating and covered in fairly dense vegetation. There are only five dwellings within 500 metres of the WWTP.

2.0 Site Operations

The Russell WWTP serves the community of Kororāreka/Russell and Tapeka Point as well as accepting a small volume of leachate from the neighbouring Russell landfill.

The WWTP is a multi-stage treatment process, which includes inlet screens, secondary treatment using two sequencing batch reactors (SBR) and settling ponds with tertiary sand filters and UV disinfection with the treated wastewater discharged using a deep bore system.

The wastewater is pumped to the WWTP, where solids larger than 10 mm are screened from the wastewater. The wastewater is then distributed between two sequencing batch reactor tanks, where dissolved contaminants are removed. The liquid is then decanted into a series of settlement ponds before being filtered through a sand filter. Once filtered, the wastewater is disinfected using ultra-violet light. The final treated wastewater is discharged into land via a series of deep bores across a ridge line above the WWTP.

2.1 Sources of Odour

Odour is generated during the treatment of wastewater through the decomposition of organic material present in the effluent or that are produced in the treatment process. Wastewater may differ considerably in terms of physical and chemical properties depending on the catchment, however in the case of Kororāreka/Russell the wastewater is primarily from residential properties and does not include a significant component of industrial waste, except for a small volume of landfill leachate that may lead to a range of different types of odour.

At the Russell WWTP the greatest odour potential comes from the inlet works, followed by the SBR's and any sludge handling process. Raw effluent enters the site via the inlet works where it is screened to remove grit and other large material. The material collected in the screen is stored in a bag before being taken off-site to be disposed of at a landfill. This material has the potential to be odorous, and the longer it is stored on-site the higher the potential for odour occurs. The length of time the screen material is stored on-site varies, but typically the material is removed weekly.

The SBR process cycles between anaerobic and aerobic (aerated) conditions which create different environments to promote different types of bacteria to breakdown the organic material. During normal operating conditions, only low levels of odour is generated by the activated sludge process.

The sludge generated by the activated sludge process has the potential to be a source of odour, especially if it sits for long periods of time without aeration as it can turn septic and create significant odour. The sludge from the Russell WWTP is stored in tanks prior to be taken off-site via truck for disposal. While in the tanks the potential for odour is low, but when pumped into the truck there is the potential for odour discharges. The remainder of the wastewater is pumped directly into the deep bores and given that this is a closed system and the water is well treated there is little potential for odour from this part of the operation.

Other processes onsite such as the sand filters and the UV disinfection, are expected to only be generate low levels of odour.

2.1.1 Odour Control

Currently the Russell WWTP does not have any specific odour control devices such as biofilters, scrubbers, flares etc. The Russell WWTP plant controls any odour through management of the wastewater treatment process, and ensuring that the plant is working at optimal conditions. This level of control appears to be sufficient as there have been no complaints received by NRC for the Russell WWTP (Section 5.1).

As the site relies on correct management techniques to control odour PDP recommends that if the plant operation is to change, or the risk of odour is to increase, then an Odour Management Plan is recommended.

2.2 Other Potential Discharges

Given the nature of the process is treating wastewater it is likely that the effluent contains pathogens and therefore there is potential for these pathogens to become airborne. For pathogens to become airborne there typically needs to be some form of disturbance occurring. In the case of the Russell WWTP, the main potential for disturbance occurs in the SBR which forces air from the bottom to aerate the effluent. Here air bubbles rise to the surface and pop, and as they pop there is the potential for a very small amount of wastewater to become airborne. As this activity occurs inside a tank, PDP considers in the first instance that there is little potential for these small particles to exit the tank.

If these airborne droplets were to the leave the tank the survival rates of microbes drop off depending on ambient temperature, humidity and time. A study by NIWA[1] also showed a very low presence of pathogens in aerosols from wastewater irrigation spray. The study concluded that on average there was very little risk (<0.1%) of becoming ill from repeated exposure to irrigation spray at a distance greater than 10 metres from the source.

Given that the aeration occurs in a tank and the site is surrounded by dense vegetation, PDP considers that the potential for off-site pathogen effects is extremely low to negligible and therefore has not discussed this any further in this assessment.

3.0 Consent Requirements

The Proposed Regional Plan for Northland (PRPN) is currently operative in part, however the rules that apply to the Russell WWTP are not under appeal and therefore are considered operative. Under the PRPN the discharge odour to air from a WWTP falls under the discretionary activity rule C.6.2.2 which states the following:

The discharge of treated wastewater from a wastewater treatment plant into water or onto or into land, and any associated discharge of odour into air resulting from the discharge, are discretionary activities.

For the avoidance of doubt this rule covers the following RMA activities:

- *Discharge of treated wastewater from a wastewater treatment plant into water or onto or into land where it may enter water and any associated discharge of odour into air (s15(1)).*

[1] Fonterra, Microbial Risk Assessment Summary, 7 July 2020.

- *Discharge of treated wastewater from a wastewater treatment plant onto or into land and any associated discharge of odour into air (s15(2)(A)).*

4.0 Assessment Methodology

4.1 Qualitative Assessment Methodology

Complaints are likely to occur when odours become detectable and recognisable. However, there are many situations when the release of a potentially odorous compound does not result in an odour nuisance effect. It is the subjective judgement of an odour's hedonic tone that enables the decision to be made as to whether it is a nuisance or not. The factors that contribute to an odour nuisance effect include the frequency (F) of odour impact, the intensity (I), the duration of exposure (D), the offensiveness (O) and the location (L). This type of assessment is recommended by the Ministry for the Environment (MfE) Good Practice Guide for Assessing and Managing Odour[1] (MfE GPG Odour) and the same guidance has been adopted in the PRPN to determine if odour is offensive or objectionable.

The FIDOL factors are explained in greater detail below:

- Frequency: relates to how often an individual is exposed to odour. Factors determining this include the frequency that the source releases odour (including its source type, characteristics and the rate of emission of the compound or compounds); prevailing meteorological conditions; and topography.
- Intensity: is the perceived strength of the odour or the odour detection capacity of individuals to the various compound(s). An increase in intensity of odour will increase the potential for odour complaints. Subjective measurements are made on a scale of 1 to 6 and qualitative measurements are in odour units (OU or OU/m^3).
- Duration: is the amount of time that an individual is exposed to odour. Combined with frequency, this indicates the exposure to odour. The duration of an odour, like its frequency, is related to the source type and discharge characteristics, meteorology, and location. The longer the odour detection persists in an individual location, the greater the level of complaints that may be expected, particularly if the odours are unpleasant or obnoxious.
- Offensiveness: is a subjective rating of an odour's pleasantness and relates closely to hedonic tone. Offensiveness is related to the sensitivity of the 'receptors' to the odour emission, i.e. whether the odorous compound is more likely to cause nuisance.

[1] MfE Good Practice Guide for Assessing and Managing Odour, November 2016

- Location: is the type of land use and the nature of human activities in the vicinity of an odour source. The same process in a different location may produce more or less odour depending on local topography and meteorological conditions. It is also important to note that in some locations certain odours may be more acceptable than in other locations (e.g. the expectation that rural smells will occur as part of the rural environment and industrial smells will occur in industrial areas).

PDP has assessed each of these factors to determine if off-site odours are likely to be offensive or objectionable.

4.2 Sensitive Receptors

A site investigation was undertaken to identify discrete receptors deemed sensitive to changes in air quality as a result of potential discharges to air from the Russell WWTP. These receptors are summarised in Table 1.

In the context of this assessment, the PRPN provides the following definition of Odour Sensitive Areas:

- residential buildings and associated garden areas, and
- schools, hospital buildings, care facilities and grounds, and
- amenity areas where people congregate including parks and reserves, and
- community buildings and grounds, including places of worship and marae.

PDP has identified a number of nearby sensitive receptors within 500 metres of the Russell WWTP, and Figure 1 presents the location of the nearest receptors in relation to the WWTP.

Table 1: Location of Receptors located close to the WWTP

Receptor Name	Address	Closest Distance to WWTP (m)	Direction Relative to the WWTP
R1	6169 Russell Whakapara Road	370	Southwest
R2	6169A Russell Whakapara Road	400	West Southwest
R3	43 Florance Avenue	400	Northwest

Figure 1: Location of the nearby sensitive receptors

4.3 Field Odour Investigation

Subjective field odour investigations (or odour surveys) were carried out at the Russell WWTP, by an odour assessor using the FIDOL factors to understand the level of odours for the area.

The investigations were carried out in accordance with the guidance contained in MfE GPG Odour and the PRPN. The findings of these odour surveys are presented in Section 5.3.

4.4 Wind Speed and Wind Direction

Wind can have a significant effect on odour transportation. The Russell WWTP has an Automatic Weather Station (AWS) installed onsite which is operated by NIWA. PDP has reviewed the location of this site and the data collected, and while the wind sensor is relatively low to the ground (approximately 2.5 metres), PDP considers that this AWS provides a good representation of wind in this area with the measured wind directions influenced by the localised terrain.

The distribution of hourly average wind speeds and directions recorded at the Russell WWTP for the three-year period 1 January 2020 and 31 December 2022 is shown in Figure 2 and Table 2 presents the distribution frequency of wind speed. The predominant lower speed winds (less than 3 m/s) originate from the northeast, with calms (winds less than 0.5 m/s) occurring 0.15 percent of the time.

Based on PDP's experience, it is these light wind conditions which have the greatest potential to cause odour nuisance effects due to a reduction in the dispersion and dilution of odour emissions.

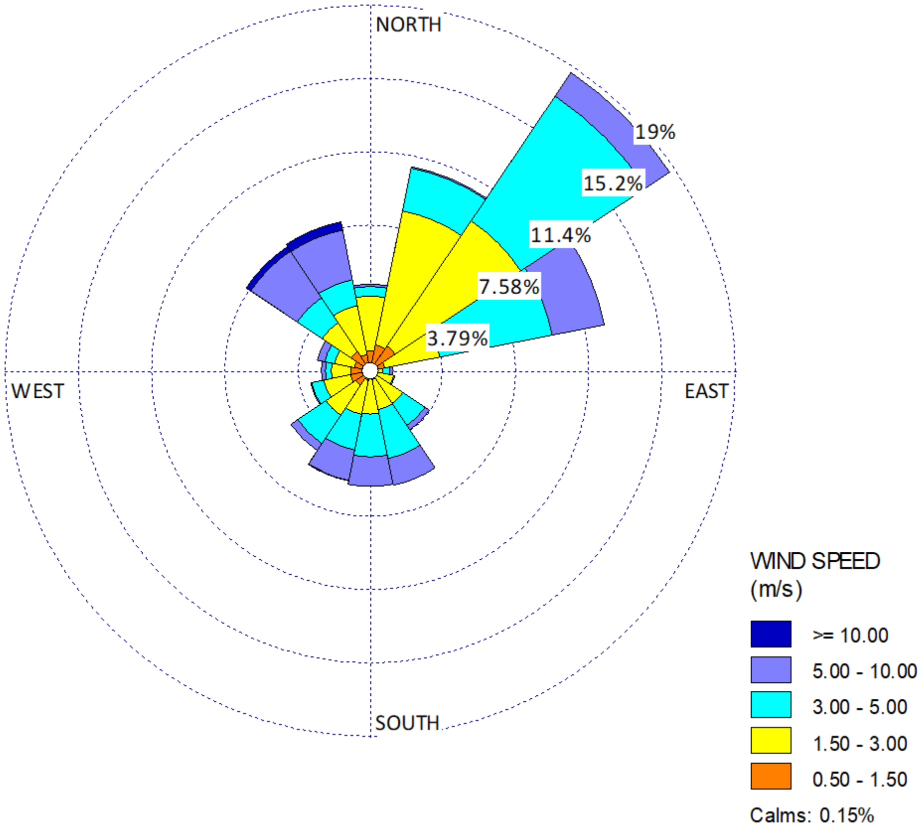


Figure 2: Russell WWTP Windrose – January 2020 to December 2022

Table 2: Wind Speed Frequency Distribution (2018-2020)

Direction	Wind Speed (m/s)		Total (%)
	0-3	>3	
North	3.9	0.6	4.5
North northeast	8.5	2.3	10.8
Northeast	9.4	9.2	18.6
East northeast	3.7	8.7	12.4
East	0.7	0.5	1.2
East southeast	1.3	0.1	1.4
Southeast	2.1	1.6	3.7
South southeast	2.1	4.0	6.1
South	2.3	3.7	6.0
South southwest	2.3	3.5	5.8
Southwest	2.8	2.2	5.0
West southwest	2.5	0.7	3.2
West	2.1	0.5	2.6
West northwest	1.9	0.9	2.8
Northwest	3.0	4.7	7.8
North northwest	3.5	4.4	7.9

5.0 Odour Assessment

5.1 Complaint History

PDP has approached the NRC for information on whether there have been any odour complaints in relation to this site. NRC records state that there are no instances of any odour related complaints from the Russell WWTP. This lack of complaints would suggest that the current site systems and management are effective.

5.2 Odour Observation Methodology

The qualitative ambient odour monitoring methodology used in the assessment is a variation of the method described in the German Standard Verein Deutscher Ingenieure (VDI) 3940 "Determination of Odorants in Ambient Air by Field Inspections" (VDI Method). This is the method recommended in the Ministry for the Environment (MFE) Good Practice Guide for Assessing and Managing Odour in New Zealand and is commonly used in Australia and Europe for odour assessment.

5.2.1 Qualitative Odour Scout

The modified method used by PDP involved using a single 'field odour scout' to visit a selection of sites and sample the ambient air every 10 seconds for 10 minutes giving a total of 60 samples per location. The field odour scout recorded the intensity of the odour (according to a set intensity scale), the odour character (from a list of 40 various odour descriptors), the wind direction, the wind speed, any rainfall, and the time and date for every sample. The intensity scale is that described in the MFE Good Practice Guide and is listed in Table 4. The wind direction was determined and recorded by the field odour scout using a compass.

Table 3: Odour Intensity Scale

Intensity Level	Odour Intensity	Odour Description
0	No Odour	No Odour
1	Very Weak	Odour is difficult to smell and there is doubt as the whether the odour is actually present.
2	Weak	Odour is present, but the character is difficult to determine.
3	Distinct	The odour is present, and the character/source of the odour is recognisable.
4	Strong	The odour is present, and the character/source of the odour is obvious.
5	Very Strong	The odour is offensive. Exposure to this level would be considered undesirable.
6	Extremely Strong	Odour is overpowering inciting nausea.

5.3 Field Odour Investigation

A site investigation was carried out by PDP staff on 29 September 2023 to understand the level of odour, with odour observations undertaken from 8:45am to coincide with lower windspeeds. At the time of the observations wind speeds were low to moderate (all below 3 m/s), and PDP considers that these conditions were good in terms of undertaking odour observations.

Where odour associated with the WWTP was detectable the odour was classified as "very weak" to "distinct" and having a "sewage" type character (unpleasant). The odour detected around the discharge fields had "very weak" to "weak" musty odour (neutral), however it was unclear if the source of the odour was related to the WWTP operations or due to the damp conditions. Odour associated with the WWTP was only ever detected downwind of the site and the strongest odours were detected at the fence line of the SBR. However, this odour was infrequent and appeared to coincide with a pump operation.

However once away from the site the odour was weaker in intensity. As experienced with other similar odour sources, the odour became weaker and transient in nature the greater the distance from the source, and the odours associated with the WWTP were not detected more than 50 metres from the site, and no odour associated with the WWTP was detected at the road.

No odours that might be considered objectionable or offensive by members of the public were detected off-site. Overall, the odour from around the WWTP on the day of observations were low and consistent with the level of odour expected from a similar size operation.

6.0 Odour Assessment

It is generally accepted that odours associated with wastewater and the treatment of wastewater could be considered unpleasant by the general population if the source becomes septic, and therefore odour from these activities needs to be appropriately managed.

However, it is PDP's experience that even with all appropriate management techniques or mitigation measures in place there is the potential that from time to time odours may be detectable off-site. Consequently, PDP considers that it is appropriate to use the FIDOL assessment tool to determine whether the odours have the potential to be offensive and objectionable.

6.1 Frequency

Frequency relates to how often odours will be experienced at an off-site receptor. In terms of odour from the WWTP, odour emissions are generally constant however they have the potential to be higher during peak season (summer) or during certain activities such as removing sludge from the site. Therefore, the frequency at which odour could be detected at a neighbouring property will be a combination of the odour emission rate from the site and certain meteorological conditions, such as those which produce poor dispersion conditions.

As already mentioned, for odours to be experienced off-site these odour events have to occur during periods of poor dispersion, typically when wind speeds are below 3 m/s. Based on the meteorological data presented in Section 4.4, light winds (less than 3 m/s) capable of transporting odour, account for approximately 52 percent of all winds. The predominant low wind speeds occur from the northeast and occur approximately 9.4 percent of the time. Table 4 presents the frequency of low wind speeds in the direction of the nearby receptors and these range between infrequent and moderately frequent. Considering the variability and the limited hours of some of the higher potential odour emissions from the WWTP such as peak flows, the removal of sludge and screened material, the likelihood of appropriate wind conditions all occurring at the same time the frequency of odours experienced at these locations is further reduced.

Table 4: Frequency of low wind speeds in the direction of nearby receptors

Receptor Name	Downwind direction	Percentage of low windspeeds	Frequency of wind
R1	Northeast	9.4	Moderately Frequent
R2	East northeast	3.7	Infrequent
R3	Southeast	2.1	Infrequent

Notes:
1. *<5% infrequent, 5-12% moderately frequent, 12-20% frequent, >20% very frequent*

6.2 Intensity

Odour associated with WWTP can have a strong intensity and can be considered offensive and objectionable. However, based on the relatively small size of the Russell WWTP and that it is an activated sludge process with tertiary treatment the odour potential is reduced. During PDP’s observations the odour was detectable in light winds at a distance of up to 50 metres from the site and was described as having a very weak to weak intensity at this distance.

The intensity is also related to the wind conditions and the resulting level of dilution that occurs between the source and the receptor. In essence, the stronger the wind, the more dilution of odour will occur. Considering the distance of the site to the receptors, odour from WWTP should undergo some level of dilution, particularly before it reaches any dwelling. Additionally, the surrounding terrain is undulating and covered in dense bush which will help with increasing the level of dilution of an odour.

Given that the majority of the time the WWTP will only produce low odour concentrations, the surrounding activities will typically only experience low odour intensities. However, on occasion some activities such as sludge removal will occur which will result in higher intensity odour.

For the majority of the time, any odours that are generated are expected to be weak or indiscernible at or beyond the site boundary.

6.3 Duration

As discussed previously, odour associated with the WWTP, will generally have very low intensity off-site and is only detectable close to the WWTP itself. When sludge is being removed for off-site disposal there is an increased likelihood that odour could be detected further from the operational area.

As with frequency, the duration that anyone would be exposed to odour depends on the time the wind blows in a specific direction along with the duration that the activities occur. Typically, the duration that odour could be experienced off-site under normal day to day running of the WWTP will be short and intermittent. However, during other parts of the process such as removing sludge, which can take a up to an hour to complete, the duration of the odour event could be for extended periods. However, if these activities were to cause an issue, WWTP staff can undertake these activities during periods that would result in low off-site effects, such as undertaking this work during stronger winds (>3 m/s), preferably from the north.

6.4 Offensiveness

If strong wastewater type odours were experienced off-site, they could be considered offensive by a member of the public. However, as the receptors are at least 370 metres away from the WWTP operations, any odour should be diluted by the time it reaches any receptor, to the point that it is indiscernible.

Additionally, based on the NRC records for the site, there have been no odour related complaints from the Russell WWTP. Based on the odour observations undertaken by PDP, when odour was detected away from the primary and secondary processes, it had a weak intensity. Given the weak intensity the character was indiscernible character and therefore PDP considers that there will be no offensive odours off-site.

6.5 Location

To a large extent the location of the source in proximity to sensitive receptors is possibly the most important of the FIDOL factors. In this instance due to the fact that even if odours are generated there is little potential for adverse effect as there are no receptors close to the WWTP. In this case, PDP considers that the location of the site is well placed in terms of the distance to all the receptors being greater than 370 metres away.

Additionally, the area surrounding the WWTP is undulating and covered in dense bush. This will help with the mixing of any odour and therefore will result in an increase in dilution.

7.0 Conclusion

Having assessed the potential odour from the Russell WWTP discharge against the FIDOL factors, PDP considers that there is a low likelihood of off-site odour effects being categorised as objectionable and offensive at nearby receptor locations. This is based on the following:

- Based on the meteorological data for the area, the closest receptors would only be downwind of the Russell WWTP between 2.1 and 9.4 percent of the time which is considered infrequent to moderately frequent. As the odour emission rates from WWTP can be varied, there is an even lower probability of higher emissions rates occurring at the same time as low wind speeds blowing in the directions of these receptors.
- The intensity of the odour from the WWTP was typically very weak to weak close to the source, with the occasional distinct odours. Within 50 meters of the source the odour became indiscernible, or no odour associated with the plant was detected at all.
- The duration of the odour from a WWTP can vary, with events such as sludge or screened material removal which could up to an hour, however these activities would be infrequent. The normal background odours from a WWTP can be more constant, but based on PDP's observations and experience at other similar sources when approximately 10 to 50 meters from the source the odour becomes more intermitted as a result of wind fluctuations such as wind direction and wind speed changes.
- There have been no odour complaints received by the NRC for the site, which would indicate that the site operations and management is working well.

- The nearest receptors are located more than 370 metres from the WWTP. Purely on distance these receptors are unlikely to experience odours from the WWTP. Additionally the terrain between the WWTP and these receptors is undulating and covered with dense bush which will help mix and odour and therefore result in good dilution further reducing any odour potential.

Appendix J: Russell WWTP Operations and Maintenance Manual

RUSSELL WWTP OPERATIONS AND MAINTENANCE MANUAL

REV	DATE	DETAILS
1	11/10/2023	Issued For Comment

	NAME	DATE
Prepared by:	Phillip Shoebridge	29/09/2023
Reviewed by:	Reviewed By Larey-Marie Mulder	06/10/2023
Approved by:	Richard Pearson	11/10/2023

CONTENTS

1 INTRODUCTION

1.1 PURPOSE

The purpose of this manual is to standardise and document the way in which the treatment plant is run and allow people who are unfamiliar with the plant to quickly come up to speed with the process and the critical operations and maintenance tasks for the plant, this manual is intended to be a living document and should be updated anytime a significant change is made.

This manual also compliments the Russell WWTP management plan which outlines the way in which the plant is operated to fulfill its resource consent conditions.

1.2 MANUAL STRUCTURE

The manual gives background information and a description of the overall system and individual processes, followed by the way in which the plant operates, how the plant is monitored and required sampling for smooth operation and compliance, emergency response procedures, a troubleshooting guide, and critical maintenance tasks and frequencies.

1.3 LOCATION

The Russell wastewater treatment plant is located approximately 1 kilometre to the southeast of Russell Township, between Florence Avenue and Uruiti Road at 6140 Russell Whakapara Road, Russell 0272.

The site consists of the treatment plant, wetlands, disposal fields, and borders adjacent reserve blocks and the local landfill transfer station.

Figure 1 : Aerial photograph of the Russell WWTP

1.4 PLANT MANAGEMENT AND KEY PERSONNEL

The plant is managed and operated by Ventia under contract from the Far North District Council, the contract details for the key operations personnel are outlined below:

Matthew Arthur – (Alliance Manager) Mathew.arthur@ventia.com

Karl Schenker – (Operations Manager) karl.schenker@ventia.com

Johan Guy – (Treatment Manager) johan.guy@ventia.com 027 265 3871

Tommy Gordon – (Treatment Supervisor South) tommy.gordon@ventia.com 021 453 039

Ramati Kingi – (Treatment Operator/Plant Supervisor, Russell and Kawakawa) Raumati.Kingi@ventia.com 021 970 548

1.5 SITE ACCESS

Site access is from Russell Whakapara Road, via an accessway, the access way has a lockable farm style gate, the entire site has a perimeter farm style fence, and the treatment plant itself is surrounded by a 2.2 m high wire security fence with the only access via gates which are locked when the site is not attended. Keys to the site are held by all operators and senior Ventia staff. Ventia are responsible for issuing and controlling entry permits to the site, Ventia are also the controllers of the site induction process and ensuring visitors are aware of existing hazards and hazardous areas onsite.

Anyone requiring access to the site must do so by contacting Ventia and following Ventia's entry procedures.

All visitors to the site are to report to the plant operator and register in the visitor's logbook, visitors shall sign out in the logbook recording the time they have left the site.

1.6 HEALTH AND SAFETY

The main hazards that are encountered at the Russell WWTP are:

- Biological hazard from handling wastewater
- Hydrogen sulphide
- Methane gas
- Chemical exposure
- Working around water
- Slips trips and falls.
- Exposure to UV in the UV treatment area
- Rotating equipment
- Electrical hazards
- Noise hazards

For more information, please see the site-specific safety plan in Appendix A.

2 SYSTEM OVERVIEW

2.1 CATCHMENT AREA

The plant treats wastewater from the Russell and Tapeka Point communities, as well as a small volume of leachate from the Russell landfill. There are approximately 550 connections to the scheme. The area is a popular tourist destination that has a permanent population of approximately 800 people that can swell to 4000 during peak holiday times.

2.2 INFLUENT FLOW AND LOAD

The Russell WWTP receives wastewater from the Russell township and leachate form the adjacent landfill. The wastewater is pumped into the plant from a single rising main, and the leachate is pumped from a leachate buffer tank to a constructed wetland, and then on to the WWTP via connection to the main inlet rising main.

The SBR reactors also receive recycled wastewater from various sources around site via the site waste return system.

Trending of historical data shows that the incoming total daily flows can range from 200 m^3/day to 1650 m^3/day, plant is consented to discharge 1235 m^3/day of treated wastewater.

2.3 PROCESS OVERVIEW

The Russell wastewater treatment plant is based on a sequential batch reactor (SBR) activated sludge process the plant consists of the inlet works, sequential batch reactors (SBRs), pressure filter system, UV Disinfection system, sludge handling system, wetlands, and a borehole disposal system. Figure 2 below shows the current configuration of the Russell WWTP.

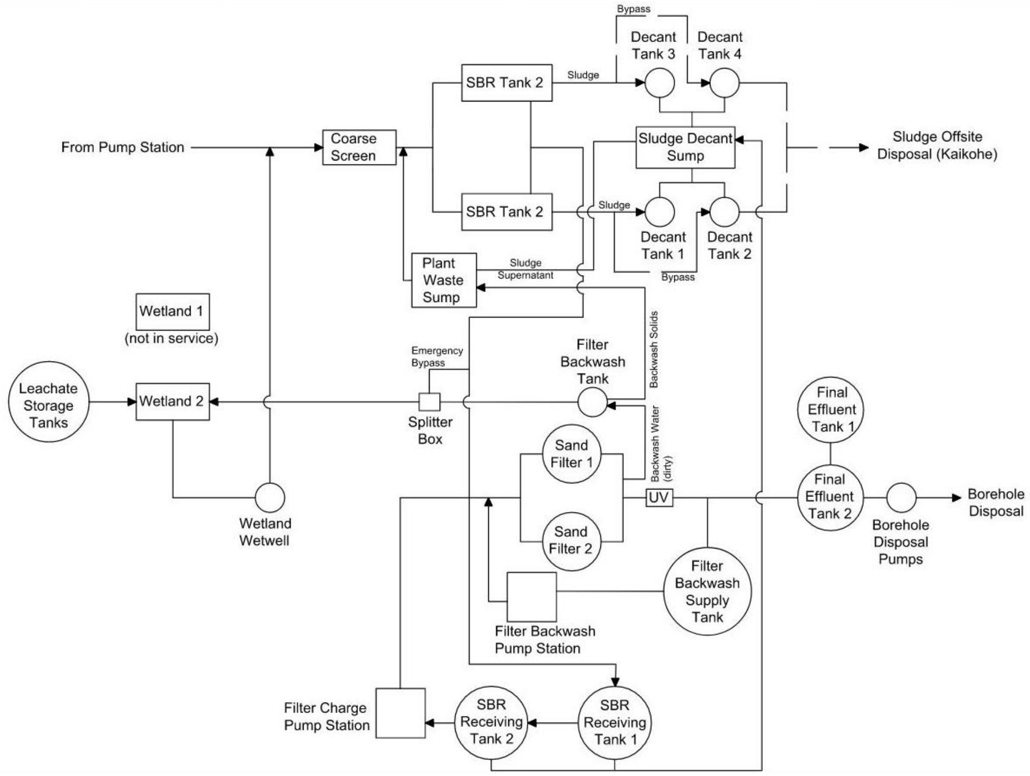


Figure 2 : Current configuration of the Russell WWTP

2.3.1 INLET WORKS

Drawing Reference: P&ID 2, 3, and 4

The wastewater from the surrounding catchment area as well as the water pumped from wetland 2, which contains filter backwash water and landfill leachate joins a common rising main before being sent to the rotary inlet screen on top of SBR 1.

The SBRs also receive incoming wastewater from the plant waste sump which collects the decant from the sludge tanks, and sludge from the filter backwash tank. The plant waste sump riser bypasses the inlet rotary screen and goes straight to the outlet channel of the screen.

Hope Avenue is the terminal pump station in the Russell wastewater reticulation. Two pumps pump the raw wastewater to the WWTP.

The Hope Ave pump station has a capacity of is 21 l/s with one pump running. The pumps pumping from the wetland wetwell have a capacity of 7.7 L/s running one pump, and 12.5 l/s running two pumps.

Trending of historical data over 12 months shows that peak flows instantaneous flows to the to the plant were 18 L/s.

2.3.2 SEQUENTIAL BATCH REACTORS

Drawing Reference: P&ID 2, and 4

Screened influent and incoming wastewater from the plant waste sump enter the SBR influent splitter box and flow to the filling SBR.

The wastewater is treated in the SBR via an activated sludge process for the removal of organics and ammonia.

The dimensions of SBR tanks are as follows:

- SBR 1 - 14m x 4.4m x 6.2m.
- SBR 2 – 14m x 5.8 x 6.2m

The SBR reactors go through a sequence of steps (Filling, Settling, Decanting, and Idling), during the filling step air is introduced via up to two of three blowers to supply oxygen to the biomass and promote mixing, once full the SBR enters a settling phase after which the clarified supernatant water is decanted from the SBR by way of a decanter arm, and sent down stream to storage tanks.

Waste activated sludge is periodically removed from the bottom of the SBR tanks to the sludge settling system.

There are several parameters which are important to the SBR activated sludge process. These are:

- **Mixed liquor suspended solids (MLSS**), this is a measure of the living and dead solids in the reactor related to the biomass, as well as any non-biomass suspended solids such as high molecular weight organics or inorganic particles (dust, grit etc). The level of MLSS gives an indication of the concentration of biomass in the system, and should be between 1500 and 3000 mg/L. This concentration is controlled through removing sludge from the reactor by varying the wasting rate.
- **Sludge Retention Time (SRT)**, this is a function of the waste activated sludge volumes and the total sludge inventory of the reactors. This should usually be 15 days with a minimum of 7 days to allow time for the denitrification process.
- **Sludge settling test,** Sludge settling is an indicator of how well the sludge settles in the SBR tanks. Typically, good settling results would be less than 500mL in a 1000mL measuring cylinder after 30 minutes.
- **Sludge Volume Index (SVI)** this is a measure of the sludge settleability that is estimated by dividing Sludge Settling Test results (in mL/L) by MLSS (in g/L). A result less than 120 is desired and indicates

a good settling sludge, above 150 indicates poorly settling sludge and is indicative of filamentous growth.

- **pH,** for a healthy biomass the pH should ideally be between 7 and 8.5.
- **Dissolved Oxygen (DO),** Oxygen is required for the survival and the biomass and its metabolic processes, ideally this is in the range of 1 to 2.5 ppm.

2.3.3 SBR SUPERNATANT RECEIVING TANKS

Drawing Reference: P&ID 2, and 5

The decanted effluent from the SBR units goes into a series of two supernatant receiving tanks, these tanks automatically purge settled solids from the bottom of them back to the site sludge system decant sump, the supernatant from the SBRs flows first into tank 1 and then into the second tank via a mid-level connection between the two tanks.

There is an outlet on the bottom of the second tank which is the pump suction for the pressure filter charge pumps, the pumps are on off level control with variable speed driven by a turbidity meter in the suction, there is an overflow from the tanks to the wetlands via the pressure filter back wash receiving tank and then the SBR flow splitter, the capacity of each SBR supernatant receiving tank is: 30 m^3.

2.3.4 FILTERS AND UV

Drawing Reference: P&ID 2, 7, and 8

Two pressure sand filters operate in parallel. The media depth in the filters is 1.22m, and each filter has a diameter of 2.47m. The filters were initially designed as multi-media filters, but the plant operation has converted the filters to single media filters for better operating efficiency.

The filter operation is fully automatic, and the backwash sequence is automatically initiated based on differential pressure readings from either filter. Backwash water is supplied from a dedicated backwash water supply tank and pump.

The dirty backwash water is sent to the filter backwash tank, which has a storage capacity of $20m^3$. The backwash solids are drained to the plant waste sump, and the liquid is sent to the SBR flow splitter and on to the wetlands.

The filtered water flows into an open UV channel (Trojan UV 3000 PTP), where disinfection takes place. The UV unit operates at a maximum capacity of 14 l/sec. Effluent from the UV channel discharges into the final backwash water supply tank, and the final effluent tanks, a vertical dropper in the line prior to the final effluent tanks means that the backwash water supply tank fills first and once full then the full flow will automatically pass to the final effluent tanks.

2.3.5 CONSTRUCTED WETLANDS

Drawing Reference: P&ID 2, and 6

There are two wetlands, only wetland two is in service, wetland one is undergoing conversion to a flow balancing system for influent wastewater, however that is not completed, therefore this manual will require an update when it is completed later. This area of each wetland is.

Wetland one - $894m^2$

Wetland two - $596m^2$

Wetland two receives the leachate from the adjacent landfill, and at times may also receive pressure filter backwash water, and overflow from the SBR supernatant receiving tanks, or directly from the SBRs themselves if the SBR receiving tanks are out of service.

There is a pump station at the outlet of the wetlands, in which two submersible pumps one duty pump and one assist pump transfer the effluent to tie into the Hope Avenue rising main then on to the inlet of the wastewater treatment plant. The capacities of the pumps are:

- One pump running - Duty pump - 28m^3/h
- Two pumps running Duty plus assist pump - 45m^3/h

2.3.6 DISPOSAL BORES

Drawing Reference: P&ID 8, and 9

UV effluent is collected in the final effluent tanks. This is pumped by three borehole pumps to the disposal boreholes, which are grouped into three areas A, B and C, each with a dedicated rising main and pump. Each bore area has several bore groups that can be operated independently to one another.

2.3.7 SLUDGE HANDLING

Drawing Reference: P&ID 2, and 10

Each SBR tank has a dedicated sludge decant and storage tank, each with a storage volume of 23m^3. Sludge produced during the operation of the SBRs is directed into the sludge decant tanks.

Sludge undergoes consolidation in the sludge decant tanks, and the supernatant is discharged into the sludge decant sump before the liquid is drained to the plant waste sump for returning to the SBR tanks. The withdrawal of the supernatant is automatic via floating decanter assembly within the tanks. The consolidated sludge from the sludge decant tanks is transferred to the downstream sludge storage tank via an air-lift pump.

The sludge in the sludge storage tanks undergoes further consolidation and thickening, where the supernatant is manually decanted into the sludge decant sump. The settled sludge in the storage tanks is transported offsite for further processing and disposal.

2.3.8 CRITICAL PROCESS CONTROL POINTS

Table 1 below outlines the critical process control points that must be maintained for the plant to run effectively and meet its consented discharge water quality conditions. Table 2 below outlines the consented discharge water quality parameters, if any values fall outside the ranges in Table 1 or 2 below then corrective action must be taken to maintain the effectiveness of the treatment plant and compliance with the resource consent.

To assist in recovering from a process upset or a discharge water quality result outside of the consented water parameters please follow the trouble shooting guide in the trouble shooting section of this manual.

Table 1 : Critical process control parameters

Critical Control Points			
Location	**Parameter**	**Values**	**Reasons**
Influent	pH	7.0-8.5	Extreme pH values may affect biological processes
Influent	Flow	TBA (requires process modeling)	Potential overloading of plant
SBRs	pH	7.0-8.5	Extreme pH values may affect biological processes.
SBRs	DO	> 1.5mg/L (when aerated)	Required for ammonia and organic oxidation

SBRs	MLSS	1,500-3,000mg/L	Optimum concentration for activated sludge process
SBRs	SVI	50-150mg/L	For good settling SVI should be < 150mg/L
Post Filtration	Ammoniacal Nitrogen	< 5.0mg/L	Indicates good nitrification
Post Filtration	Turbidity	< 5.0 NTU	Elevated level will offset UV performance
Post Filtration	UV Transmissivity (UV-T)	>50%	UV performance will be affected if UV-T falls below this percentage
Post Filtration	UV flow rate	< 14L/sec	Higher flow rates will compromise the performance of the UV disinfection

Table 2 : Consented water quality discharge limits

Parameter	**Discharge Limits**	
	Rolling Median	**Rolling 90th percentile**
Five Day Biochemical Oxygen Demand, BOD_5 (mg/L)	10	25
Suspended Solids, TSS (mg/L)	10	25
Total Kjeldahl Nitrogen (mg/L)	20	40
Total Phosphorus (mg/L)	15	20
E coli (cfu/100mL)	50	1000 (Max)

3 OPERATING PHILOSOPHY

3.1 INFLUENT & INLET WORKS

3.1.1 REFERENCE P&IDS

P&ID 2, 3, & 4

3.1.2 FUNCTIONAL DESCRIPTION

The raw wastewater is pumped form the Hope Avenue pump station (2 pumps duty/standby) at a maximum rate of 21 l/s (one pump) into the main rising main. The wetwell pumps operate on a VSD controlled by the level.

This is joined by leachate, filter backwash water, and collected rainwater which is pumped form wetland two via the wetland wet well (T-09) at up to 12.5 l/s.

The combined inflow is discharged into a rotary inlet screen E-1 on top of SBR 1, the screen operates when a flow is measured at the flow meter in the rising main (FM-01) the screenings are manually raked into a chute and collected in a bag for disposal the screened effluent from the rotary screen is sent to a flow splitter (T-05) on top of SBR 1.

The plant waste sump (TK-04) which is located behind the blower shed collects water from the site sludge tanks (T-01 to T-04), via the sludge decant sump (T-18), sludge from the filter back wash tank (TK-10), and sludge from the heel of the SBR receiving tanks (TK-1 and TK-2). The plant waste sump has a temporary submersible pump that operates on, on off level control and pumps the site waste via a dedicated riser that joins the incoming screened wastewater downstream of the rotary screen on SBR 1 this flow rate is not measured.

The combined flow from the screened incoming wastewater and the site waste sump flows from the flow splitter into either SBR1 or SBR2, the selection of SBR is controlled by a valve on the inlet to SBR 1, when the valve to SBR 1 is closed the water flows over a weir to fill SBR2, when SBR2 is full the valve on SBR 1 opens and the water flows to SBR1, this is further detailed in the SBR section.

Figure 3 : Plant waste sump

Figure 4 : Inlet rising main and incoming effluent flowmeter FM01.

Figure 5 : Rotary inlet screen

3.1.3 EQUIPMENT

Description	Tag
Plant Waste Sump	TK- 04
Plant Waste Pump	P-02
Rotary Inlet Screen	E-01
Influent Flow Splitter	T-05
Screenings Bin	N/A

3.1.4 INSTRUMENTATION

Description	Tag
Main plant influent flowmeter	FM-01

3.1.5 SETPOINTS

Setpoint	Instrument	Typical Value
N/A	N/A	N/A

3.1.6 ALARMS

Description	Instrument	Alarm Setpoint
Screen Jammed Alarm	N/A	General SBR Fault

3.2 SEQUENTIAL BATCH REACTORS

3.2.1 REFERENCE P&ID

P&ID 2, and 4

3.2.2 FUNCTIONAL DESCRIPTION

The screened influent and plant waste return exit the flow splitter to SBR 1 and 2, the flow is directed to either SBR1 or SBR2 via opening and closing of valve IV01 which is a butterfly valve on the outlet of the flow splitter in the dropper that goes into SBR 1, the butterfly valve is controlled on the level of the SBRs.

The SBRs treat the wastewater via an activated sludge process and run through a fully automated sequential cycle.

The cycle consists of four steps, react (fill and aerate), settle, decant, and idle.

- **REACT (Fill and Aerate)**

The influent flow splitter has two weir plates, one is lower than the other, the lower weir directs the flow to SBR 1, when SBR 1 is full the butterfly valve IV01 on the outlet to SBR 1 closes and, the weir box fills and overflows to SBR 2.

To aid in the biological process oxygen is supplied to the SBRs. The bottom of each SBR tank has a network of air diffusers, there are three blowers that supply the air to the SBR tank diffusers, there are two large blowers that are used in a duty/standby arrangement and one smaller blower that is used together with a large blower or alone, as required.

At the start of the SBR filling step the blowers supply the filling SBR with air at a constant high rate before reverting to dissolved oxygen (DO) control once reaching an operator set level, a VSD ramps the speed of the blowers up and down depending on how close or far away they are from the DO target. Operators can adjust the DO target depending on the season, during winter the typical value is 1.5 ppm, and in summer when there are high loads and high average flows the target is 4 ppm.

The active blowers can be selected via the plants control system. During summer either one large blower operates, or one large plus one small operate together. During winter generally one small blower or one large blower is sufficient depending on the load. The blowers contain internal fault monitoring that will shut the blower down and raise an alarm in on the SCADA should the blower encounter a fault.

There is a DO low level alarm that will be triggered if the DO drops below a preconfigured set point.

The air supply to each SBR is selected via air actuated valves AV01 and AV02, air is also supplied from the blowers to the sludge tanks the sludge tanks have no control over the blower system.

As well as DO probes, each SBR tank also has a pH probe for process monitoring.

- **Settling**

When the level in the filling SBR tank reaches the high level setpoint (SBR High Level), the influent valve from the flow splitter to SBR1 (IV01) will open or close to switch from one SBR to the other. The SBR that was filling will now enter the settling phase.

- **Decant**

Each reactor has an automatic decanter which lowers during the decant phase to decant the clarified treated wastewater (SBR supernatant).

The decant phase is started when the filling of the other SBR reaches a level setpoint, when this setpoint is reached the decanter will rapidly lower from its position 100 mm above the water's surface, to the water's surface and decanting will begin, the decant arm will continue to drop at a set decant rate.

The decant arm continues to drop until the decanting reaches it decant low limit. The low limit is set by the liquid level not by the level of the decanter, during lowering the decanter level and the water level is monitored, if there is a discrepancy between the two the decanter will stop and raise and alarm in the SCADA.

The level in the filling SBR that starts the decant cycle in the settling SBR is a critical parameter that may need to be manually adjusted depending on incoming flows to allow maximum settling of the settling SBR to achieve the best possible water quality.

The combined discharge from both reactors is sent to the SBR supernatant receiving tanks.

- **Idle**

After the decant phase the SBR enters the Idle phase whilst the other SBR is still filling, during the idle phase the SBR receives intermittent aeration from the blowers to prevent the settled sludge from going anerobic, this intermittent aeration is set for 30 seconds every 60 minutes.

Figure 6 : SBR Reactor 1

Figure 7 : SBR Reactor 2

Figure 8 : Weir box influent splitter (T-05) and valve IV01 at inlet to SBR 1

Figure 9 : Decanter SBR Reactor 1

Figure 10 : Decanter SBR Reactor 2

Figure 11 : The three aeration system blowers

3.2.3 EQUIPMENT

Description	Tag
Inlet flow splitter	T-05
SBR Inlet valve	IV-01
SBR 1 Tank	SBR 1
SBR 2 Tank	SBR 2
Blower 1	P-3
Blower 2	P-4
Blower 3	P-5

SBR1 Air system control valve	AV-01
SBR2 Air system control valve	AV-02
SBR 1 Decanter	E-2
SBR 2 Decanter	E-3

3.2.4 INSTRUMENTATION

Description	Tag
Blower system air pressure	PI-14
SBR 1 Dissolved Oxygen Probe	DOIT-04
SBR 2 Dissolved Oxygen Probe	DOIT-09
SBR 1 pH Probe	pHIT-05
SBR 2 pH Probe	pHIT-10
SBR 1 Level Transmitter	LT-06
SBR 2 Level Transmitter	LT-11
SBR 1 Decanter Level	TBA
SBR 2 Decanter Level	TBA

3.2.5 SETPOINTS

Setpoint	Instrument	Typical Value
SBR 1 High Level	LT-06	5720 mm
SBR2 High Level	LT-11	5720 mm
SBR 1 Low Level	LT-06	5240 mm
SBR2 Low Level	LT-11	5240 mm
SBR 1 Decant Trigger Level	LT-06	5400 mm
SBR 2 Decant Trigger Level	LT-11	5400 mm
SBR Settling Time 1 & 2		20 minutes
SBR 1 DO Setpoint	DOIT-04	1.5 to 4 ppm
SBR 2 DO Setpoint	DOIT-09	1.5 to 4 ppm
Frequency of blower operation during idle phase (DN Interval Time)		60 minutes
Duration of blower operation during idle phase (DN Pulse Time)		30 seconds

3.2.6 ALARMS

Description	Instrument	Alarm Setpoint
SBR 1 Low dissolved oxygen alarm	DOIT-04	TBA
SBR 2 Low dissolved oxygen alarm	DOIT-09	TBA
Decanter level vs water level mismatch	N/A	200 mm
Decanter level over torque	N/A	General SBR fault Alarm

3.3 CONSTRUCTED WETLANDS AND LEACHATE STORAGE

The wetlands were originally intended to be the receiving area for the SBR decant, this would then be sent to the pressure filters for treatment prior to borehole disposal, however the wetlands are no longer used in this way, this manual and attached P&IDs describes the way in which the plant currently operates.

There is a proposal and pipe work in place so that in future wetland one will be used as a balancing pond for screened incoming wastewater, however this line up is not completed and is not in use.

Should the way in which the wetlands are used change in future then an update to this manual and the P&IDs will be required.

3.3.1 REFERENCE P&ID

P&ID 2, 3, and 5

3.3.2 FUNCTIONAL DESCRIPTION

Wetland 1 is currently not in service and there is no water being sent to wetland one, however rainwater is pumped out of wetland 1 via the wetland wetwell when required.

Wetland 2 receives the leachate from the landfill leachate storage tank (TK-009), the landfill leachate is pumped from the landfill leachate storage tank from a submersible pump which has an on off switch based on the level of the tank. Leachate volumes are monitored via a totaliser at the leachate storage tank FT-01.

Wetland 2 may also receive the pressure filter backwash wastewater from the backwash wastewater tank (TK-10), lastly wetland 2 receives SBR decant whenever the SBR supernatant receiving tanks are bypassed or if they are full and overflow via the SBR receiving tanks overflow.

Each wetland has a collection sump (TK-18 & TK-19), and each collection sump has two outlets at different levels to control the level of water in the wetlands, (V-12 & 13 wetland 1, V-14 & V-15 wetland 2).

The top outlet from each collection sum has a skimmer. From the wetlands the sumps drain to manholes and then to the wetland wetwell TK-09. the wetland wetwell has two pumps that operate in duty assist arrangement.

Leachate from the adjacent landfill is pumped from the leachate storage tank (TK-009) and into wetland 2, in wetland 2 it combines with any filter backwash water, SBR decant water, and rainwater, and is pumped via the wetland wet well via either one pump in duty at 8 l/s, or two pumps as duty assist at 12.5 l/s. Pump operation is level controlled by a level sensor in the wetland wetwell (LS-16).

When the level in the wetland wetwell reaches a high level setpoint (Wetland Wetwell High Level) the duty pump will start. The assist pump will start if the water level reaches the high high level setpoint (Wetland Wetwell High High Level). Both pumps will stop when the low-level set point is reached (Wetland Wetwell Low Level).

Figure 12 : Leachate Storage Tank (TK-009)

Figure 13 : Wetland 1

Figure 14 : Wetland 2

3.3.3 EQUIPMENT

Description	Tag
Wetland 1 (not in service)	TK-07
Wetland 2	TK-08
Wetland 1 collection sump (not in service)	TK-18
Wetland 2 collection sump	TK-19
Wetland 1 level control valves	V-12 & V-13
Wetland 2 level control valves	V-14 & V-15
Wetland Wet Well	T-09
Leachate Storage Tank	TK-009
Leachate Pump	P-01

3.3.4 INSTRUMENTATION

Description	Tag
Wetland Wetwell Level Transmitter	LS-16
Leachate Flow Totalizer	FT-01

3.3.5 SETPOINTS

Setpoint	Instrument	Typical Value
Wetland Wetwell High Level	LS-16	40% full
Wetland Wetwell High High Level	LS-16	60% full
Wetland Wetwell Low Level	LS-16	20% full
Wetland Wetwell Level Alarm	LS-16	70% full

3.3.6 ALARMS

Description	Instrument	Alarm Setpoint
Wetland Wet Well	LS-16	70%

3.4 SBR SUPERNATANT RECEIVING TANKS

3.4.1 *REFERENCE P&ID*

P&ID 2, and 5

3.4.2 *FUNCTIONAL DESCRIPTION*

The supernatant treated effluent from the SBR tanks is decanted and flows via gravity to the SBR supernatant receiving tanks.

A single manual selection valve in the common line from the SBRs can switch the SBR supernatant flow from the SBR supernatant receiving tanks, to the wetlands in the case of the SBR supernatant receiving tanks needing to be bypassed.

The decanted supernatant from SBR 1 and SBR 2 flows to the first SBR receiving tank 1, and then on to the second SBR receiving tank 2 by way of a connection between the two midways up the sides of the tanks. Both receiving tanks have sludge drains near the bottom of the tanks that are operated by air actuated valves. Five minutes into the decant cycle the drain on SBR supernatant receiving tank one opens for several seconds to drain any accumulated sludge that has been received with the SBR supernatant liquid, the second SBR supernatant receiving tank sludge drain is operated on a cyclic timer every 20 to 30 minutes and drains for 6 seconds. Both sludge drains are sent to the site sludge decant sump T18.

There is a second connection between the two tanks near the tank bottoms, which is normally closed but can be opened to assist in sludge equalisation between the tanks.

A suction from the second SBR supernatant receiving tank 2 delivers the treated supernatant water to the pressure filter charge pumps (P-001 A and B) these pumps are on an auto cycling duty selection. The switching on and off of the sand filter charge pumps is controlled by the level transmitter (LT-001) in SBR supernatant receiving tank 2, the pumping rate is controlled by a turbidity transmitter (TT-001) in the pump suction, the pumps are VSD controlled, if the turbidity is below a predetermined maximum set point the pumps begin to ramp up speed, if the turbidity set point is exceeded the pumps ramp their speed down until the turbidity is below the predetermined set point, the pumps continue to ramp up and down based on the turbidity in the pump suction whenever the pumps are operating and feeding the pressure filters.

The SBR supernatant receiving tanks have an overflow on SBR receiving tank 1 that connects to the sand filter backwash tank and is subsequently sent to the wetlands.

Figure 15 : SBR Receiving Tank 1 (Left) & Tank 2 (Right), with pressure filter charge pump house (far left)

Figure 16 : Pressure filter charge pumps (P-001 A/B)

3.4.3 EQUIPMENT

Description	Tag
SBR supernatant Tank 1	TK-1
SBR supernatant Tank 2	TK-2
Sand Filter Charge Pumps A/B	P-001
SBR supernatant Tank 1 Sludge outlet Valve	AV-138
SBR supernatant Tank 2 Sludge outlet Valve	AV-139

3.4.4 INSTRUMENTATION

Description	Tag
SBR Supernatant Receiving Tank 2 Level Transmitter	TBA
Pressure filter charge pumps suction turbidity meter	TT-001

3.4.5 SETPOINTS

Setpoint	Instrument	Typical Value
SBR Supernatant Tank 2 Pump Start Level	LT-001	60%
SBR Supernatant Tank 2 Pump Stop Level	LT-001	20%
Maximum suction turbidity	TT-001	Variable

3.4.6 ALARMS

Description	Instrument	Alarm Setpoint
N/A	N/A	N/A

3.5 FILTERS

3.5.1 REFERENCE P&ID

P&ID 2, and 7

3.5.2 FUNCTIONAL DESCRIPTION

The outlet of the SBR supernatant receiving tanks is pumped to two pressure sand filters. The pressure sand filters operate in parallel.

— **Service Cycle**

During the service cycle effluent from the SBR supernatant receiving tanks flows in through the top of the sand filters with the flow being controlled by the level in SBR supernatant receiving tank 2 and the suction turbidity from SBR supernatant receiving tank 2 Giving and average normal flow rate of 28 to 29 m^3/h (the filtered water exits the sand filters and is sent for UV treatment for disinfection).

— **Filter Backwash Cycle**

The differential pressure (DP) across filters is measured by pressure sensors on each unit (PDIT21 & PDIT22), once the DP reaches 25 kPa on either filter, the filters automatically go into a backwash cycle, although the filters are run in service in parallel, the backwash is completed sequentially, first filter one and then filter two.

The filter back wash contains four steps:

- **Step 1 –** Once the DP setpoint of either filter reaches the maximum setpoint the filters beginning the backwash cycle by draining down. The drain down of the filters is time controlled.
- **Step 2 –** At the end of the drain down step, there is an air scour step to assist in cleaning of the material from the beds, this step runs for a preset time (Filter air scour time)
- **Step 3** – In this step the filters are backwashed by pumping water from the dedicated backwash water supply tank via the filter backwash water supply pump the backwash water supply tank has a low level setpoint, provided the tank level is above the low level set point the filter back wash pump will start at the start of the backwash step and run on a fixed speed, if the filter backwash tank falls below the low level setpoint the pumps will stop to protect the pumps from running dry.. The backwash water enters the filters through the bottom and exits through the top taking accumulated debris with it, the dirty back wash water is sent to the filter backwash tank (TK-10) and subsequently to the wetlands.
- **Step 4** – Following the completion of the backwash step on the first filter the second filter will enter the backwash cycle.

— **Manual Bypass**

Under exceptional circumstance where the filters are not operational, the pressure filters can be manually bypassed. This means that effluent from the SBR supernatant receiving tanks is pumped directly to the UV channel.

The bypass is initiated by closing the filter inlet control valve VV-01, and opening valve VM-042.

Using the manual bypass results in the potential for poor quality effluent to be sent to the bores and the potential for a resource consent breach.

— **Filter backwash tank**

Dirty backwash water is collected in the filter backwash tank (TK-10), via actuated valve VV03. The filter backwash tank is located next to the filter building.

The level in the backwash tank is controlled by a fixed weir, which discharges the filter backwash water to the wetlands.

Accumulated sludge is removed via an outlet on the bottom of the tank and sent to the site sludge decant sump.

Figure 17 : Backwash water supply tank (left) and Backwash supply pump house (right)

Figure 18 : Backwash water supply pump

Figure 19 : Pressure filters 1 (foreground) and 2 (background)

Figure 20 : Filter backwash tank TK-10

3.5.3 EQUIPMENT

Description	Tag
Filter 1	E-04
Filter 2	E-05
Filter Backwash Water Supply Tank	TBA
Filter Backwash water supply pump	TBA
Filter Backwash Tank	TK-10
Filter inlet control valve	VV-01
Filter Manual Bypass valve	VM-42

3.5.4 INSTRUMENTATION

Description	Tag
Differential Pressure Indicator Filter 1	PDIT-21
Differential Pressure Indicator Filter 2	PDIT-22
Filter Backwash Water Supply Tank Level	TBA

3.5.5 SETPOINTS

Setpoint	Instrument	Typical Value
Filter 1 Differential Pressure	PDIT-21	25 kPa
Filter 2 Differential Pressure	PDIT-22	25 kPa
Filter Drain down time Filter 1 & 2		60 sec
Filter air scour time Filter 1 & 2		300 sec
Filter backwash supply water tank low level	TBA	20%
Filter backwash supply water tank high level	TBA	60%

3.5.6 ALARMS

Description	Instrument	Alarm Setpoint
Differential Pressure Filter 1	PDIT-21	TBA
Differential Pressure Filter 2	PDIT-22	TBA

3.6 UV STERILISATION

At the time of writing this manual there is a pending upgrade to come for the UV serialisation part of the process, however this manual is based on the current operation of the plant. In future when the changes are made to the UV steriliser this manual will need to be updated.

3.6.1 REFERENCE P&ID

P&ID 2, and 8

3.6.2 FUNCTIONAL DESCRIPTION

Filtered water from the pressure filters passes through the UV channel before entering the backwash water supply tank first, and then the final effluent tanks (TK-12 and TK-31).

The backwash water supply tank is filled first so it receives the best quality of water at the start of the pressure filter run.

The UV unit has its own control and monitoring system which operates the lamps and ballast and monitors the UV lamp intensity. There is no alarm from the UV control system to the Plant SCADA.

The effluent flow rate discharged from the plant is measured by flowmeter FT-24, located immediately prior to the UV channel. The final effluent turbidity is monitored by a turbidity analyser (Turb26). There is no alarm on the turbidity.

Figure 21 : UV Channel

3.6.3 EQUIPMENT

Description	Tag
UV Channel	E06
Automatic sampler valve	V30
Effluent Tank 1	TK-12
Effluent Tank 2	TK-31

3.6.4 INSTRUMENTATION

Description	Tag
Final effluent flow meter	FT-24
UV Light intensity	UV-25
Turbidity meter	Turb26
Final effluent Tank 1 Level	LT-27
Final Effluent Tank 2 Level or Level Switch	LS-28

3.6.5 SETPOINTS

Setpoint	Instrument	Typical Value
UV Light intensity	UV-25	Is not functional
Turbidity meter	Turb26	TBA
Final effluent Tank 1 Pump Start	LT-27	60%
Final effluent Tank 1 Pump Stop	LT-27	20%
Final Effluent Tank 2 Pump Start	LS-28	60%
Final Effluent Tank 2 Pump Stop	LS-28	20%

3.6.6 ALARMS

Description	Instrument	Alarm Setpoint
Final effluent Tank 1 High Level	LT-27	TBA
Final Effluent Tank 2 High Level	LS-28	TBA

3.7 BOREHOLE DISPOSAL

3.7.1 REFERENCE P&ID

P&ID 2, 8, and 9

3.7.2 FUNCTIONAL DESCRIPTION

Three final effluent tanks collect the plants treated wastewater, however one of these tanks is used for backwashing the plants pressure filters, and the remaining two tanks TK-12 and TK-31 are used as storage prior to sending the water to the boreholes for disposal.

Each borehole area has a dedicated rising main and disposal pump:

- Bore pump 1 (BP-001) pumps effluent to area A.
- Bore pump 2 (BP-002) to area B.
- Bore pump 3 (BP-003) to area C.

The starting and stopping of the pumps is controlled by the level transmitters in in the effluent tanks TK-12 and TK-31.

There is a manual valve arrangement on the pump discharge pipework that allows the operator to line up the disposal bores with the disposal pumps as required. There are also pneumatically operated valves that are operated from the control room to choose which disposal group bore area will be used.

The operating borehole disposal area is selected in the control room, which bore is being used is selected based on the resource consent conditions.

Under normal operating conditions effluent is discharged to a bore area for a period of 8hrs each, however this depends on the pressure in the bores.

The manual switches are shown in Figure 22, where bore set 1, 2 and 3 correspond to bore areas A, B and C respectively.

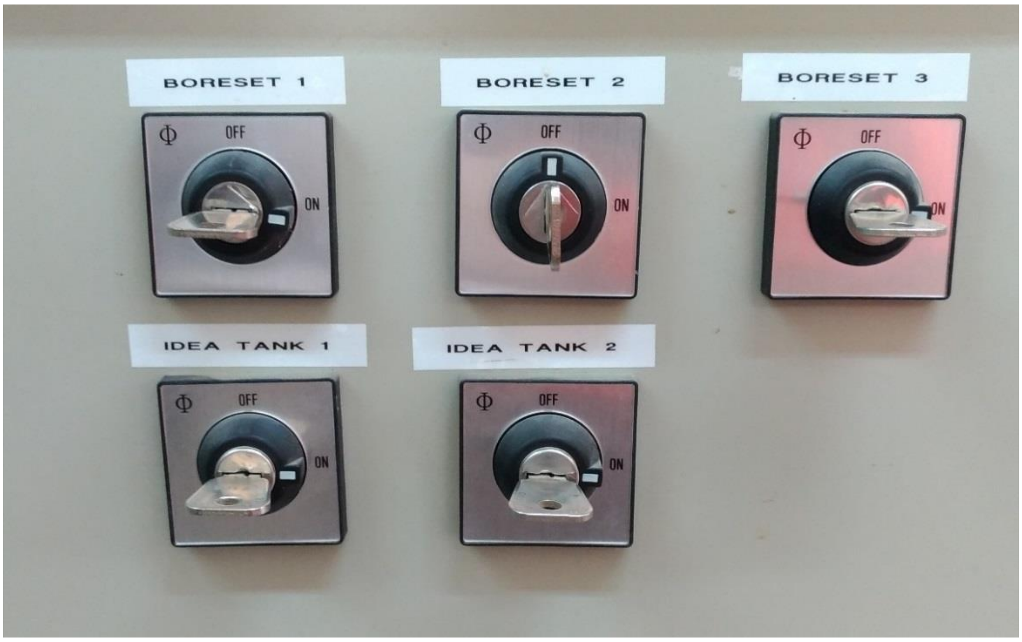


Figure 22 : Borehole Disposal Area Switches

Each bore area includes several sets of bores in a group, flow to each group is designed to be controlled by an electrically actuated group valve. Depending on the bore area each bore group includes between 5-8 individual boreholes.

Each individual borehole has a diaphragm valve that closes off when the bore becomes full and reaches a preset pressure. Once all bore holes in a group are full the water is sent to the next available bore group in the bore area, the discharge to the bore area will shut down after 8 hours or will trip based on bore area rising main pressure whichever comes first.

Each individual borehole as well as each borehole group has its own flow meter (totaliser).

Figure 23 : Borehole Disposal Pumps

3.7.3 EQUIPMENT

Description	Tag
Bore Pump 1	BP-001
Bore Pump 2	BP-002
Bore Pump 3	BP-003
Bore Disposal Area A (Bore groups A to D)	Bore Area A
Bore Disposal Area B (Bore Groups E to L)	Bore Area B
Bore Disposal Area C (Bore Groups M & N)	Bore Area C

3.7.4 INSTRUMENTATION

Description	Tag
Bore Pump 1 Discharge Pressure Indicator	PI-29
Bore Pump 1 Discharge Pressure Transmitter	PT-30
Bore Pump 2 Discharge Pressure Indicator	PI-32
Bore Pump 2 Discharge Pressure Transmitter	PT-33
Bore Pump 3 Discharge Pressure Indicator	PI-35
Bore Pump 1 Discharge Flow Switch	FS-31
Bore Pump 2 Discharge Flow Switch	FS-34
Bore Disposal Area A (Bore groups A to D) Flow Indicator	TBA
Bore Disposal Area B (Bore Groups E to L) Flow Indicator	TBA
Bore Disposal Area C (Bore Groups M & N) Flow Indicator	TBA
Bore groups A to N flow indicators	TBA

3.7.5 SETPOINTS

Setpoint	Instrument	Typical Value
Borehole Disposal Area A – Borehole Disposal Groups (A-D) Individual Bore Set Pressure	PT-30	9.4 kPa
Borehole Disposal Area B – Borehole Disposal Groups (E-L) Individual Bore Set Pressure	PT-33	11.0 kPa
Borehole Disposal Area C – Borehole Disposal Groups (M-N) Individual Bore Set Pressure	N/A	9.4 kPa

3.7.6 ALARMS

Description	Instrument	Alarm Setpoint
TBA	TBA	TBA

3.8 SLUDGE HANDLING

3.8.1 REFERENCE P&ID

P&ID 2 and 10,

3.8.2 FUNCTIONAL DESCRIPTION

The sludge handling system consists of a series of two tanks for each SBR, the first tank receives the waste activated sludge (WAS) from its respective SBR, the first tank is used for settling of the sludge and decanting the supernatant water as the sludge settles, the decanted liquid is sent to the sludge decant sump where it is returned to the front of the SBR via the plant waste sump. The second tank receives the settled sludge from the first tank where it is further dewatered and stored prior to being trucked offsite.

The waste activated sludge receiving system runs through a timed sequence of events that is triggered by the SBR cycle, firstly the sludge decant tank goes through a preparation stage, and finally the sludge decant tank receives the waste activated sludge from the SBR. The SBR cycle lengths vary during operation this means that sludge can be removed from the SBR at any time in the cycle.

- **WAS Receiving tank preparation.**

During the SBR cycle the sequence to prepare the sludge decant tank begins, firstly the supernatant liquid is decanted via the tanks floating weirs by opening valves DV-11 or DV-12, the decant runs for a set period, at the end of decanting the air lift pump operates, (P-08 or P-09), and pumps the WAS into the sludge storage tank (T-3 or T-4)

- **Receiving WAS**

After the sludge decant tank has been decanted and the WAS activated sludge has been sent to T-3 or T-4 the valve will open on the relevant SBR (either VM-11 or VM-12) for an operator set predetermined time to waste the sludge to the relevant receiving tank (T-1 or T-2) the time the wasting valve is open for is adjusted by the operator based on the desired MLSS for the SBR reactor.

The waste sludge can also be sent directly to the sludge storage tanks, bypassing the sludge decant tanks via a manual line up connected to each SBR at VM-15 and VM-16 respectively., this route may be used if the usual tank is out for maintenance or there is an issue with the automated valve.

The sludge decant tanks (T-1 and T-2) are periodically aerated via the sites air blower system to prevent the settled sludge form going anerobic.

- **Sludge storage tank processing**

The handling of the sludge in the sludge storage tanks is manual. Both sludge storage tanks are equipped with a series of three valves at different levels in the side of the tanks. This allows the operators to check the quality of any supernatant water in the sludge storage tanks, and manually skim this water back to the sludge decant sump for reprocessing via the plant waste sump to the SBRs.

Sludge is periodically trucked off site for disposal when the sludge tanks are full. As with the sludge decant tanks, air is also introduced from the site blower system periodically to prevent the storage sludge form going anerobic.

Figure 24 : Sludge handling system

3.8.3 EQUIPMENT

Description	Tag
SBR 1 Sludge Decant Tank	T-1
SBR 2 Sludge Decant Tank	T-2
SBR 1 Sludge Storage Tank	T-3
SBR 2 Sludge Storage Tank	T-4
Sludge Decant Sump	T-18
Sludge Waste Control Valve SBR 1	VM-11
Sludge Waste Control Valve SBR 2	VM-12
Sludge Decant Tank Decant Valve SBR 1	DV11
Sludge Decant Tank Decant Valve SBR 2	DV12
Sludge Airlift Pump SBR 1	P-08
Sludge Airlift Pump SBR 2	P-09

3.8.4 INSTRUMENTATION

Description	Tag
Waste Activated sludge Flowmeter SBR 1	FT-36
Waste Activated sludge Flowmeter SBR 2	FT-37
Sludge Decant Tank Level Switch SBR 1	LSH-38
Sludge Decant Tank Level Switch SBR 2	LSH-40
Sludge Decant Tank Level Transmitter SBR 1	LT-39
Sludge Decant Tank Level Transmitter SBR 2	LT-41

3.8.5 SETPOINTS

Setpoint	Instrument	Typical Value

De-sludge Time SBR 1	VM-11	28 Seconds (varies based on MLSS target)
De-sludge Time SBR 2	VM-12	28 Seconds (varies based on MLSS target)
Sludge Interval SBR 1		3 hrs (varies depending on inflow and batching)
Sludge Interval SBR 1		3 hrs (varies depending on inflow and batching)
Aeration Time Sludge Decant Tank TK-14	AV-11	60 secs
Aeration Time Sludge Decant Tank TK-03	AV-12	60 secs
Sludge Settling Time Sludge Decant Tank TK-14		20 minutes
Sludge Settling Time Sludge Decant Tank TK-03		20 minutes
Sludge Transfer Time Sludge Decant Tank 1		16 minutes
Sludge Transfer Time Sludge Decant Tank 2		16 minutes
Supernatant Decant Time Sludge Decant Tank 1		35 minutes
Supernatant Decant Time Sludge Decant Tank 2		35 minutes

3.8.6 ALARMS

Description	Instrument	Alarm Setpoint
Sludge Decant Tank TK-14 High Level Alarm	LSH-38	95%
Sludge Decant Tank TK-03 High Level Alarm	LSH-40	95%

4 MONITORING SAMPLING AND REPORTING

This section outlines the monitoring sampling and reporting requirements for the plant, these requirements fall into two categories, these are:

- Operational, required for the running of the plant to keep it running at its maximum performance in a reliable manner.
- Compliance, required to ensure the plant is staying within the bounds of its current resource consent.

Some monitoring is by the way of online monitoring of instruments that report back to the plants SCADA system, and some are read and recorded in the field, others are samples which are either analysed onsite or sent away to an external laboratory for analysis.

The frequency of operational monitoring is driven by the minimum required to run and troubleshoot the plant, allowing early indications of problems, as well as trend past performance for troubleshooting. The frequency of the compliance monitoring driven by the resource consent.

4.1 OPERATIONAL

There are several parameters which are critical for the control of the plant to meet its performance objectives, these are listed in the table below:

Table 3 : Critical control parameters

Plant Location	Parameter	Values	Reason
Influent	pH	7.0-8.5	Extreme pH values may affect biological processes
Influent	Flow	TBA (requires process modeling)	Potential overloading of plant
SBRs	pH	7.0-8.5	Extreme pH values may affect biological processes.
SBRs	DO	> 1.5mg/L (when aerated)	Required for ammonia and organic oxidation
SBRs	MLSS	1,500-3,000mg/L	Optimum concentration for activated sludge process
SBRs	SVI	50-150mg/L	For good settling SVI should be < 150mg/L
Post Filtration	Ammoniacal Nitrogen	< 5.0mg/L	Indicates good nitrification
Post Filtration	Turbidity	< 5.0 NTU	Elevated level will offset UV performance
Post Filtration	UV Transmissivity (UV-T)	>50%	UV performance will be affected if UV-T falls below this percentage
Post Filtration	UV flow rate	< 14L/sec	Higher flow rates will compromise the performance of the UV disinfection

The table below lists the operational monitoring parameters for the plant, items marked with a * are required for both operational monitoring and compliance monitoring.

Table 4 : Operational Monitoring parameters

Location	Parameter	Instrument	Method	Frequency				
				Continuous	Daily	2 x per week	Weekly (winter), 2 x week summer	Weekly (summer), Fortnightly (winter)
Influent	Record total influent flow rate	FM01	Online monitoring via the site SCADA	✓				
Rain Gauge	Record rainfall	AT18	Manual reading of rain gauge		✓			
SBRs	DO	DOIT4 (SBR1)	Online monitoring via the site SCADA	✓				
	pH	DOIT9 (SBR2)		✓				
Sludge	Record flow from SBRs to sludge decant tanks	FT36 (sludge decant tank)	Online monitoring via the site SCADA		✓			
		FT37 (sludge decant tank 2)	Online monitoring via the site SCADA		✓			
UV Outlet	Temperature*	NA	Handheld devices		✓			
	pH*	NA			✓			
	DO*	NA			✓			
	Turbidity	Turb26	Turb26	✓				
UV Disinfection System	UV transmissivity	UVI25			✓			
	UV running hours	UV control panel			✓			
	UV temperature				✓			
Influent	Ammoniacal Nitrogen		Onsite test			✓		
SBR 1 and 2	MLSS		Offsite lab test				✓	
	SVI		Offsite lab test				✓	
Wetland Wet Well Level	Wetland Level	LS16			✓			

SBR Supernatant receiving tanks Level					✓			
Pressure filters					✓			
UV Outlet	$cBOD_5$		Offsite test					✓
	TSS							✓
	Total Kjeldahl Nitrogen							✓
UV Outlet	Ammoniacal Nitrogen		Onsite test					✓
								✓

4.1.1 OPERATIONAL REPORTING

Hard copies of Operator logs, which include operational lab test results, and daily checks are stored onsite, critical process data and lab results from the external lab are stored in water outlook.

4.2 COMPLIANCE

Under the resource consent the following must be monitored:

- Volume of landfill leachate being sent to the treatment plant.
- Treated wastewater quality post the UV channel.
- Volume of water disposed to boreholes.
- Ground water quality via monitoring bores
- Ground water levels and seepage

Table 5 : Resource Consent compliance

Sample Point	Parameter	Instrument	Frequency					
			Daily	Fortnightly	Monthly	Every 3/6 months	Annually	Following any rainfall event
Plant Inflow	Total plant inflow	FM-01	✓					
	Landfill leachate inflow	FT-01	✓					
Disposal Boreholes	Total volume of discharged treated wastewater	FT-24	✓					
	Disposal flow to each group				✓			

Sample Point	Parameter	Instrument	Frequency					
			Daily	Fortnightly	Monthly	Every 3/6 months	Annually	Following any rainfall event
UV Outlet	Temperature	Handheld devices	✓					
	pH			✓				
	DO			✓				
UV Outlet	E.coli	Offsite test		✓				
	BOD_5			✓				
	Total Kjeldahl Nitrogen			✓				
	Total Phosphorus			✓				
Disposal Borehole Groups	The monthly discharge volume at each disposal borehole group	Borehole group flow instruments			✓			
Observation bores and Piezometers	Groundwater depth	N/A			✓			
								✓
Observation Bores	Faecal Coliforms	Offsite test				✓		
	Total Kjeldahl Nitrogen							
	Total Phosphorus							
Disposal Borehole Areas A, B and C	Visual assessment for surface seepage and wet zones	Onsite inspection					✓	

4.2.1 LANDFILL LEACHATE

The volume of landfill leachate discharged to the WWTP via the rising main should ‘not exceed a rolling average of 5m^3 per day, as calculated using the seven most recent days from midnight to midnight’ (Condition 2).

Operators are also required to record the daily volume of leachate discharged to the WWTP. This is measured by flow meter FT-01.

4.2.2 TREATED WASTEWATER QUALITY

The treated wastewater quality is assessed by collecting samples from the UV outlet and performing the necessary in-situ and offsite lab tests.

For this monitoring each sample should be made up of three samples of equal volume, taken at least one minute apart (Monitoring Programme – Clause 2)

As stated in the consent, sampling should be undertaken once a fortnight for the initial 12 months, following that, the frequency may be reduced to once a month if there has been a period of 12 months of consistent monitoring showing, the wastewater has fully complied with the discharge limits (Monitoring Programme – Clause 2.1).

PARAMETERS AND DISCHARGE LIMITS

Each sample should be tested for E. coli and the determinants listed in Table 6. In addition to this the temperature pH and DO level of the sample should also be recorded (Monitoring Programme – Clause 2).

Table 6 : Parameters and discharge limits

PARAMETER	Discharge Limits	
	Rolling Median	Rolling 90th percentile
Five Day Biochemical Oxygen Demand, BOD_5 (mg/L)	10	25
Suspended Solids, TSS (mg/L)	10	25
Total Kjeldahl Nitrogen (mg/L)	20	40
Total Phosphorus (mg/L)	15	20
E coli (cfu/100mL)	50	1000 (Max)

4.2.3 BOREHOLE DISCHARGE

The discharge to the borehole disposal system should not exceed 1,235 m^3 per day, as measured by the flow meter prior to the UV disinfection system (FT-24).

As specified in Condition 3 of the sites resource consent, the flow meter is required with an error of ±5% or less. A verification record of the flowmeter accuracy needs to be submitted to Northland Regional Council every 5 years.

4.2.4 GROUND WATER QUALITY

The groundwater quality is monitored by collecting samples from observation bores in areas A, B and C. Separate samples should be collected from the following observation bores:

Area A – Observation bores 2 and 6

Area B – Observation bores 8, 9, 11 and 13

Area C – Observation bore 15.

Sampling should be undertaken at least once every 3 months.

This may be reduced to once every 6 months if after 3 consecutive years of 3 monthly monitoring, the compliance conditions have been met. (Monitoring Programme – Clause 4.1).

The samples taken from the observation bores need to be sent to the lab for analysis of the following parameters:

Faecal Coliforms

Total Kjeldahl Nitrogen

Total Phosphorus

To remain within the consent conditions the tested samples must not show an upward trend for the tested parameters shown above.

4.2.5 GROUNDWATER LEVELS AND SEEPAGE

The groundwater level in all observation bores and piezometers should be measured once a month and following any rainfall event exceeding 45mm (Monitoring Programme – Clause 5).

An annual visual assessment for surface seepage and wet zones is also required.

The results of this monitoring should be recorded.

4.2.6 COMPLIANCE REPORTING

Internal reporting of compliance is through operator logs, lab test results, and the plants SCADA system, this data is exported to Water Outlook, and The Far North District Council compliance manager compiles a report which is sent to the Far North District council once a month, and compliance against the resource consent is tracked in the CS-Vue compliance information monitoring system.

5 EMERGENCY REPONSE PLANS

5.1 CONTINGENCY MEASURES

The table below outlines the contingency measures in case of emergency situations.

Table 7 : Treatment Plant Contingency measures

Treatment plant contingency measures	
Incident	**Contingency Measure**
High flows in summer peak and extreme weather events	TBC
Overflow of effluent from treatment site	Fully bunded treatment plant site, with manual control discharge valve
Pump/power failure at Terminal Pump Station (Hope Ave)	Power failure alarm to operators
	Storage tanks and generators at pump station
Power failure at Plant	Plant equipped with a backup generator
	Power failure alarm to operators
High flow to SBR tanks	SBR cycle length will reduce to complete cycle more quickly
SBR tanks leak/tank failure (catastrophic failure)	SBRs equipped with high level alarms
	SBR plant area is bunded
	Periodic condition inspections
Blockage of SBR splitter outlet.	Upstream treatment will reduce solids load
	Level alarm in distribution chamber
Leakage through wetlands	Wetland two is lined with PE to prevent seepage, wetland one is not in service
	Regular inspection of wetland area
Overflow from wetlands due to pump failure or blockage	Significant storage in wetlands
	Wetland wetwell equipped with duty/assist pumps providing redundancy

Treatment plant contingency measures	
Incident	**Contingency Measure**
	Level alarm in wetland wetwell
One of the pressure filters not operable	Bypass the affected filter
	Repair filter
	Slow the feed rate to the remaining filter
	Monitor turbidity and UV intensity
UV critical fault	Stop discharge
	Repair UV
	Keep critical spares to minimise down time
Overflow of final effluent tanks	Gravity overflow to SBR splitter
	Final effluent tanks equipped with level alarms
Failure of bore disposal rising mains	Pipes are entrenched to prevent damage
	Air valves installed at high points
	Pressure sensor at borehole pumps will alarm if low pressure is detected
	Bore areas can be operated independently if maintenance is required, storage in wetlands can be utilised
Overflow of disposal boreholes	Prevented by float valve in each borehole
	Pressure sensor at borehole pumps will stop pumps if high pressure is detected because of individual boreholes closing
	Regular inspection
	Volume of overflow limited to volume of holding tank

Treatment plant contingency measures	
Incident	**Contingency Measure**
Overflow to wider environment	Enactment of the Spill Protocol

5.2 EMERGENCY RESPONSE PLANS

5.2.1 SPILLS

In the case of a spill from the treatment plant into the environment the following steps must be taken, by the operator and Far North District Council (FNDC).

1) The wastewater treatment operator must respond to all spills associated with the wastewater treatment process to assess the severity of the incident.
2) The treatment operator shall notify the Northland District Health Board and Northland Regional Council if the spill is to water or is likely to enter water. The treatment plant manager or on-call Manager must also be notified.
3) The wastewater treatment plant operator, in communication with FNDC and the Northland Regional Council, shall take such action to ensure ongoing unauthorised discharges from the treatment plant are halted, and shall undertake any action practicable to remedy or mitigate the effects of the spill on the receiving environment.
4) FNDC shared service support officer is to contact the relevant Iwi.
5) In the event of a spill to water, Northland District Health Board (NDHB) will likely carry out an initial public health risk assessment to determine the areas at risk because of the spill and will advise FNDC of those areas. Should marine farms be affected, NDHB will liaise with the effected farmers regarding any action to be taken.
6) Following discussion between NDHB and FNDC regarding the need to erect warning signs and the location of warning signs, the required signage will be erected by the FNDC at the agreed locations. NDHB will confirm when the warnings can be removed.
7) Depending on the severity of the event, FNDC communications officer may issue a press release and/or statement to local radio stations stating that a spill has occurred and advising the areas affected.
8) Communication between FNDC and the operator will continue during the event. The level of communication will be determined by the severity of the spill.

6 TROUBLESHOOTING GUIDE

6.1 FAULTS AND TROUBLESHOOTING

If something is not as it should be, take photos and enter information into site logbook. This will help with troubleshooting and identification of regular problems on site.

If you are not sure, ask for technical support.

This table is a guide to the most likely causes of issues, how they may manifest and actions to be taken.

Record all actions taken when troubleshooting as when the problem goes away, the plant needs to be put back as it was before. E.g., Change of setpoint, change of timer etc need to be logged.

Table 8 : Faults and troubleshooting

Faults and Troubleshooting		
Process Troubleshooting		
Problem	**Possible Causes**	**Corrective Actions to be Taken**
SBR Dissolved oxygen is low <0.5 ppm at end of Aeration cycle	- Plant overload - Aeration Failure - Aging Diffusers	-Check influent. And leachate - Confirm Blower operation - Confirm air valve operation - If system operational and DO setpoint not met repeatedly, particularly holiday periods, replace diffusers
SBR Dissolve Oxygen is >> set point at end of aeration cycle	- Incorrect set point - Blower control	- Check set point and dwell times for blower response. - Confirm blower operating to correct speed
SBR MLSS Low	-incorrect sampling time -excessive WAS -	-Sample during aeration cycle only -Recalculate WAS required Check WAS system valves and timers correct. Adjust for seasonal changes
SBR MLSS is High	-incorrect sampling time-excessive WAS -	-Sample during aeration cycle only -Recalculate WAS required Check WAS system valves and timers correct. Adjust for seasonal changes
SBR SVI is low < 50	Low MLSS Poor sampling Very good settling sludge	Monitor regularly and look for trends. Check MLSS Sample only in aeration cycle Correct MLSS if needed.
SBR SVI is High > 150	High MLSS Poor Sampling Filamentous growth (straw colour of sludge)	Monitor regularly and look for trends. Check MLS Sample only in aeration cycle If filaments – see below
SBR foam- White Foam	Characterised as whitish colour, light, > 0.3m depth. Starts in corners. Maybe windblown.	Check MLSS. Too low MLSS will allow foaming of wastewater when

Faults and Troubleshooting		
Process Troubleshooting		
	Incorrect MLSS Over aeration Detergent dump	aerated. Common on plant start up for 2 –3 days. If persistent and windblown, add surfactant in small quantities and lower DO set point.
SBR foam- Light Brown Foam	Characterised as light brown foam may be stable for several hours. Easily dispersed with hose. May be smelly in summer. Rapid onset – toxic shock affecting both SBRs. Transitionary foam – startup of aeration cycle. Over aeration	- If toxic shock, Waste sludge heavily and Reseed ASAP. - - transitionary – do nothing. - Consider when it occurs and adjust aeration set points. - Consider hose spray to suppress if nuisance.
SBR foam – dark brown Foam	Filamentous growth Depth up to 0.6 m. Stable like chocolate mousse even in aeration	Filament ID required. Check DO, check pH, check MLSS. Usual strategy is run on lower MLSS for 1 week to reduce effect. Reseed plant if persistent. DO NOT drop MLSS below 1500 mg/l or white foam effect will occur. Alum dose can improve settlement.
SBR Scum build up	Denitrification in tank Grease builds up. Foam – as above. Bacterial wall growth	Denitrification is normal. Foam should disperse with aeration. White Grease – periodic tank wall washing. Sucker truck away. Check commercial grease traps in network and PS. Clean as needed. Thick, unsightly layer on side of tank, often dark grey/black. - build-up of bacterial slime. Hose off to clean.
SBR build-up of filaments	Low DO, low pH, High or low F/M,	Identify filament type as indicator of possible issues. Increase WAS and reduce MLSS
Sludge Blanket loss	Filaments High SVI Excess MLSS	Check plant operation and conditions. Confirm MLSS, SVI. adjust as needed. If filaments, increase WAS.
Low pH in SBR	Unusually wastewater Low alkalinity nitrification	Check pH of inflow. Check Leachate pH. Test for alkalinity on incoming sewage. Need 7.3 mg/l of alkalinity for every 1 mg/l of NH3-N removed +70-100 mg/l spare. Add more alkalinity if needed daily. Sodium Bicarb is easy to use form.
Post filtration ammoniacal Nitrogen is High > 5 ppm	High ammonia in Insufficient DO Insufficient MLSS Poor BOD removal Toxic inhibition Low alkalinity	Summer NH3 expected at 70 –100 mg/l, normally 30 mg/l. Check aeration (as above) Check MLSS, increase if needed.

Faults and Troubleshooting		
Process Troubleshooting		
		If suspect toxicity (often seen with turbid SBR decant) sample and test inflow. Report to FNDC. Prepare to reseed plant.
Post Filtration Turbidity is High > 5 NTU	Colloidal particles Poor washing Poor back wash water quality	Check BOD removal in SBR- increase MLSS and DO if needed. Check operation of sand filter and valves. Drain and Clean wash water tank.
Post Filtration UV Transmissivity is low < 50%	As Post filtration Turbidity above.	
Post Filtration UV Flow rate is High > 14 l/sec	Pump changes Pipe break	Confirm pump only as duty operating. Check pipeline for leaks.
Rotary screen trips out	Screen overloaded- rag Stone blockage Loss of water freezing	Clean throat of screen. Remove blockages. Check water available. If freezing occurs, turn screen off and use manual bypass until defrosted. If regular, add lagging and trace heating. Consider wider discharge chute.
Build-up of grit in channel to SBRs	Confirm by visual inspection	Call in sucker truck to remove grit
Blower to SBRs operating longer than usual	Dirty DO Probe Diffuser quality poor Blower mechanical fault	Clean and calibrate DO probe. Monitor cycle and replace diffusers if unable to meet DO set point. Check Blower belts, pulleys and VSD settings.
High turbidity reading post UV	MLSS too high	Test MLSS concentration in SBRs
		Remove excess sludge by adjusting the opening duration of the sludge discharge valve from SBRs as required.
		Increase backwashing frequency of pressure filters
Filter capacity reduced	Solids carryover- Blanket loss high Denitrification Dirty intermediate tank Chemical precipitation	See above for sludge blanket control. Denitrification is normal. Check DO peak allows DO to reach zero in settle phase not in decant phase. Lower DO Set point if needed. Clean intermediate tank

Faults and Troubleshooting		
Process Troubleshooting		
		High back pressure on pumps due to chemical deposits. take one filter out of service and soak in weak citric acid overnight. Backwash and return to service.
UV lamp performance deterioration	Dirty lamps Scratched lamps Poor inflow to UV Poor upstream performance (particularly BOD)	Isolate uV and clean. Inspect UV lamps for condition and replace failed parts. Check autocleaning. Hypo wash if needed. - see uV manual. Poor TSS – see above. Poor BOD_ see above. If after above lamp output poor, replace lamps and check ballast cards.
Effluent Quality Compliance Troubleshooting		
Five Day Biochemical Oxygen Demand, BOD5 (mg/L) is high > 5	Low DO in SBR, Low MLSS Excess Load to SBR (E.g., one out of service). Solids carry through sand filter	Check plant for correct operation. Adequate DO and MLSS are needed to treat fully. Sand filter checks above
Suspended Solids, TSS (mg/L) is high > 10	Solids carry through of Sand filter. Poor backwash water quality	See above solids carry over. Clean backwash water tank.
Total Kjeldahl Nitrogen (mg/L) is High > 20	Seasonal NH3 concentrations Low DO, low MLSS Insufficient alkalinity	Check influent. Check aeration and MLSS are correct adjust if needed. Check pH in effluent If < 6.8 alkalinity may be insufficient. Add Bicarb granules daily.
Total Phosphorus (mg/L) is High > 15	Solids loss in effluent	Resolve cause of solids loss. Can be lowered by dosing Alum. 3 mg/l of Al (as metal) needed for 1 mg/l PO_4- as P.
E coli (cfu/100mL) is high > 50	solids loss in effluent UV lamp deterioration UV Lamp failure	As above
Borehole drain rate is reduced	Solids pumping into bores	Inspect and arrange blockage clearing
		Improve upstream treatment e.g., slow filter feed rate
Overflow from disposal borehole	Finger filters blocked giving incorrect pressure reading	Clean finger filter and replace as required

7 MAINTENANCE

7.1 ROUTINE CHECKS AND MAINTENANCE SCHEDULE

Table 9 : Routine checks and maintenance schedule

General												
Task	**FREQUENCY**											
	Daily	Weekly	Twice weekly or as required	Fortnightly	Monthly	Monthly or as required	Every 3 Months	Every 6 Months	Annually	Annually or as required	Every 2 years	As required
Plant walks around general check	✓											
Investigate for any odours	✓											
Grease all working parts as required					✓							
Check level in generator diesel tank					✓							
Run generator (by electrician)					✓							
Maintain road drains and grates							✓					
Oil padlocks							✓					
Check embankment for seepage, erosion, weeds, and vermin							✓					
General housekeeping and repairs to main building							✓					
Check all valves are operational								✓				
Simulate all class A alarms and assess performance								✓				
Full electrical and mechanical check for each pump (by electrician)									✓			
Check main switchboard and main earth (by electrician)									✓			
Check electrical installations (by electrician)									✓			
Check air valves, inspect, clean, and reinstall									✓			
Inlet Works												
Record flow from leachate pumps	✓											
Remove screenings	✓											
Organise service on rotary screw									✓			
SBRs												
Check level sensor readings	✓											
Check SBR decanter operation	✓											
Clean instruments in tanks		✓										

General												
Task	FREQUENCY											
	Daily	Weekly	Twice weekly or as required	Fortnightly	Monthly	Monthly or as required	Every 3 Months	Every 6 Months	Annually	Annually or as required	Every 2 years	As required
Check SBR MLSS and Sludge Settling Test results, Ammonia results, adjust wasting rates as required		✓										
Calculate SBR sludge age based on MLSS and sludge wasting results				✓								
Top up driver gearbox oil							✓					
Test operation of high level cut off valves								✓				
Drain SBRs for inspection and painting										✓		
Adjust sludge waste rate												✓
Wetlands												
Clean level probe					✓							
Check discharge chamber for fouling					✓							
Clean outlet structures					✓							
Remove debris from wetwell					✓							
Check operation of indication lights in wetland pump station							✓					
Remove accumulated sludge from media in wetlands							✓					
Lift and clean pumps in wetwell								✓				
Pressure Filters												
Check differential pressure sensor	✓											
Check backwash operation		✓										
Check for chemical scaling and perform acid wash as required									✓			
Drain filter media and top up as required											✓	
UV System												
Check UV intensity meter is operational	✓											
Check turbidity panel	✓											
Clean UV lamps as required	✓	✓										
Clean turbidity meter		✓										
Clean cabinet interior and exterior								✓				
Change lamps as required									✓			
Boreholes												

General												
Task	**FREQUENCY**											
	Daily	Weekly	Twice weekly or as required	Fortnightly	Monthly	Monthly or as required	Every 3 Months	Every 6 Months	Annually	Annually or as required	Every 2 years	As required
Record which borehole groups are operating		✓										
Record total flow to disposal boreholes		✓										
Record operational hours and currents for each borehole pump		✓										
Inspect lids for damage, surface drainage and effluent overflow					✓							
Change operating boreholes as per protocol					✓							
Inspect finger filters and group control valves; clean and replace as required					✓							
Re-grease borehole pumps					✓							
Check operation of indication lights in borehole pump station							✓					
Check stormwater float valve switch							✓					
Test operation of group control valves								✓				
Sludge System												
Arrange for sucker truck to remove sludge from sludge storage tanks			✓									
Check sludge storage tanks and adjust decant valves as required		✓										
Blowers and Air Compressors												
Clean strainers and traps on air lines						✓						
Check receiver for oil/sludge accumulation					✓							
Check oil and fan belt on blowers							✓					
Replace oil in blowers								✓				
Check operation of safety valves on compressor								✓				
Organise service on blowers and compressors									✓			

APPENDIX A - SITE SPECIFIC SAFETY PLAN (TO BE PROVIDED BY VENTIA)

APPENDIX B - RESOURCE CONSENT

APPENDIX C – PROCESS & INSTRUMENTATION DIAGRAMS (P&IDS)

APPENDIX F – MECHANICAL SERVICE MANUAL (TO BE PROVIDED BY VENTIA)

APPENDIX G - CRITICAL SPARES (TO BE PROVIDED BY VENTIA)

APPENDIX H - CONTROL PHILSOPHY (TO BE PROVIDED BY VENTIA)

APPENDIX I - OPERATOR LOGSHEETS

APPENDIX J - SAMPLING PROCEDURES

1. PURPOSE

The aim of this Procedure for Far North Waters Alliance is to

(a) To describe sampling requirements.

(b) To ensure operators and laboratory staff maintain sample integrity.

2. SCOPE

This document applies to activities carried out by Water/Wastewater Treatment Operators and Lab staff sampling, either water or wastewater, and handling and preservation of samples transferred to the Laboratory for testing or transport to another Laboratory.

3. PROCEDURE

Background

When the Treatment Operators or qualified samplers have delegated responsibility for sample collection, handling, and preservation, there shall be strict adherence to correct sampling procedures, complete identification of the sample, and prompt transfer of the sample to the laboratory as specified. in Standard Methods for the Examination of Water and Wastewater. Far North Waters Alliance Kaikohe Laboratory is an IANZ Registered Lab and must adhere to Laboratory Standard Methods. This procedure sets out the sampling requirements to be followed.

4. METHOD

4.1 MICROBIOLOGICAL SAMPLES

4.1.1 Sample Collection, Handling and Preservation - Container

- Use a sterilized sample container 100 mL (BLUE TOP) containing sodium thiosulfate preservative (a chlorine neutralizer) if analysing treated water or a yellow top container if analysing untreated water. Bottles are available from the laboratory.,
- Keep sample containers clean and free from contamination before and after collecting the sample. Do NOT open them prior to collecting the sample.
- Examine the sample container for cracks or other signs that sterility may be compromised, if any of these indications are found, discard the container, and use a suitable one.
- Label the sample container with the samples site, date, time, and sampler’s name.
- Ensure hands are clean and washed before sampling.

4.1.2 Flush the System

- For locations at which the sample must be collected from a tap, inspect the outside of the tap. If water leaks around the outside of the tap, select a different sampling site.

- Remove any aerators, strainers, attachments, or purification devices from the tap.
- If necessary, remove debris and sterilize the tap outlet.
- DO NOT take samples from a flexible hose or garden hose. Sample from the cold water taps only.
- Allow the water to run for at least 1-2 minutes before collection. This will help to remove stagnant water from the system.
-

4.1.3 Sterilize the Tap

- Flame the tap for at least 15 seconds. Slowly open the tap and let it run for 1-2 minutes.

OR

- Wash the outside of the tap and as much of the inside as possible with a 1% hypochlorite solution, using a spray bottle. Leave to stand for 1-2 minutes so the tap will be disinfected.

4.1.4 Collect the Sample

- If the sample is for a chlorinated supply, measure the chlorine residual (FAC). Record the chlorine residual on the sample label.
- Before taking the sample, reduce the tap flow rate to a steady flow. The flow rate should be low enough to ensure that no splashing occurs as the container is filled. Do not adjust the flow rate while taking the sample.
- Remove the cap with the free hand. Be careful NOT TO TOUCH the inside of the container or the container cap. Continue to hold the cap in one hand with the inside facing down while the bottle is being filled. Do NOT lay the cap down. Do NOT breathe on the container or cap.
- Do NOT rinse the container.
- Fill the container to the 100mL mark. Do NOT allow the container to overflow, carefully replace the cap.
- Complete the sample label, include all required information: sampling site, date, time, and sampler name.5. 1

4.1.5 Storage and Transport

- If transport to the lab is to exceed 1 hour, samples shall be kept in a refrigerator or cooler with ice packs to maintain a temperature of 10°C or less, until delivered to the lab. Or if the sample temperature at time of receipt is less than the temperature at time of collection. Samples should not be frozen or exposed to light.
- Transport the sample to the laboratory as soon as possible and for analysis within 24 hours of collection. Check ahead with the lab about day and/or time deadlines for sample acceptance to ensure meeting the 24-hour criterion.

4.2 CHEMICAL SAMPLES

4.2.1 Sample Collection, Handling and Preservation- Container

- Use a clean sample bottle (YELLOW TOP) or other clean container containing no preservative. Bottles are available from the laboratory. Note Far North Waters Kaikohe Laboratory is an IANZ Registered/Telarc Approve Lab and must adhere to Laboratory Standard Methods.
- Keep sample containers clean and free from contamination before and after collecting the sample. Do NOT open them prior to collecting the sample.
- Examine the sample bottle for cracks, a missing seal, or other defects. If any of these indications are found, discard the bottle, and use a suitable one.
- Label the sample container with the sampler's name, location of the site and/or sample location number, date, and time.

4.3 NON-CHLORINATED WATER SYSTEMS

-

4.3.1 Flush the System

- For locations at which the sample must be collected from a tap, inspect the outside of the tap. If water leaks around the outside of the tap, select a different sampling site.
- Remove any aerators, strainers, attachments, or devices from the tap.
- If necessary, remove debris and sterilize the tap outlet, for example by swabbing with a disinfecting wipe.
- DO NOT take samples from a flexible hose or garden hose. Sample from the cold-water faucets only
- If the sample is to be taken from a tap or a pump, allow the water to run for at least 1-2 minutes before collection. This will help to remove stagnant water from the system.

4.3.2 Collect the Sample

- Before taking the sample, reduce the tap flow rate to a steady flow. The flow rate should be low enough to ensure that no splashing occurs as the container is filled. Do not adjust the flow rate while taking the sample. At sampling points where the water runs continuously do not adjust the flow rate.
- Whilst holding he sample container at the base, remove the cap with the free hand.
- Do NOT rinse the bottle.
- Fill the bottle to the neck or fill line. Do NOT allow the bottle to overflow. Carefully replace the cap.
- Complete the sample identification details on the label. Include all required information: sampling site, time, and sampler name.

4.4 EFFLUENT, ENVIRONMENTAL AND WASTEWATER SYSTEMS

4.4.1 Check the Site Location is Correct

- Check the Resource Consent for the location at which the sample must be collected. The sample sites are exact in location and purpose.

4.4.2 Collect the Sample

- Before taking the sample, check the sample method required. Variations may require triplicate samples, composite sampling, specific time of day, frequencies between samples, paired samples.
- Some tests need to be done in the field at the time of sampling e.g., Dissolved Oxygen, temperature.

- Refer to the Quality Manager for advice.
- Collect the samples as per instructions. +
- Fill the bottle to the fill line. Do NOT allow the bottle to overflow. Carefully replace the cap.
- Complete the sample identification details on the label. Include all required information including sampling location, site number, date, time, sampler name.

4.4.3 Storage and Transport

- Samples shall be kept in a refrigerator or cooler with ice packs to maintain a temperature of <5°C until delivered to the lab. Samples should not be frozen.
- Transport the sample to the laboratory as soon as possible and within 24 hours of collection. Check ahead with the lab about day and/or time deadlines for sample acceptance to ensure meeting the 24-hour criterion.

4.5 LABORATORY

When the sample is delivered to the laboratory:

1) The following information shall be added to the sample register.

    a. Date and time of sample arrival.
    b. Name of sampler; and
    c. Name of the person receiving the sample for the laboratory; and

2) Each sample shall be assigned a laboratory number.

3) Records necessary to establish chain-of-custody of the samples shall be maintained.

4) Micro samples should be analyzed on the day of arrival in the laboratory and within 24 hours after collection for compliance purposes.
5) Samples should be refrigerated and delivered to the laboratory as soon as possible after collection and analyzed as soon as practicable at the laboratory.

4.6 PRE-SAMPLING CONSIDERATIONS

Pre-Dispatch

Prior to dispatching to a site or facility, the following information should be known.

- • The exact locations to be sampled
- • The parameters to be sampled
- • The types of samples to be taken
- • The type of containers
- • The preservatives needed.

In addition, the sampler should be aware of process and flow variations, recent.
shutdowns, etc. (i.e., weekends, holidays, seasonal factors).

Health and Safety

Safety equipment should be available including Personal Protective Equipment (PPE) particularly for sampling of wastewater or environmental samples.
Some sample containers contain acid as a preservative. Wear gloves and take care. not to cause splashing when filling.

Equipment

sampling and testing equipment should be calibrated and checked to be sure. functions
properly and the user is familiar with its operation.

Training

Training for samplers shall be given under the supervision of the Laboratory Manager.

RESPONSIBILITIES

Water/Wastewater Treatment Operator Duties

- Check the Resource Consent f or the appropriate sample type, location and
- Attend the site and sample as per method above.
- Return the sample/s, with correct identification, handling, and preservation, to the laboratory for testing.
- Note any deviations on the sample label.
- Report and record details of deviations and actions taken.

Quality Manager/Staff Duties

- Monitor incoming samples to ensure sampling methods, times and temperatures are adhered to.
- Provide technical support to treatment operators.
- Follow-up any deviation or fault to ensure compliance.
- Liaise with Treatment Supervisors/Operations Manager.

Operations Manager/ Quality Manager Duties

- Ensure all treatment operators and laboratory staff have been fully briefed and understand this procedure.
- Report monthly to FNDC, Notify FNDC Northland Health and Northland Regional Council of non-compliances, recording details of the incident and actions taken.

Appendix K: Statutory Assessment

Table 10: National Policy Statement Freshwater Management 2020

Objective/Policy	Assessment
Objective	
Objective 1 a. The objective of this National Policy Statement is to ensure that natural and physical resources are managed in a way that prioritises: i. first, the health and well-being of water bodies and freshwater ecosystems ii. second, the health needs of people (such as drinking water) iii. third, the ability of people and communities to provide for their social, economic, and cultural well-being, now and in the future.	The proposal meets Objective 1 in terms of the hierarchy of priorities. The proposal prioritises the health and wellbeing of the affected waterbodies through measures in the proposed EMS, which includes: - maintaining the health and well-being of the small streams and wetlands to ensure they are protected; or - If monitoring results show degradation, through an AMA FNDC will upgrade the KR-WWTP to reduce the contaminant load discharged, or if the KR-WWTP is unable to be upgraded sufficiently to meet this objective, revise the BPO for an alternative wastewater solution that can. Unlike drinking water, wastewater discharges are not listed specifically as a second priority in objective 1. However, the sanitary disposal of wastewater in an urban environment, even a small urban environment, is critical for providing for the health needs of people to avoid infection and disease. The proposal to revise the BPO once cultural effects are known, ensures the discharge will give effect to the wider elements of Te Mana o Te Wai.
Policies	
Policy 1: Freshwater is managed in a way that gives effect to Te Mana o te Wai.	There are 6 key principles to Te Mana o te Wai. The first three principles Mana whakahaere, kaitiakitanga and Manaakitanga relate to the obligations of tangata whenua to make decisions to maintain, protect and sustain the health and wellbeing of freshwater. This also includes the process for which tangata whenua are involved in decision making relating to freshwater. FNDC has started consultation with mana I te whenua, however they the consultation to date has not been sufficient to properly allow mana I te whenua to
Policy 2: Tangata whenua are actively involved in freshwater management (including decision-making processes), and Māori freshwater values are identified and provided for.	

Table 10: National Policy Statement Freshwater Management 2020

Objective/Policy	Assessment
	have mana whakahaere over this proposal. Therefore, FNDC request that timeframes for public notification are extended under s.37 until mana i te whenua have had adequate involvement to proceed. The other three principles of Te Mana o te Wai are governance, stewardship, care and respect. FNDC as stewards of the property and the discharge, will manage the receiving water bodies through the proposed EMS.
Policy 3: Freshwater is managed in an integrated way that considers the effects of the use and development of land on a whole-of-catchment basis, including the effects on receiving environments.	The application crosses multiple forms of water, once discharged into land via bore injection, it migrates into groundwater, seeping into small streams, through the Uruti bay wetland and into the coastal marine area. The application acknowledges this interconnection and has assessed the effects of the discharge on each freshwater element.
Policy 4: Freshwater is managed as part of New Zealand's integrated response to climate change.	An integrated response to climate change implies various actions all uniting to address increasing global temperatures. The proposal has considered the effects on climate change, primarily through the proposal to annually review the stability of the bunds around the two ponds. This is to ensure the risk of flood from climate change will not result in a spill of wastewater into flood water.
Policy 5: Freshwater is managed through a National Objectives Framework to ensure that the health and well-being of degraded water bodies and freshwater ecosystems is improved, and the health and well-being of all other water bodies and freshwater ecosystems is maintained and (if communities choose) improved. **Policy 7:** The loss of river extent and values is avoided to the extent practicable. **Policy 9:** The habitats of indigenous freshwater species are protected.	The initial monitoring of the receiving environment indicates that for some analytes, the NPS-FM guideline values are not meeting the national bottom lines within the NOF, however this should be more accurately established after a consistent monitoring period. The AMA proposes for this application is to continue monitoring the effects within the receiving environment, and if after the initial two-year period of sampling the receiving environment is unable to meet the NOF bottom lines, improvements to the KR-WWTP will be made through revision in the BPO and implemented within the duration of the consent.
Policy 6: There is no further loss of extent of natural inland wetlands, their values are protected, and their restoration is promoted.	Initial assessment of the receiving wetland environments is that the discharge is having a low effect. To ensure there is no further loss to the value of these wetlands, the proposed monitoring will require FNDC to compare annual

Table 10: National Policy Statement Freshwater Management 2020

Objective/Policy	Assessment
	monitoring results and undertake restoration or maintenance of the wetland, if pest weeds are shown to be become an issue.
Policy 12: The national target (as set out in Appendix 3) for water quality improvement is achieved.	These provisions provide higher level policy guidance and are not specifically relevant to the proposal. However, the monitoring collected onsite will be shared with NRC through annual reporting and can be used by NRC to establish wider information on freshwater quality within the region.
Policy 13: The condition of water bodies and freshwater ecosystems is systematically monitored over time, and action is taken where freshwater is degraded, and to reverse deteriorating trends.	
Policy 14: Information (including monitoring data) about the state of water bodies and freshwater ecosystems, and the challenges to their health and well-being, is regularly reported on and published.	
Policy 15: Communities are enabled to provide for their social, economic, and cultural wellbeing in a way that is consistent with this National Policy Statement.	The proposed activity is consistent with Policy 15 which enables communities to provide for their economic well-being, including productive economic opportunities, while putting the health and well-being of the water body first.

Table 11: Regional Policy Statement for Northland

Objective/Policy	Assessment
Water Quality	
Objective 3.2 *Improve the overall quality of Northland's fresh and coastal water with a particular focus on:* *(a) N/A* *(b) Increasing the overall Macroinvertebrate Community Index status of the region's rivers and streams;* *(c) Reducing sedimentation rates in the region's estuaries and harbours;* *(d) Improving microbiological water quality at popular contact recreation sites, recreational and cultural shellfish gathering sites, and commercial shellfish growing areas to minimise risk to human health; and* *(e) Protecting the quality of registered drinking water supplies and the potable quality of other drinking water sources.*	NRC has established freshwater quality objectives in Table 22 of the pRPN. The Groundwater and Surface Water Quality Effects Assessment (Appendix D) compared the water quality from two monitoring samples against these standards. Although two water quality samples give an indication of freshwater quality, it does not take into account the many variables, including weather, KR-WWTP performance, time of year, and proposed upgrades to the KR-WWTP. At least two years' worth of monthly samples are considered a minimum to determine a more accurate freshwater quality state. FNDC propose to undertake monthly monitoring of the parameters set in the regional plans for freshwater, and if after two years the water quality within the H.3 standard is not met, FNDC will undertake improvements to the KR-WWTP within the lifetime of the consent duration.
Policy 4.2.1 Improving overall water quality *Improve the overall quality of Northland's water resources by:* *(a) Establishing freshwater objectives and setting region-wide water quality limits in regional plans that give effect to Objective 3.2 of this regional policy statement.* *(b) Reducing loads of sediment, nutrients, and faecal matter to water from the use and development of land and from poorly treated and untreated discharges of wastewater; and* *(c) Promoting and supporting the active management, enhancement and creation of vegetated riparian margins and wetlands.*	

Table 11: Regional Policy Statement for Northland

<table>
<tr><th>Objective/Policy</th><th>Assessment</th></tr>
<tr><td colspan="2">Indigenous ecosystem and biodiversity</td></tr>
<tr><td>Objective 3.4 Indigenous ecosystems and biodiversity

Safeguard Northland's ecological integrity by:
a) Protecting areas of significant indigenous vegetation and significant habitats of indigenous fauna;
b) Maintaining the extent and diversity of indigenous ecosystems and habitats in the region; and
c) Where practicable, enhancing indigenous ecosystems and habitats, particularly where this contributes to the reduction in the overall threat status of regionally and nationally threatened species.

Policy 4.4.1 Maintaining and protecting significant ecological areas and habitats.

(1) In the coastal environment, avoid adverse effects, and outside the coastal environment avoid, remedy or mitigate adverse effects of subdivision, use and development so they are no more than minor on:
(a) Indigenous taxa that are listed as threatened or at risk in the New Zealand Threat Classification System lists;
(b) Areas of indigenous vegetation and habitats of indigenous fauna, that are significant using the assessment criteria in Appendix 5;
(c) Areas set aside for full or partial protection of indigenous biodiversity under other legislation.
(2) N/A
(3) Outside the coastal environment and where clause (1) does not apply, avoid, remedy or mitigate adverse effects of subdivision, use and development so they are not significant on any of the following:
(a) Areas of predominantly indigenous vegetation;
(b) Habitats of indigenous species that are important for recreational, commercial, traditional or cultural purposes;</td><td>The receiving environment of the KR-WWTP is both within and out of the CMA, therefore both points (1) and (3) of policy 4.4.1 are relevant.

The Uruti Bay wetlands are within the coastal environment, which is referred to as 'Wetland 1' in the Ecological Assessment. Wetland 1 is recorded to have matuku-hūrepo (Australian Bittern, Botaurus poiciloptilus, Threatened-Nationally Critical), pūweto (spotless crake, Porzana tabuensis, At-Risk Declining) and mātātā (North Island fernbird, Poodytes punctatus, At-Risk Declining). eDNA sampling also indicated longfin eel (Anguilla dieffenbachii) which has a conservation status of 'At Risk – Declining' to be present. However, the Ecological Effects Assessment (Appendix F) considers the discharge to be having only a low impact on the receiving ecological environment. No significant adverse effects were detected that require further avoidance.

It is important to note that the Uruti bay has been valued as a SEA whilst being the receiving environment for the wastewater. The discharge is not new, yet the area continues to be recognised for its high ecological value.

To ensure the discharge does not introduce any new effects, which aren't expected as the contaminant quantity and load are to remain the same, FNDC will monitor the wetland, for weed growth which is the most likely adverse effect from additional nutrients from the KR-WWTP.</td></tr>
</table>

Table 11: Regional Policy Statement for Northland

Objective/Policy	Assessment
(c) Indigenous ecosystems and habitats that are particularly vulnerable to modification, including wetlands, dunelands, northern wet heathlands, headwater streams, floodplains and margins of freshwater bodies, spawning and nursery areas. *(4) For the purposes of clause (1), (2) and (3), when considering whether there are any adverse effects and/or any significant adverse effects:* *(a) Recognise that a minor or transitory effect may not be an adverse effect;* *(b) Recognise that where the effects are or maybe irreversible, then they are likely to be more than minor;* *(c) Recognise that there may be more than minor cumulative effects from minor or transitory effects.* *(5) For the purpose of clause (3) if adverse effects cannot be reasonably avoided, remedied or mitigated then it may be appropriate to consider the next steps in the mitigation hierarchy i.e. biodiversity offsetting followed by environmental biodiversity compensation, as methods to achieve Objective 3.4.*	This AEE takes into account minor effects, as provided for by (4), however none of the effects listed in the Ecological Effects Assessment (Appendix F) are irreversible if the discharge were to cease. As the KR-WWTP is within its own small catchment, no other human activity contaminant sources are considered likely to cause cumulative effects. Wild fowl and animals within the catchment could however effect e. Coli levels.
Regionally Significant Infrastructure	
Objective 3.7 Regionally significant infrastructure *Recognise and promote the benefits of regionally significant infrastructure, (a physical resource), which through its use of natural and physical resources can significantly enhance Northland's economic, cultural, environmental and social wellbeing.*	This application seeks the reconsenting of RSI, which is an activity listed in Schedule 1 of the Civil Defence Emergency Management Act (Policy D2.9 (6)). The KR-WWP provides a functional need for the Kororāreka/Russell and Takepa Point communities by safely disposing of wastewater. Alternative methods and locations for disposal are assessed in the BPO. The BPO concludes that continuing discharges to the borefield is the BPO at this time. Water quality monitoring confirms that the existing discharge is not causing a significant adverse effect on wate quality,
Policy 5.3.2 – Regionally significant infrastructure Particular regard shall be had to the significant social, economic, and cultural benefits of regionally significant infrastructure when considering and determining resource consent applications or notices of requirement for regionally significant infrastructure.	

Table 11: Regional Policy Statement for Northland

Objective/Policy	Assessment
Policy 5.3.3 – Managing adverse effects arising from regionally significant infrastructure (1) *Allow adverse effects arising from the establishment and operation of new regionally significant infrastructure and the re-consenting of existing operations where:* (a) *The proposal is consistent with Policies 4.4.1(1), 4.4.1(2). 4.6.1(1)(a), 4.6.1(1)(b), 4.6.1(2) and 4.6.2 (1);* (b) *The proposal does not result in established water quality limits or environmental flows and / or levels being exceeded or otherwise could lead to the over-allocation of a catchment (refer to Policy 4.1.1);* (c) *Damage to and / or loss of the relationship of iwi with ancestral sites, sites of significance, wāhi tapu, customary activities and / or taonga is avoided or otherwise agreed to by the affected iwi or hapū; and* (d) *In addition to the matters outlined in 1) (a) – (c) above, other adverse effects are avoided, remedied or mitigated to the extent that they are no more than minor.* (2) *N/A* (3) *When managing the adverse effects of regionally significant infrastructure decision makers will give weight to:* (a) *The benefits of the activity in terms of Policy 5.3.2;* (b) *Whether the activity must be recognised and provided for as directed by a national policy statement;* (c) *Any constraints that limit the design and location of the activity, including any alternatives that have been considered which have proven to be impractical, or have greater adverse effects;*	however proposed monthly water quality monitoring will confirm this. If after two years the receiving environment is shown to not meet the water quality standards within H.3 of the pRPN, upgrades to the KR-WWTP will be undertaken to ensure effects are compliant with the standards where possible, as required by policy 5.3.3 (d). Condition (3) of policy 5.3.3 requires a balanced approach between the potential adverse effects of RSI, and the positive benefits the infrastructure provides. This includes consideration of BPO which has been undertaken. The proposal also has provision to update the BPO after 2 years of water quality results.

Table 11: Regional Policy Statement for Northland

Objective/Policy	Assessment
(d) Whether the proposal is for regionally significant infrastructure which is included in Schedule 1 of the Civil Defence Emergency Management Act as a lifeline utility and meets the reasonably foreseeable needs of Northland. *(e) The extent to which the adverse effects of the activity can be practicably reduced. Such an assessment shall also take into account appropriate measures, when offered, to provide positive effects, either within the subject site or elsewhere provided that the positive effects accrue to the community of interest and / or resource affected; and* *(f) Whether a monitoring programme for any identified significant adverse effects with unknown or uncertain outcomes could be included as a condition of consent and an adaptive management regime (including modification to the consented activity) is used to respond to such effects.* *(g) Whether the infrastructure proposal helps to achieve consolidated development and efficient use of land.*	
Efficient infrastructure	
Objective 3.8 – Efficient and effective infrastructure *Manage resource use to:* *(a) Optimise the use of existing infrastructure;* *(b) Ensure new infrastructure is flexible, adaptable, and resilient, and meets the reasonably foreseeable needs of the community; and* *(c) Strategically enable infrastructure to lead or support regional economic development and community wellbeing.*	As part of this proposal, FNDC will upgrade the KR-WWTP to optimise performance. Further upgrades may also be considered if water quality monitoring suggests further upgrades are the BPO. This approach of optimising the existing KR-WWTP is supported by Objective 3.8, Policy 5.2.1 and Policy 5.2.2.
Policy 5.2.1 – Managing the use of resources *Encourage development and activities to efficiently use resources, particularly network resources, water and energy, and promote the reduction and reuse of waste.*	

Table 11: Regional Policy Statement for Northland

Objective/Policy	Assessment
Policy 5.2.2 Future proofing infrastructure *Encourage the development of infrastructure that is flexible, resilient, and adaptable to the reasonably foreseeable needs of the community.*	
Tangata Whenua	
Objective 3.12 Tangata whenua role in decision-making *Tangata whenua kaitiaki role is recognised and provided for in decision-making over natural and physical resources.*	FNDC recognise the important of the role mana I te whenua play in resource management decision making. FNDC request that the public notification of this application is delayed under s.37 so mana i te whenua values understood and any concerns addressed.
Policy .1.1 Tangata Whenua *The regional and district councils shall provide opportunities for Tangata whenua to participate in the review, development, implementation, and monitoring of plans and resource consent processes under the Resource Management Act 1991.*	
Natural Character	
Policy 4.6.1 – Managing effects on the characteristics and ualities natural character, natural features and landscapes *(1) In the coastal environment:* *a) N/A* *b) Where (a) does not apply, avoid significant adverse effects and avoid, remedy or mitigate other adverse effects of subdivision, use and development on natural character, natural features and natural landscapes. Methods which may achieve this include:*	The Uruti Bay head mangroves are identified to have HNC and span the coastal and landward boundary, therefore Policy 4.6.1 is relevant to this application. The contributing factor of the Uruti Bay head mangroves to Natural character is the largely indigenous vegetation with few pest plants. Specifically, it is the continuum from mangroves, to saltmarsh to freshwater wetland. The Ecological Effects Assessment (Appendix F) concludes that the discharge from the KR-WWTP is not causing a significant adverse effect on the ecology, and therefore the natural character of Uruti Bay wetlands.

Table 11: Regional Policy Statement for Northland

Objective/Policy	Assessment
(i) Ensuring the location, intensity, scale and form of subdivision and built development is appropriate having regard to natural elements, landforms and processes, including vegetation patterns, ridgelines, headlands, peninsulas, dune systems, reefs and freshwater bodies and their margins; and *(ii) In areas of high natural character, minimising to the extent practicable indigenous vegetation clearance and modification (including earthworks / disturbance, structures, discharges and extraction of water) to natural wetlands, the beds of lakes, rivers and the coastal marine area and their margins; and* *(iii) Encouraging any new subdivision and built development to consolidate within and around existing settlements or where natural character and landscape has already been compromised.* *(2) N/A* *(3) When considering whether there are any adverse effects on the characteristics and qualities of the natural character, natural features and landscape values in terms of (1)(a), whether there are any significant adverse effects and the scale of any adverse effects in terms of (1)(b) and (2), and in determining the character, intensity and scale of the adverse effects:* *a) Recognise that a minor or transitory effect may not be an adverse effect;* *b) Recognise that many areas contain ongoing use and development that:* *(i) Were present when the area was identified as high or outstanding or have subsequently been lawfully established* *(ii) May be dynamic, diverse or seasonal;* *c) Recognise that there may be more than minor cumulative adverse effects from minor or transitory adverse effects; and d) Have regard to any restoration and enhancement on the characteristics and qualities of that area of natural character, natural features and/or natural landscape.*	The Ecological Effects Assessment (Appendix F) considers the KR-WWTP to be having less than minor effects on ecology within the receiving environment but acknowledges this is from a limited set of data. Therefore, proposed monitoring to ensure effects remain minor at most is proposed as conditions of consent. Included within this is the visual inspection of pest species. The Uruti Bay wetlands is recognised as having few pest plant species. Nutrients within wastewater can promote weed growth, so the proposed conditions are to monitor for pest plant growth, and to undertake pest plant control if there is a monitored increase in pest plants within the wetlands.

Table 12: Proposed Natural Resources Plan for Northland

Objective	Policy	Assessment
Water Quality		
F.1.2 Water Quality *Manage the use of land and discharges of contaminants to land and water so that:* *1) existing water quality is at least maintained, and improved where it has been degraded below the river, lake or coastal water quality standards set out in H.3 Water quality standards and guidelines, and* *2) the sedimentation of continually or intermittently flowing rivers, lakes and coastal water is minimised, and* *3) the life-supporting capacity, ecosystem processes and indigenous species, including their associated ecosystems, of fresh and coastal water are safeguarded, and the health of freshwater ecosystems is maintained, and* *4) the health of people and communities, as affected by contact with fresh and coastal water, is safeguarded, and*	**D.4.1 Maintaining overall water quality** *When considering an application for a resource consent to discharge a contaminant into water or onto or into 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 H.3 Water quality standards and guidelines 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 H.3 Water quality standards and guidelines; and* *b) consider whether any improvements to water quality are required in order to achieve F.1.2 Water quality;* *3) where a water quality standard in H.3 Water quality standards and guidelines is currently exceeded, ensure that any resource consent for a new discharge will not, or is not likely to, cause or contribute to a further exceedance of a water quality standard in H.3 Water quality standards and guidelines;* *4) where a water quality standard in H.3 Water quality standards and guidelines is currently exceeded and the exceedance of the water quality standard is caused or*	This application seeks to maintain water quality in the receiving environment by ensuring the same consent contaminant discharge rate and contaminant load as the previous consent. The Groundwater and Surface Water Quality Effects Assessment (Appendix D) notes that further information is required to determine if the water quality standards in H.3 are currently met. The proposed monitoring programme will be specifically tailored to ensure an assessment against the water quality criteria in Table H.3 can be made within two years of the consent being granted. Once further data has been collected, and if water quality needs to be improved, FNDC will assess if further upgrades to the KR-WWTP are required or if an alternative discharge location is the BPO. FNDC will implement the outcome of that decision within the duration of this consent. Any upgrades to meet the revised BPO will need to be implemented in a timeframe agreed with NRC. As there may be various upgrade requirements, it is not suitable to determine an upgrade timeframe without knowing what it may involve. This approach is supported through policy D.4.1 (4(a) and (b)) and (5). The Ecological Effects Assessment (Appendix F) confirms that even with the discharge currently occurring,

Table 12: Proposed Natural Resources Plan for Northland

Objective	Policy	Assessment
5) *the health and safety of people and communities, as affected by discharges of sewage from vessels, is safeguarded, and* 6) *the quality of potable drinking water sources, including aquifers used for potable supplies, is protected, and* 7) *the significant values of Outstanding Freshwater Bodies and natural wetlands are protected, and* 8) *kai is safe to harvest and eat, and recreational, amenity and other social and cultural values are provided for.*	*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 H.3 Water quality standards and guidelines; 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* 6) *where a discharge will, or is likely to, cause or contribute to:* a) *an exceedance of the coastal sediment quality guidelines in H.3.4 Coastal sediment quality guidelines, or* b) *a transitory exceedance of the toxicants, metals and metalloids standard in Table 22: Water quality standards for ecosystem health in rivers, and the activity is associated with the establishment, operation, maintenance or upgrade of Regionally Significant Infrastructure, determine whether higher levels of contaminants in the particular location*	indigenous biodiversity and ecosystems are not significantly adversely affected by the discharge which gives effect to Objective F.1.2 (3). Human contact with fresh and coastal water has been assessed in the QMRA to be of low risk to human health and is considered to be less than minor. There are no known sources of human drinking water downstream from the discharge, and based on the small catchment, it is not possible for a new groundwater take to occur without FNDC becoming aware as they are the property owners of the land downgradient of the of the disposal borefield.

Table 12: Proposed Natural Resources Plan for Northland

Objective	Policy	Assessment
	affected by the discharge can be provided for while still achieving F.1.2 Water quality, and set appropriate levels of contaminants in accordance with best practice methodology to safeguard the ecosystem values present at the location affected by the discharge; and *7) where existing water quality is unknown, or the effect of a discharge on water quality is unknown, the activity must be managed using a precautionary approach, which may include adaptive management. Note: For the purpose of (6)(b) of this policy, best practice methodology can be determined by reference to ANZECC2000 Australian and New Zealand Guidelines for Fresh and Marine Water Quality Number 4, Volume 1 or any replacement guidelines.*	
	D.4.3 Municipal, domestic and production land wastewater discharges *An application for resource consent to discharge municipal, domestic, horticultural or farm wastewater to water will generally not be granted unless:* *1) the storage, treatment and discharge of the wastewater is done in accordance with recognised industry good management practices, and* *2) a discharge to land has been considered and found not to be environmentally, economically or practicably viable.*	The BPO has assessed various options for the wastewater discharge. Options which are not good industry practice, were excluded from the short-list. When operated as designed, the treatment and discharge from the KR-WWTP represents good practice, as reported in the Performance Assessment Report (Appendix C). With the upgrades committed by FNDC to refurbish Pond#1 to provide more flow balancing, and replacing the UV system, along with the programme to complete refurbishment of the disposal bores, the discharge will

Table 12: Proposed Natural Resources Plan for Northland

Objective	Policy	Assessment
		be operating in accordance with good management practices. Appendix J) contains a recently updated OMM. FNDC propose as a condition of consent that the KR-WWTP is operated in accordance with this OMM, and that the OMM is reviewed and updated annually to ensure it continues to reflect best practice.
	D.4.5 Transitional policy under Policy A4 of the National Policy Statement for Freshwater Management 2017 *3) When considering an application for a discharge, the consent authority must have regard to the following matters:* *a) the extent to which the discharge would avoid contamination that will have an adverse effect on the life-supporting capacity of freshwater including on any ecosystem associated with freshwater, and* *b) the extent to which it is feasible and dependable that any more than minor adverse effect on freshwater, and on any ecosystem associated with freshwater resulting from the discharge will be avoided.* *4) When considering an application for a discharge, the consent authority must have regard to the following matters:*	The monitoring and Ecological Effects Assessment (Appendix F) demonstrates that the existing discharge is having a low impact on the ecosystems within the freshwater. Without the wastewater flow contributing to the small streams, the small streams are more likely to be considered overland flow paths, of which they would have limited life supporting capacity. The existing discharge is not causing contamination that is having an adverse effect on the health of people and communities as affected by their contact with the freshwater. The more rigorous monitoring proposed is considered appropriate to ensure that the discharge does not result in any more than minor effects.

Table 12: Proposed Natural Resources Plan for Northland

Objective	Policy	Assessment
	a) the extent to which the discharge would avoid contamination that will have an adverse effect on the health of people and communities as affected by their contact with freshwater, and *b) the extent to which it is feasible and dependable that any more than minor adverse effect on the health of people and communities as affected by their contact with freshwater resulting from the discharge will be avoided.* *5) This policy applies to the following discharges (including a diffuse discharge by any person or animal): a) a new discharge, or b) a change or increase in any discharge of any contaminant into freshwater, or onto or into land in circumstances that may result in that contaminant (or, as a result of any natural process from the discharge of that contaminant, any other contaminant) entering freshwater.*	
Indigenous biodiversity		
F.1.3 Indigenous ecosystems and biodiversity *In the coastal marine area and in freshwater bodies, safeguard ecological integrity by:* *2) protecting areas of significant indigenous vegetation and significant habitats of indigenous fauna, and*	***D.2.18 Managing adverse effects on indigenous biodiversity*** *Manage the adverse effects of activities on indigenous biodiversity by:* *6) in the coastal environment:* *a) avoiding adverse effects on:* *i. indigenous taxa that are listed as threatened or at risk in the New Zealand Threat Classification System lists, and*	The receiving environment of the KR-WWTP includes the freshwater environment and the CMA. Therefore, both points (1) and (2) of policy D.2.18 are relevant. The Uruti Bay is an area of Significant Marine Mammal and Seabird and SEA so point (3) must also be considered. The Uruti Bay wetlands are within the CMA, which is referred to as 'Wetland 1' in the Ecological Effects Assessment (Appendix F). Wetland 1 is recorded to have avifauna and fish species that are classified as 'At-

Table 12: Proposed Natural Resources Plan for Northland

Objective	Policy	Assessment
3) maintaining regional indigenous biodiversity, and *4) where practicable, enhancing and restoring indigenous ecosystems and habitats to a healthy functioning state, and reducing the overall threat status of regionally and nationally threatened or at risk species, and* *5) preventing the introduction of new marine or freshwater pests into Northland and slowing the spread of established marine or freshwater pests within the region.*	*ii. the values and characteristics of areas of indigenous vegetation and habitats of indigenous fauna that are assessed as significant using the assessment criteria in Appendix 5 of the Regional Policy Statement, and* *iii. areas set aside for full or partial protection of indigenous biodiversity under other legislation, and* *b) avoiding significant adverse effects and avoiding, remedying or mitigating other adverse effects on:* *i. areas of predominantly indigenous vegetation, and* *ii. habitats of indigenous species that are important for recreational, commercial, traditional or cultural purposes, and* *iii. indigenous ecosystems and habitats that are particularly vulnerable to modification, including estuaries, lagoons, coastal wetlands, intertidal zones, rocky reef systems, eelgrass, northern wet heathlands, coastal and headwater streams, spawning and nursery areas and saltmarsh, and* *7) outside the coastal environment:* *a) avoiding, remedying or mitigating adverse effects so they are no more than minor on:*	risk Declining’ and ‘Threatened-Nationally Critical’. However, the Ecological Effects Assessment (Appendix F) considers the discharge to be having only a low impact on the receiving ecological environment. No significant adverse effects were detected that require further avoidance. It is important to note that the Uruti bay has been valued as a SEA whilst being the receiving environment for the wastewater. The discharge will not be a new effect on the wetland; therefore, the high value of the wetland takes this discharge into account. To ensure the discharge does not introduce any new effects, although this is not expected, FNDC will monitor the wetland, in particular for weed growth which is the most likely adverse effect from the increase in nutrients.

Table 12: Proposed Natural Resources Plan for Northland

Objective	Policy	Assessment
	i. indigenous taxa that are listed as threatened or at risk in the New Zealand Threat Classification System lists, and *ii. areas of indigenous vegetation and habitats of indigenous fauna, that are significant using the assessment criteria in Appendix 5 of the Regional Policy Statement, and* *iii. areas set aside for full or partial protection of indigenous biodiversity under other legislation, and* *b) avoiding, remedying or mitigating adverse effects so they are not significant on:* *i. areas of predominantly indigenous vegetation, and* *ii. habitats of indigenous species that are important for recreational, commercial, traditional or cultural purposes, and* *iii. indigenous ecosystems and habitats that are particularly vulnerable to modification, including wetlands, wet heathlands, headwater streams, spawning and nursery areas, and* *8) recognising areas of significant indigenous vegetation and significant habitats of indigenous fauna include:* *a) Significant Ecological Areas, and*	

Table 12: Proposed Natural Resources Plan for Northland

Objective	Policy	Assessment
	b) Significant Bird Areas, and *c) Significant Marine Mammal and Seabird Areas, and* *9) recognising damage, disturbance or loss to the following as being potential adverse effects:* *a) connections between areas of indigenous biodiversity, and* *b) the life supporting capacity of the area of indigenous biodiversity, and* *c) flora and fauna that are supported by the area of indigenous biodiversity, and* *d) natural processes or systems that contribute to the area of indigenous biodiversity, and* *10) assessing the potential adverse effects of the activity on identified values of indigenous biodiversity, including by:* *a) taking a system-wide approach to large areas of indigenous biodiversity such as whole estuaries or widespread bird and marine mammal habitats, recognising that the scale of the effect of an activity is proportional to the size and sensitivity of the area of indigenous biodiversity, and* *b) recognising that existing activities may be having existing acceptable effects, and* *c) recognising that minor or transitory effects may not be an adverse effect, and*	

Table 12: Proposed Natural Resources Plan for Northland

Objective	Policy	Assessment
	d) recognising that where effects may be irreversible, then they are likely to be more than minor, and *e) recognising that there may be more than minor cumulative effects from minor or transitory effects, and* *11) recognising that appropriate methods of avoiding, remedying or mitigating adverse effects may include:* *a) careful design, scale and location proposed in relation to areas of indigenous biodiversity, and* *b) maintaining and enhancing connections within and between areas of indigenous biodiversity, and* *c) considering the minimisation of effects during sensitive times such as indigenous freshwater fish spawning and migration periods, and* *d) providing adequate setbacks, screening or buffers where there is the likelihood of damage and disturbance to areas of indigenous biodiversity from adjacent use and development, and* *e) maintaining the continuity of natural processes and systems contributing to the integrity of ecological areas, and f) the development of ecological management and restoration plans, and* *12) recognising that significant residual adverse effects on biodiversity values can be offset or compensated:*	

Table 12: Proposed Natural Resources Plan for Northland

Objective	Policy	Assessment
	a) in accordance with the Regional Policy Statement for Northland Policy 4.4.1, and *b) after consideration of the methods in (6) above, and* *13) recognising the benefits of activities on biodiversity values that:* *a) restore, protect or enhance ecosystems, habitats and processes, ecological corridors and indigenous biodiversity, and* *b) improve the public use, value or understanding of ecosystems, habitats and indigenous biodiversity.*	
Economic wellbeing		
F.1.5 Enabling economic well-being *The use and development of Northland's natural and physical resources is efficient and effective and managed in a way that will improve the economic, social and cultural well-being of Northland and its communities.*	**D.2.2 Social, cultural and economic benefits of activities** *Regard must be had to the social, cultural and economic benefits of a proposed activity, recognising significant benefits to local communities, Māori and the region including local employment and enhancing Māori development, particularly in areas of Northland where alternative opportunities are limited.*	The proposal results in little economic gain for the region, limited to the continued employment of KR-WWTP operating staff. The economic benefit of the proposal is the financial savings to the community as ratepayers by upgrading and continuing to use the existing infrastructure. Providing wastewater service enables the community to function in a healthy state by limiting infection and disease.

Table 12: Proposed Natural Resources Plan for Northland		
Objective	**Policy**	**Assessment**
Regionally Significant Infrastructure		
F.1.6 Regionally Significant Infrastructure *Recognise the national, regional and local benefits of Regionally Significant Infrastructure and renewable energy generation and enable their effective development, operation, maintenance, repair, upgrading and removal.*	**D.2.5 Benefits of Regionally Significant Infrastructure** *Particular regard must be had to the national, regional and locally significant social, economic, and cultural benefits of Regionally Significant Infrastructure.* **D.2.7 Minor adverse effects arising from the establishment and operation of Regionally Significant Infrastructure** *Enable the establishment and operation (including reconsenting) of Regionally Significant Infrastructure by allowing any minor adverse effects providing:* *1) The Regionally Significant Infrastructure proposal is consistent with:* *a) all policies in D.1 Tāngata whenua, and* *b) D.2.16 Managing adverse effects on Historic Heritage, and c) D.2.17 Managing adverse effects on Natural Character, Outstanding Natural Landscapes and Outstanding Natural Features, and* *c) D.2.18 Managing adverse effects on indigenous biodiversity, and* *2) the Regionally Significant Infrastructure proposal will not likely result in over-allocation having regard to the allocation limits in H.4.3 Allocation limits for rivers, and*	This application seeks the reconsenting of RSI, which is an activity listed in Schedule 1 of the Civil Defence Emergency Management Act 2002 (Policy D2.9 (6)). The KR-WWTP provides a functional need for the Kororāreka / Russell and Takepa Point communities by safely disposing of wastewater. Alternative methods and locations for disposal are assessed in the BPO. However, at this point in time, the BPO is to continue the existing operations. FNDC recognise that it has not yet assessed the short-list BPO options against mana I te whenua values, which will be included after more engagement with mana I te whenua. To manage minor effects from the KR-WWTP, an AMA is proposed as described in section 5.3. Immediate improvements to the KR-WWTP involve the repair and upgrade of Pond #1 and the UV system. There will be no adverse effects associated with these upgrades. As assessed above, the application has not been fully assessed against all policies in D.1 relating to Tāngata whenua. FNDC request that public notification of this application is delayed under s.37 to allow for further engagement to understand the cultural effects of the proposal. Should effects of the proposal result in

Table 12: Proposed Natural Resources Plan for Northland

Objective	Policy	Assessment
	3) *other adverse effects arising from the Regionally Significant Infrastructure are avoided, remedied, mitigated or offset to the extent they are no more than minor.*	unacceptable effects on mana I te whenua values, FNDC propose to work with mana I te whenua to find an appropriate solution either through mitigation of the existing discharge, or updating and implementing the BPO.
	D.2. Maintenance, repair and upgrading of Regionally Significant Infrastructure Enable the maintenance and upgrading of established Regionally Significant Infrastructure wherever it is located by allowing adverse effects, where: 1) the adverse effects whilst the maintenance or upgrading is being undertaken are not significant or they are temporary or transitory, and 2) the adverse effects after the conclusion of the maintenance or upgrading are the same, or similar, to those arising from the Regionally Significant Infrastructure before the activity was undertaken.	
	D.2.9 Appropriateness of Regionally Significant Infrastructure proposals (except the National Grid) *When considering the appropriateness of a Regionally Significant Infrastructure activity (except the National Grid), have regard and give appropriate weight to:* 1) *the benefits of the activity in terms of D.2.5 Benefits of Regionally Significant Infrastructure, and* 2) *whether the activity must be recognised and provided for by a National Policy Statement, and*	

Table 12: Proposed Natural Resources Plan for Northland

Objective	Policy	Assessment
	3) any demonstrated functional need for the activity, and *4) the extent to which any adverse environmental effects have been avoided, remedied or mitigated by route, site or method selection, and* *5) any operational, technical or location constraints that limit the design and location of the activity, including any alternatives that have been considered which have proven to be impractical, or have greater adverse effects, and* *6) whether the activity is for Regionally Significant Infrastructure which is included in Schedule 1 of the Civil Defence Emergency Management Act as a lifeline utility and meets the reasonably foreseeable needs of Northland, and* *7) the extent to which the adverse effects of the activity can be practicably managed, inclusive of any positive effects and environmental offsets or compensation proposed, and* *8) whether an adaptive management regime (including modification to the consented activity) can be used to manage any uncertainty around the occurrence of residual adverse effects, and* *9) whether the activity helps to achieve consolidated development and the efficient use of land and resources, including within the coastal marine area.*	

Table 12: Proposed Natural Resources Plan for Northland

Objective	Policy	Assessment
Tangata whenua involvement and values		
F.1.9 Tangata whenua role in decision making *Tāngata whenua's kaitiaki role is recognised and provided for in decision making over natural and physical resources.*	**D.1.1 When an analysis of effects on tāngata whenua and their taonga is required** *A resource consent application must include in its assessment of environmental effects an analysis of the effects of an activity on tāngata whenua and their taonga if one or more of the following is likely:* *1) adverse effects on mahinga kai or access to mahinga kai, or* *2) any damage, destruction or loss of access to wāhi tapu, sites of customary value and other ancestral sites and taonga with which Māori have a special relationship, or* *3) adverse effects on indigenous biodiversity in the beds of waterbodies or the coastal marine area where it impacts on the ability of tāngata whenua to carry out cultural and traditional activities, or* *4) the use of genetic engineering and the release of genetically modified organisms to the environment, or 5) adverse effects on taiāpure, mataitai or Māori non-commercial fisheries, or* *5) adverse effects on protected customary rights, or* *6) adverse effects on Sites and Areas of Significance to Tāngata Whenua mapped in the Regional Plan.*	Consultation with mana i te whenua is ongoing. A CIA has not been received yet for this project. FNDC will provide the CIA to NRC once engagement has progressed further, as it would be inappropriate to assess cultural effects without mana i te whenua input. The QMRA (Appendix H) considers the risk of consumption of raw shellfish collected from within the receiving Uruti Bay from discharges from the KR-WWTP. The risk of gastrointestinal illness based on expected performance is modelled to be 0.038%. It is recognised that gastrointestinal illness risk is not the only factor which mana I te whenua may consider when choosing to collect kai moana, however this will be informed through consultation.

Table 12: Proposed Natural Resources Plan for Northland

Objective	Policy	Assessment
	D.1.2 Re uirements of an analysis of effects on tāngata whenua and their taonga *If an analysis of the effects of an activity on tāngata whenua and their taonga is required in a resource consent application, the analysis must:* *1) include such detail as corresponds with the scale and significance of the effects that the activity may have on tāngata whenua and their taonga, and* *2) have regard to (but not be limited to):* *a) any relevant planning document recognised by an iwi authority (lodged with the Council) to the extent that its content has a bearing on the resource management issues of the region, and* *b) the outcomes of any consultation with tāngata whenua with respect to the consent application, and* *c) statutory acknowledgements in treaty settlement legislation, and* *3) follow best practice, including requesting, in the first instance, that the relevant tāngata whenua undertake the assessment, and* *4) specify the tāngata whenua that the assessment relates to, and* *5) be evidence-based, and*	To enable mana i te whenua to have meaningful contribution to the decision making associated with this consent application, further consultation between FNDC and tāngata whenua is required. FNDC propose to provide NRC with a full assessment of cultural effects which meets the requirements of Policy D.1.2. This will be supplied as soon as possible, and before a decision is made on this application.

Table 12: Proposed Natural Resources Plan for Northland

Objective	Policy	Assessment
	6) *incorporate, where appropriate, Mātauranga Māori, and 7) identify and describe all the cultural resources and activities that may be affected by the activity, and* 7) *identify and describe the adverse effects of the activity on the cultural resources and cultural practices (including the effects on the mauri of the cultural resources, the cultural practices affected, how they are affected, and the extent of the effects), and* 8) *identify, where possible, how to avoid, remedy or mitigate the adverse effects on cultural values of the activity that are more than minor, and* **9)** *10) include any other relevant information.*	
	D.1.3 Affected persons *The following persons must be considered an affected person regarding notification where the adverse effects on the following resources and activities are minor or more than minor:* *Table 16*	FNDC has requested public notification recognising the importance of public participation in determining activities which relate to public infrastructure.
Air Quality		
F.1.13 Air Quality *Human health, ambient air quality, cultural values, amenity values and the environment are protected from significant adverse*	**D.3.1 General Approach to managing air quality** **D.3.2 General approach to managing adverse effects of discharges to air**	The Air Quality Effects Assessment concludes that odour effects from the KR-WWTP are not likely to increase. There are no records of odour complaints from the KR-WWTP, and this is not expected to change due to the operational processes and distance from the nearest

Table 12: Proposed Natural Resources Plan for Northland

Objective	Policy	Assessment
effects caused by the discharge of contaminants to air.	*Adverse effects from the discharge of contaminants to air are managed by:* *1) avoiding, remedying, or mitigating cross-boundary effects on dust, odour, smoke and spray-sensitive areas from discharges of dust, smoke, agricultural spray drift and odour; and* *2) protecting dust, odour, smoke and spray-sensitive areas from exposure to dangerous or noxious levels of gases or airborne contaminants; and* *3) recognising that land use change can result in reverse sensitivity effects on existing discharges to air, but existing discharges should be allowed to continue where appropriate.*	sensitive receiver. Should the odour risk increase, or complaints be received, FNDC will prepare and implement and Odour Management Plan. At present, and Odour Management Plan is not considered necessary due to the current and expected low odour effects.
	D.3.4 Dust and odour generating activities *When considering resource consent applications for discharges to air from dust or odour generating activities:* *1) require a dust or odour management plan to be produced where there is a likelihood that there will be objectionable or offensive discharges of dust or odour at the boundary of the site where the activity is to take place, or where the activity is likely to cause a breach of the ambient air quality standard for PM10 in Schedule 1 of the National Environmental Standard for Air Quality. The dust or odour management plan must include: a) a description of dust or odour generating activities, and b) potentially affected dust-sensitive areas or odour-sensitive areas, and c) details of good management practices that will be used to control dust or odour to the extent that adverse effects from dust or odour at the boundary of the site are avoided, remedied or mitigated, and* *2) N/A*	

Appendix L: Draft Proposed Conditions of Consent

Suggested conditions of consent

To undertake the following activities associated with the Kororāreka/Russell Wastewater Treatment Plant (KR-WWTP) on Sec 1 SO 310696 Blk I Russell SD at or about location co-ordinates 1703384E 6096527N:

AUT.XXXXXXXXX:	To discharge treated wastewater, including Russell Landfill leachate, to land via disposal boreholes.
AUT. XXXXXXXXX:	To discharge contaminants to air (primarily odour) from the treatment plant and borehole disposal areas.

(Note: All location co-ordinates refer to Geodetic Datum 2000, New Zealand Transverse Mercator Projection)

Subject to the following conditions:

AUT.XXXXXXXX DISCHARGES OF CONTAMINANTS TO LAND

General

1. All activities to which this resource consent relates shall be undertaken generally in accordance with the information contained in the resource consent application documents and subsequently provided further application information including the following, in order of precedence:

   (a) Any documentation that has received written certification under the conditions of this consent from the Northland Regional Council (NRC).

   (b) Response to section 92 (Resource Management Act 1991 (RMA)) request for information - dated xxx [IF APPLICABLE].

   (c) The application, assessment of effects and supporting documentation (NRC doc xxx)

   Where there is any inconsistency between the application documentation and these resource consent conditions, the resource consent conditions shall prevail, and more recent documents must take precedence.

Influent / Effluent Quantity Monitoring

2. The Consent Holder must maintain a flow meter on the inlet to the treatment plant, and outlet prior to the ultraviolet light disinfection system. This meter must have a measurement error of ±5% or less.

3. The consent holder must keep a record of the total daily volume and instantaneous rate of discharge from the wastewater treatment plant using the meter required by condition 2. A copy of these records must be provided to Northland Regional Council (NRC) as required by Schedule 1 (1.0) and upon written request by the NRC's assigned monitoring officer.

4. To maintain the specified accuracy of the meter required by Condition 2, the meter must be calibrated annually, or at a duration specified by the manufacturer, by a suitably qualified and experienced person in accordance with the manufacturer's' instructions. The Consent Holder must provide the most recent calibration certificate to the NRC's assigned monitoring officer upon written request.

D R A F T

Limits

5. The volume of treated wastewater discharged from the outlet of the KR-WWTP to the borehole disposal system must not exceed 1,235 cubic metres per day. For compliance purposes, “per day” must be calculated as being 00.00 to 23.59.

6. The contaminant concentration of the following parameters in the treated wastewater, as measured at NRC sampling site 105944 (Russell Sewage @ Plant after UV), must not exceed the following limits:

Parameter	Unit	50th percentile Concentration	90th percentile Concentration
Five Day Biochemical Oxygen Demand (BODs)	g/m³	10	25
Total Suspended Solids (TSS)	g/m³	10	25
Total Kjeldahl Nitrogen (TKN)	g/m³	20	40
Total Phosphorus (TP)	g/m³	15	30

Compliance with the 50th and 90th percentile concentrations shall be in accordance with Section X of Schedule 1 (attached).

7. The concentration of *Escherichia coli* (*E. coli*) bacteria in the treated wastewater, as measured at NRC sampling site 105944 (Russell Sewage @ Plant after UV), must not exceed:

   (a) A 50th percentile concentration of 50 per 100 millilitres; nor

   (b) A maximum concentration of 1,000 per 100 millilitres in any single sample.

   For compliance purposes, the 50th percentile concentrations shall be in accordance with Section X of Schedule 1 (attached).

8. There must be no ponding or surface runoff of treated wastewater caused by the borehole disposal activity.

Groundwater Monitoring

9. Within three (3) months of commencement of this consent, the consent holder must submit a Groundwater Monitoring Infrastructure Report (GMIF) prepared by a suitably qualified and experienced person (SQEP) to NRC's Monitoring Manager for certification.

   The infrastructure required by the GMIF must be installed in accordance with the certified GMIF within 3 months of the GMIF being certified by NRC.

10. Following installation of the Groundwater Monitoring Infrastructure required by condition 9, the Consent holder must monitor groundwater quality and groundwater levels as per Schedule 1 Sections 4.0 (Attached).

11. After one year of quarterly groundwater monitoring as required by Schedule 1 (4), the Consent Holder must prepare a report prepared by a suitably qualified and experienced person (SQEP) which assesses the effects of the discharge on groundwater quality, and mounding. If the report concludes that the effects require additional mitigation or monitoring to be undertaken, this should be completed.

Natural Wetland Monitoring and Assessment

12. The Consent Holder must submit a Natural Wetland Assessment Report (NWAR) prepared by a suitably qualified and experienced person (SQEP) to the NRC's Monitoring Manager by 31 May each year. The NWAR must include, but not be limited to:

    (a) All records for wetland monitoring required by Schedule 1 Section 5.0.

    (b) An assessment of whether there has been any change in wetland condition as a result of nutrient discharges from the KR-WWTP and if so,

    (c) Recommended mitigation within the wetlands.

    All recommendations from the NWAR must be implemented within the timeframes recommended in the NWAR, or at another time as agreed by the Compliance Manager, NRC.

    If after three years of wetland monitoring it is determined that the KR-WWTP discharge is causing adverse effects to the wetland that are consistent with the envelope of effects anticipated within the AEE, then wetland monitoring can be ceased.

Receiving Environment Water Quality

13. After two years of monitoring water quality in accordance with Schedule 1(4), the Consent Holder must engage a SQEP to assess the results to determine if it meets the relevant water quality guidelines in the National Policy Statement for Freshwater Management 2020 (NPSFM) and Regional Plan (or relevant water quality standards at that time).

14. If the assessment under Condition 12 determines that water quality at sites monitored under Schedule 1(4) meets the NPSFM and Regional Plan water quality guidelines (or relevant water quality standards at that time), monitoring in Schedule 1(4.0) may reduce in frequency to twice per year.

Best Practicable Option (BPO)

15. If the assessment under Condition 12 determines that water quality at sites monitored under Schedule 1(4.0) do not meet the minimum NPSFM and Regional Plan water quality guidelines (or relevant water quality standards at that time) as a result of the consent holders discharge, the Consent Holder must revise the BPO assessment to identify discharge options that are able to meet these guidelines or contribute to betterment where the consent holder is not solely responsible for the exceedance.

16. If the revised BPO assessment required under Condition 14 identifies:

    (a) further upgrades to the KR-WWTP as the BPO, these upgrades should be completed and made operational within the duration of this consent.

    (b) an alternative discharge location or method to be the BPO, the Consent Holder must report by 31 May annually to NRC and [*Parties to be determined*] on progress towards implementing this alternative BPO at the expiry of this consent.

Inflow and Infiltration

17. The Consent Holder must submit to the NRC's Monitoring Manager, an annual programme of works that are proposed to be undertaken to investigate and minimise stormwater infiltration and groundwater inflows into the sewerage reticulation system.

18. The Consent Holder must submit a written report to the NRC's Monitoring Manager by the 31 May each year that provides details of the outcome of any stormwater infiltration and groundwater inflow investigation works undertaken in accordance with the annual programme prepared in accordance with Condition 16.

19. Safe and easy access to NRC Sampling Site 105944 (Russell Sewage @ Plant after UV) and NRC Sampling Site XXXXX (Receiving Small streams) must be provided for consent compliance and audit monitoring purposes.

AUT.XXXXXXXX DISCHARGE OF CONTAMINANTS TO AIR

20. There must be no discharge of contaminants to air at or beyond the legal boundary of Sec 1 SO 310696 Blk I Russell SD that are noxious, toxic, dangerous, offensive or objectionable to such an extent that it has, or is likely to have, a more than minor adverse effect on the environment.

General Conditions (Applies to both consents)

Operations and Maintenance

21. The Consent Holder must keep and maintain a written record of all servicing and maintenance carried out on the wastewater treatment and bore disposal system, and forward a copy of this record to the NRC's Monitoring Manager by the 31 May each year, and also upon request by that manager.

22. As a minimum, the operation and maintenance of the wastewater treatment and disposal system must be carried out in accordance with the most recent version of the Operations and Maintenance Manual (OMM) for the system, but also always subject to the conditions of these consents. The OMM must include, but not be limited to, the following:

    (a) A schedule, including frequencies, of regular inspection, servicing, and maintenance items to be carried out on the treatment and disposal systems;

    (b) Contingency measures for unauthorised discharges; and

    Changes may be made at any time to the OMM subject to certification by NRC's Monitoring Manager. An amended OMM is not operative until it has been certified by NRC's Monitoring Manager at which time it will be deemed the relevant version for compliance purposes.

Proposed upgrades

23. Within three (3) months of commencement of this consent, the Consent Holder must have refurbished Pond#1 for flow balancing purposes.

24. Within two (2) months of commencement of this consent, the Consent Holder must have replaced the UV Unit.

25. Within one (1) year of commencement of this consent, the Consent Holder must update the OMM to ensure it includes the operation and maintenance procedures for the refurbished pond required by condition 22, and the replaced UV system required by condition 23.

General conditions

26. The Consent Holder must undertake monitoring in accordance with Schedule 1 (attached). Changes may be made to Schedule 1 with the written approval of the NRC's Monitoring Manager.

27. The Consent Holder must, for the purposes of adequately monitoring the consent as required under Section 35 of the RMA, on becoming aware of any contaminant associated with the Consent Holder's operations escaping otherwise than in conformity with this consent:

(a) Immediately take such action, or execute such work as may be necessary, to stop and/or contain such escape; and

(b) Immediately notify NRC by telephone of an escape of contaminant; and

(c) Take all reasonable steps to remedy or mitigate any adverse effects on the environment resulting from the escape; and

(d) Report to the NRC's Monitoring Manager in writing within one (1) week of the cause of the escape of the contaminant and the steps taken or being taken to effectively control or prevent such escape.

(e) With regard to telephone notification, during NRC's opening hours NRC's assigned monitoring officer for these consents must be contacted. If that person cannot be spoken to directly, or it is outside of the NRC's opening hours, then the Environmental Hotline must be contacted.

28. The Consent Holder must pay reasonable costs of all testing of water and shellfish product that may be required by the Authorised Health Protection Officer in cases where a shellfish growing area has been closed by the Authorised Health Protection Officer due to a sewage spill from any part of the Russell wastewater treatment plant or borehole disposal system.

29. The NRC may, in accordance with Section 128 of the Resource Management Act 1991, serve notice on the Consent Holder of its intention to review the conditions of these consents:

(a) Annually during the month of November for any one or more of the following purposes:

i. To deal with any adverse effects on the environment that may arise from the exercise of the consent following assessment of the results of the monitoring of the consent and/or as a result of NRC's monitoring of the state of the environment, or

ii. To require the adoption of the best practicable option to remove or reduce any adverse effect on the environment; or

iii. To change existing, or impose new limits on conditions relating to the quality of the discharges and/or compliance standards to be met in the receiving waters.

(b) Within three months of formally receiving a written report that is required by these consents.

(c) The Consent Holder must meet all reasonable costs of any such review.

SCHEDULE 1

Monitoring Programme

The Consent Holder must undertake the monitoring specified in this schedule.

All samples must be collected using National Environmental Monitoring Standards (NEMS) procedures and stored in appropriate laboratory supplied containers.

All samples collected must be transported in accordance with NEMS procedures to the laboratory.

All samples must be analyses at an accredited laboratory with registered quality assurance procedures, and all analyses are to be undertaken using standard methods, where applicable. Registered Quality Assurance Procedures are procedures which ensure that the laboratory meets recognised management practices and would include registrations such as ISO 9000, ISO Guide 25, Ministry of Health Accreditation. The Consent Holder is to monitor attributes associated with the exercise of this consent in accordance with the following monitoring programme.

1.0 Wastewater Volumes

The Consent Holder must keep a written record of the daily volume of wastewater discharged, midnight to midnight, from the outlet of the treatment system using the meter required to be installed and maintained by Condition 2.

The Consent Holder must also keep a written record of the total volume of treated wastewater discharged to each individual disposal borehole group every month.

The Consent Holder must forward copies of these records monthly to the NRC and also immediately upon written request.

2.0 Treated Wastewater Quality

The following sampling and analyses must be undertaken on at least one occasion each fortnight.

During each sampling occasion, a composite wastewater sample must be collected at NRC Sampling Site 105944 (Russell Sewage @ Plant after UV).

The composite wastewater sample must be analysed for the following:

Table 1: Wastewater Sampling Requirements

Parameter
Five Day Biochemical Oxygen Demand (BODs)
Total Suspended Solids (TSS)
Total Kjeldahl Nitrogen
Total Phosphorus
Escherichia coli

Notes:

a) Temperature, pH and dissolved oxygen (DO) concentration must be recorded in the wastewater samples using an appropriate meter, and in accordance with standard procedures.

b) Analysis is to be conducted on a composite sample made up of equal volumes of each triplicate sample.

c) Any significant odours at the site are also to be noted and recorded in the monitoring report.

3.0 Compliance With Conditions 5 & 6

Compliance with the 50th and 90th percentile values shall be determined OVER a fixed 12-month period. The 50th and 90th percentile values shall be calculated using the "fortnightly" monitoring results required by Section 2 of this schedule and any monitoring results from audit sampling undertaken by the NRC.

The number of allowable exceedances within a 12-month period for the 50th and 90th percentile is shown in the following table:

Number of Samples	**50th Percentile value: Allowable number of exceedances**	**90th percentile value: Allowable number of exceedances**
12	6	1
13	7	1
14	7	1
15	8	2
16	8	2
17	9	2

4.0 Receiving Environment Water Quality

Sampling and analysis of the receiving environment must be undertaken as per Table 2 below.

Table 2: Receiving Water Quality Sampling Requirements

Sample Location	Frequency	Parameters
Groundwater monitoring bores	**Quarterly**	Groundwater level. Nitrate-N Nitrite-N Ammonia as N DRP Total Phosphorus *E. coli*
Insert new NRC sampling sites for small streams S1, S2-S7 (See Map 1)	**Monthly***	Nitrate-N Nitrite-N Ammonia as N DRP Total Phosphorus E. coli cBOD5 Electrical Conductivity pH Arsenic Chromium Copper Lead Zinc Temperature Dissolved Oxygen
*May reduce in frequency to twice per year in accordance with Condition 13.		

5.0 Natural Wetland Monitoring and Assessment

The consent holder must annually assess Wetland 1 (see Map 2) for pest plant growth and wetland plant composition. Monitoring must be undertaken by a suitably qualified ecologist and involve a walkover of each wetland with notes recording the location and abundance of pest plant species.

An assessment of change over time is to be considered on a site-by-site basis, rather than for the purposes of an upstream-downstream comparison.

Wetland assessment monitoring should be undertaken as per Table 3.

Table 3: Wetland monitoring

Sample Location	Frequency	Parameters
Insert new NRC sampling sites for EC01-EC04 (Map 2)	Biannually during a) November/December, and b) May/June	• eDNA and benthic macroinvertebrates • Water quality samples consisting of parameters listed in Table 2.
Insert new NRC sampling sites for EC05 (Map 2)	Biannually during a) November/December, and b) May/June	• eDNA • Water quality samples consisting of parameters listed in Table 2.

D R A F T

6.0 Wastewater pond assessment

The Consent Holder must annually visually inspect the structural integrity of the bund around Pond # 1 and Pond #2. Any defects should be repaired as soon as possible.

7.0 Non-Compliances

The Consent Holder must notify NRC's Monitoring Manager of any non-compliance with any conditions of consent within 48 hours of the results of the monitoring required by Sections 1 to 3 become known to the Consent Holder.

8.0 Collection of Samples

All samples must be collected using standard procedures and in appropriate laboratory supplied containers.

All samples collected as part of this monitoring programme must be transported in accordance with standard procedures and under chain of custody to the laboratory.

All samples taken must be analysed at a laboratory with registered quality assurance procedures#, and all analyses are to be undertaken using standard methods, where applicable.

Registered Quality Assurance Procedures are procedures which ensure that the laboratory meets recognised management practices as would include registrations such as ISO 9000, ISO Guide 25, Ministry of Health Accreditation.

9.0 Reporting

Monthly Reporting

The Consent Holder must forward a report to the NRC's Monitoring Manager and [Parties to be determined] by the 15th of each month for the preceding calendar month that provides the following:

(a) The wastewater volumes required by Section 1 of this schedule;

(b) Monitoring results of Section 2, 3 and 4 of this schedule;

(c) Assessment of compliance with Conditions 5 and 7 in accordance with Section 3 of this schedule;

(d) If there is a non-compliance with Conditions 5 and 7, reasons for the non- compliances and any measures undertaken to prevent further non-compliance for that reason.

All required numerical monitoring results must be provided in a Microsoft Excel spreadsheet, or otherwise an alternative format agreed to beforehand with the Regional Council.

Annual Reporting

The Consent Holder must prepare and forward an annual report to the NRC's Monitoring Manager and [*Parties to be determined*] by 31 May each year that provides the following:

a) All monitoring results required by Schedule 1.

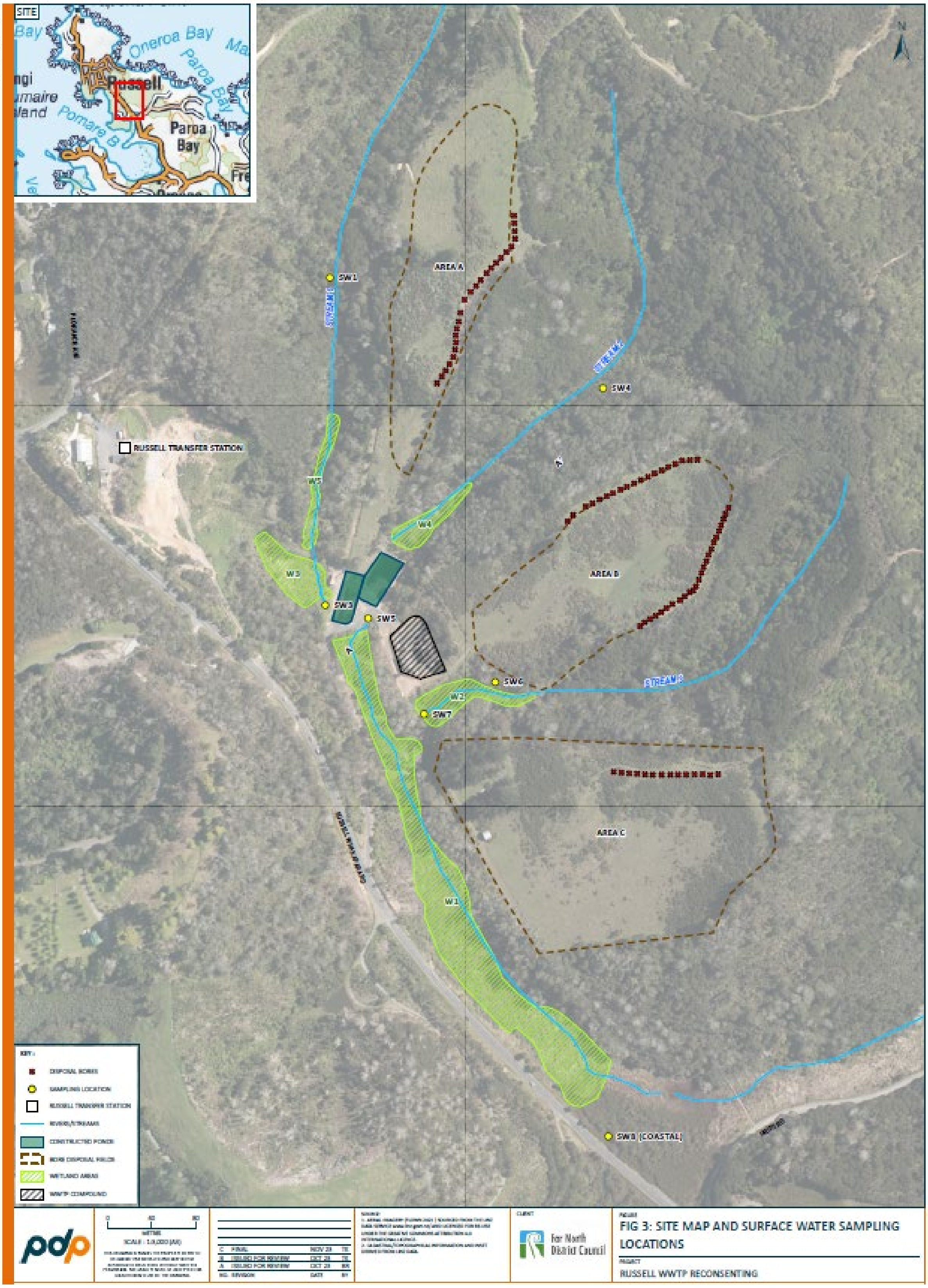
b) Notification as to if the flow meter was verification within that year as required by condition 4.

c) The NWAR required by condition 11.

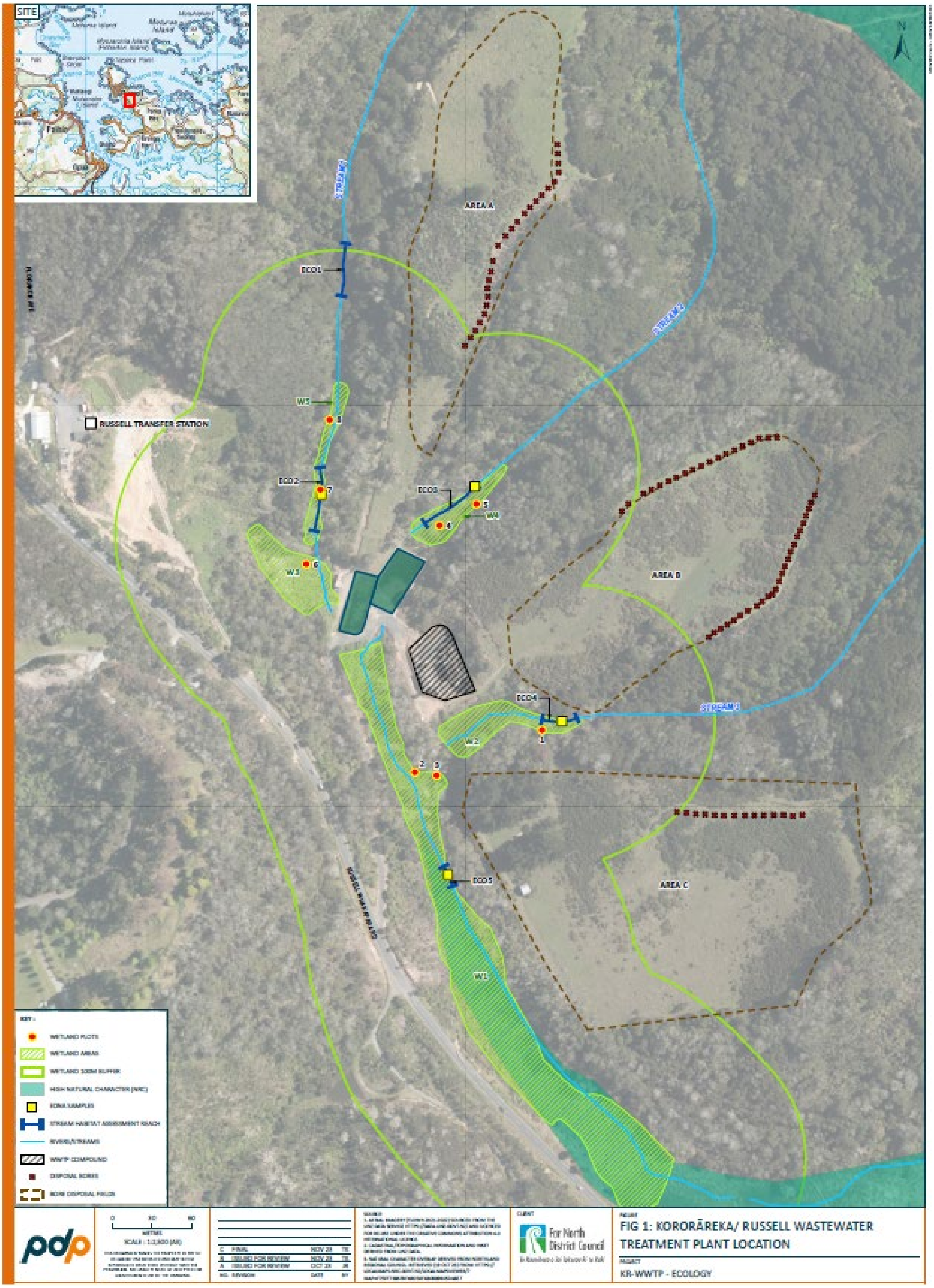
d) Progress on implementing the revised BPO in accordance with condition 15(b) (if applicable).

e) Any upgrades to the KR-WWTP or improvements made to the sewage network in the past 12 months and any proposed upgrades to the KR-WWTP and network in the next 12 months.

Map 1 – Small stream monitoring locations



Map 2 – Wetland monitoring locations



D
R
A
F
T