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Kohukohu WWTP Upgrade

Kohukohu WWTP Issues and Options

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Far North District Council

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Jacobs New Zealand Limited

Level 8, 1 Grey Street,
PO Box 10-283
Wellington, 6143
New Zealand
T +64 4 473 4265
F +64 4 473 3369
www.jacobs.com

Contents

Executive Summary

The Kohukohu wastewater treatment plant (WWTP) discharges treated wastewater into the Hokianga Harbour. The resource consent for the harbour discharge expired in August 2016. As part of the consent renewal process Far North District Council (FNDC) are investigating options to improve the performance of the WWTP, including potentially removing the discharge from the harbour altogether by moving to a land disposal system. The permanent resident population of Kohukohu was 168 at the 2018 Census. Long-term population forecasting indicates a decrease in the permanent population of the wider South Hokianga area. For the purposes of this report, the permanent resident population of Kohukohu is assumed to remain static over the design period.

The Kohukohu WWTP treats the liquid effluent from the town's septic tanks and consists of a facultative pond (oxidation pond) followed by a surface flow wetland divided into five cells. Effluent from the wetlands is discharged by gravity into a channel running through the tidal mud flats next to the WWTP. The channel joins the main Hokianga Harbour approximately 240 meters south of the WWTP. The Kohukohu WWTP is in generally good condition although the wetlands require vegetation removal.

The current WWTP generally performs well the median effluent faecal coliform concentration for the past 10 years is 800 cfu/100 mL which is comfortably within the consent rolling median limit of 5,000 cfu/100mL; the rolling five sample median has exceeded this limit on two occasions in the past 10 years. The maximum faecal coliform limit of 15,000 cfu/100mL was exceeded on six occasions in the past 10 years. A percentile limit which allows a number of exceedances is more practical for consent compliance, to allow for the natural variability of effluent quality. Similarly, for ammonia, a median or other percentile-based consent limit would be more practical than a maximum value and would reduce the risk of a non-compliance.

The recent hydrodynamic study of the wastewater discharges into the Hokianga Harbour found that a 95th percentile dilution factor of 50,000 was achieved within 100 meters of the discharge point, at a location within the tidal mud flat channel. Based on the hydrodynamic modelling results, there is no discernible effect of the Kohukohu discharge within the main body of the Hokianga Harbour.

When considering the achieved WWTP effluent quality and the hydrodynamic modelling study findings, no major drivers have been identified which substantiate the requirement for an improvement in effluent quality via a substantive WWTP upgrade, although there are some relatively inexpensive measures that would improve the disinfection performance of the WWTP. Any further improvements above this, if desired, could aim at further improving disinfection performance and reducing the public health risks of the discharge.

A desktop analysis of land disposal sites found that most of the land around Kohukohu is steep and unsuitable for land disposal; only two potentially suitable sites were located within the 5 km radius and these were less than the required disposal area of 3.0 hectares. At this time, land disposal is not considered feasible.

The study therefore identifies three upgrade options for the Kohukohu WWTP as follows:

1. Option 1) Maintain the existing system (removing vegetation from the wetlands)

2. Option 2) Plus optimisation of disinfection performance by installing curtain baffles and relocating the pond inlet pipe to the north-eastern corner of the pond

3. Option 3) Plus installation of a new UV disinfection system downstream of the wetland for further disinfection.

High level costs estimates for the shortlisted options have been prepared, and these are summarised as:

Option	1) Maintain Current	2) Optimise current	3) Optimise + UV
Cost	$140,000	$264,000	$422,000

A multicriteria analysis (MCA) has been completed at a collaborative workshop held with FNDC on the 26th August and subsequent sensitivity analysis, which demonstrates that Option 2 is preferred under most scenarios, although if cost becomes a more highly weighted criterion, then Option 1 becomes preferred. However, there is additional risk of short-circuiting with Option 1, therefore installation of curtain baffles and adjusting the inlet to reduce this risk is recommended. Our recommendations is that Option 2 be implemented for the Kohukohu WWTP based on this issues and options assessment, and the MCA outcomes.

1. Introduction

1.1 Project Background

The Kohukohu wastewater treatment plant (WWTP) was constructed in 1984. The WWTP treats liquid septic tank effluent from the settlement of Kohukohu and consists of a single facultative (oxidation) pond followed by a surface flow wetland. Treated wastewater is discharged by gravity into a channel in the tidal mud flats next to the WWTP, from where it flows into the main body of the Hokianga Harbour.

The existing resource consent for the WWTP was granted in 2002 and expired on 31 August 2016. An application for a new resource consent was lodged with Northland Regional Council (NRC) in May 2016 (Opus, 2016) and the WWTP has been operating under the old consent since that time. A copy of the existing resource consent is provided in Appendix A.

In January 2020 NRC requested additional information regarding the consent application. Far North District Council (FNDC) are currently preparing the response to the information request. In response to the request FNDC have engaged Jacobs to assess the current WWTP and identify options for the future direction of the plant, including the consideration of land-based disposal. An agreed strategy will likely be taken forward to include in the consent application and FNDC’s long term plan (LTP).

1.2 Purpose of this Report

The purpose of this report is to present the main issues facing the Kohukohu WWTP and improvement options to address these issues. A desktop assessment of potential land disposal sites has also been undertaken and is included as Appendix B.

The report will be used by FNDC to inform assessment of the options to identify a preferred upgrade strategy, as well as informing stakeholders and engaging with the community regarding the options. To aid the assessment of the option proposed assessment criteria are also presented to enable a multi-criteria analysis (MCA).

The impacts of climate change, specifically the impact of sea level rise, specifically storm surge, inundation and flooding the Kohukohu WWTP have not been considered in detail in this report. However, through our desktop assessment of viable land disposal sites we can confirm that the WWTP is not located in an area susceptible to flooding. The WWTP does however lie within the orange tsunami evacuation zone which faces a medium level of risk according to the New Zealand Civil Defence. In the long term, the effects of climate change could disrupt the operation of the WWTP. The wider issue of sea level rise will impact all coastal WWTPs. A long term, district wide approach, will be required that considers the risk posed to each of the FNDC WWTPs and then prioritises mitigation based on the assessed risk.

2. Design Basis

2.1 Design Horizon

The design horizon for this report is 2035, to align with the 15-year consent duration applied for by FNDC (Opus, 2016).

2.2 Design Population

The permanent resident population of Kohukohu was 168 at the 2018 Census. Long-term population forecasting indicates a decrease in the permanent population of the wider South Hokianga area. For the purposes of this report, the permanent resident population of Kohukohu is assumed to remain static over the design period.

2.3 Wastewater Flows

2.3.1 Dry Weather Flows

Dry weather influent flows from 2015 to 2019 are shown in Figure 2-1: Kohukohu WWTP Influent Dry Weather Flows 2015 - 2019. The black line shows the 30-day rolling average dry weather flow (ADWF). A dry weather day is defined as any day where the total rainfall for that day and the preceding two days is less than 0.5mm, which accounts for 27% of the days in the year (201 days out of 360 days).

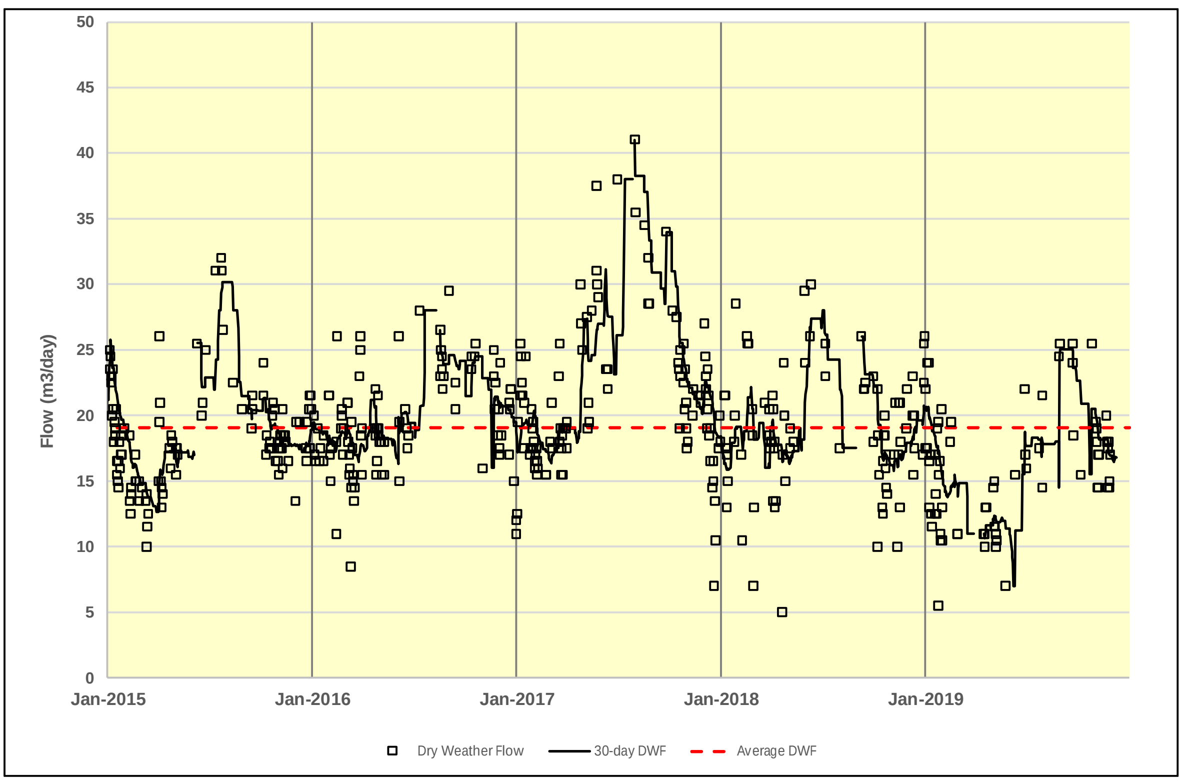

Figure 2-1: Kohukohu WWTP Influent Dry Weather Flows 2015 - 2019

There does not appear to be a peak in 30-day ADWF over the summer holiday season, unlike the Opononi WWTP which experiences a significant increase in flows over the summer. In contrast, there appears to be a peak in dry weather flows in the middle of the year. This could indicate groundwater infiltration or stormwater connections to the system or to the septic tanks feeding the system. This should be investigated further as the project progresses. The peak 30-day ADWF and annual ADWF are presented in Table 2-1: Kohukohu WWTP Dry Weather Flows 2015 - 2019.

Table 2-1: Kohukohu WWTP Dry Weather Flows 2015 - 2019

Parameter	Units	Value
Maximum 30-day ADWF	m^3/day	41
Rolling 30- day ADWF	m^3/day	20
ADWF	m^3/day	19

2.3.2 Wet Weather Flows

A wet weather day is defined as any day with greater than 5.0mm of rain and accounts for 23% of the days in the year. The highest recorded daily peak wet weather flow (PWWF) to the Kohukohu WWTP over the past 5 years was 176m^3/day, and over the past 10 years was 278m^3/day. This is a wet weather peaking factor of approximately 10 based on the 5-year maximum, and 15 on the ten-year maximum, which indicates a high level of infiltration or stormwater connections into the septic tank system, possibly from roof downpipe connections. As noted above, this should be considered further.

2.3.3 Pollutant Loads

The sewer catchment of Kohukohu is predominantly domestic, with no significant trade waste inputs. The influent to the Kohukohu WWTP is the liquid stream from individual on-site septic tanks. A well-performing septic tank should typically remove around 80% of suspended solids and 50% of the biological oxygen demand (BOD) from the raw wastewater (Auckland Regional Council, 2004). Therefore, the BOD and suspended solids concentrations and loads to the WWTP are expected to be significantly lower than for raw wastewater. However, as there is no influent sampling data, the extent of treatment provided by the septic tanks is currently not known.

2.4 Summary

The design basis for the Kohukohu WWTP is provided in Table 2-2: Kohukohu WWTP Issues and Options Report Design Basis (from flow meter data). The wet weather peaking factor of approximately 10, based on the 5-year maximum, and 15, based on the ten-year maximum, indicates a high level of infiltration or stormwater connections into the septic tank system.

Table 2-2: Kohukohu WWTP Issues and Options Report Design Basis (from flow meter data)

Parameter	Units	Current	2035
Permanent resident population		168	170
ADWF	m3/day	19	20
Maximum 30-day ADWF	m3/day	41	40
PWWF	m3/day	176	180

2.5 Land Disposal Design Basis

2.5.1 Hydraulic Loading Rate

The methodology for determining the hydraulic loading rate is based on the procedure for “Type 1” slow rate systems provided in the USEPA Process Design Manual for Land Treatment of Municipal Wastewater Effluents (USEPA, 2006). The method set out in the USEPA manual is a standard water balance methodology based on percolation rate to groundwater. Type 1 systems are designed for year-round deep percolation to groundwater as opposed to deficit irrigation systems, which avoid percolation by irrigating only the amount of water either evaporated or used by the plants (evapotranspiration). Often deficit irrigation is used in locations with long dry summer conditions. In a wetter climate, deficit irrigation is unlikely to be applicable.

Using the USEPA design methodology, a conservative hydraulic loading rate of 2.0 mm/day is derived as shown in Table 2-4: Kohukohu WWTP Land Disposal Design Basis. However, this would need to be confirmed with site specific testing of the ground conditions.

Table 2-3: Kohukohu WWTP Land Disposal Hydraulic Loading Rate Design Basis

Parameter	Units	Value	Comment
Soil type		Clay loam	All potential sites have clay loam soils see Table 7.4
Soil permeability (preliminary design)	mm/day	60	Category 4, Table 5.2 NZS1547 (2012)
Design safety factor		5%	USEPA (2006) type 1 slow rate design methodology
Design annual percolation rate	mm/day	3.0	Soil permeability x safety factor
Annual rainfall	mm /year	1,299	NIWA (2013)
Annual evapotranspiration	mm /year	877	NIWA (2013)
Annual hydraulic loading rate	mm/day	2.0	Percolation – rainfall + evapotranspiration

2.5.2 Irrigation Storage Requirement

For preliminary design purposes, 30-days storage (at ADF) is assumed for the irrigation storage pond. This is a conservative value and provides storage for a period of prolonged wet weather when the land has continuous surface ponding and is unsuitable for irrigation. The storage requirement may be reduced following detailed site investigations and rainfall analysis. However, given the poorly draining soils in the area, at this stage a conservative storage value is considered appropriate.

2.5.3 Land Disposal Design Basis Summary

The design basis for land disposal is presented in Table 2-4: Kohukohu WWTP Land Disposal Design Basis.

Note: The design basis is based on a desktop analysis using available data and is used for screening of options only. Site specific investigations have not been carried out and will be required prior to undertaking any design.

Table 2-4: Kohukohu WWTP Land Disposal Design Basis

Parameter	Units	Value
Average daily flow	m3/day	30
Hydraulic loading rate	mm/day	2.0
Irrigated area	Ha	1.50

Parameter	Units	Value
Allowance for buffer zones and storage pond	%	100
Total land area required	Ha	3.0
Irrigation application method		Solid set or drip line
Number of days storage required at ADF	days	30
Irrigation storage pond volume	m3	900

3. Existing WWTP

3.1 Existing WWTP Overview

The Kohukohu WWTP consists of a facultative pond (oxidation pond) followed by a surface flow wetland divided into five cells. Effluent from the wetlands is discharged by gravity into a channel running through the tidal mud flats next the WWTP. The channel joins the main Hokianga Harbour approximately 240 meters south of the WWTP.

An aerial photo showing the elements of the Kohukohu WWTP is provided in Figure 3-1.

Figure 3-1: Aerial Photograph of Kohukohu WWTP

3.2 Facultative (Oxidation) Pond

The facultative pond has a surface area of approximately 750 m^2 and is 1.5 meters deep. The pond has sufficient capacity to cater for the current population, however, the pond sludge level is reported to be high and is due for desludging.

The pond is square in shape, and the current inlet location is in the middle of the pond (Figure 3-2: Kohukohu WWTP Oxidation Pond). This arrangement means there is a high chance of short circuiting from inlet to outlet. An improvement in disinfection performance could be achieved by relocating the inlet to the north eastern corner of the pond and installing baffle curtains.

Figure 3-2: Kohukohu WWTP Oxidation Pond

3.3 Surface Flow Wetlands

The surface flow wetlands consist of five wetland cells in series. The wetland cells are overgrown and in need of maintenance (Figure 3-3: View of Kohukohu WWTP Constructed Wetland). The main function of the wetlands is to provide additional disinfection (through natural pathogen die-off), and algae removal (through shading of the water). Some ammonia removal can also be achieved through nitrification occurring in the plant root zones.

Figure 3-3: View of Kohukohu WWTP Constructed Wetland

3.4 Water Loss Across WWTP

Water loss across the WWTP can be significant and during dry periods it is common to record influent volumes of 10 to 20 m^3/day with no outflow recorded. The water loss could be due to a combination of seepage, although this is unlikely as the sludge will likely have blinded the base of the pond, as well as evaporation from the oxidation pond and wetlands.

3.5 Climate Change Effects

The Kohukohu WWTP is situated at the Hokianga Harbour coastline. Through GIS analysis, flood and tsunami zones were superimposed at the location of the WWTP seen in Figure 3-4. The WWTP is not located in an area susceptible to flooding. The WWTP does however lie within the orange tsunami evacuation zone which faces a medium level of risk according to the New Zealand Civil Defence. In the long term, the effects of climate change such as the wider issue of sea level rise, could disrupt the operation of many of FNDC's WWTPs. A long term, district wide approach, will be required that considers the risk posed to each of the FNDC WWTPs and then prioritises mitigation based on the assessed risk.

Figure 3-4 Kohukohu WWTP Flood and Tsunami Zones

4. Effluent Quality

4.1 Effluent Quality Results

Under the conditions of the existing resource consent, effluent samples are taken every three months. Compliance against the resource consent faecal coliform and ammoniacal nitrogen median standards is measured using rolling 5-sample median values. There are no consent limits on BOD or total suspended solids (TSS).

Figure 4-1 through Figure 4-4 present the effluent sampling results for faecal coliforms, ammoniacal nitrogen, BOD and TSS from 2010 – 2019 as well as the resource consent median and maximum values (shown as dashed lines).

The overall effluent quality statistics from 2010 to 2019 are presented in Table 4-1: Kohukohu WWTP Effluent Quality Summary 2010 - 2019. The compliance rate is calculated as the number of rolling five three-monthly sample median values or maximum values that comply with the consent standard divided by the total number of samples.

There are no significant issues of concern with the effluent quality, reflecting the pre-treatment provided by the septic tanks and the capacity of the WWTP to cater for existing loads.

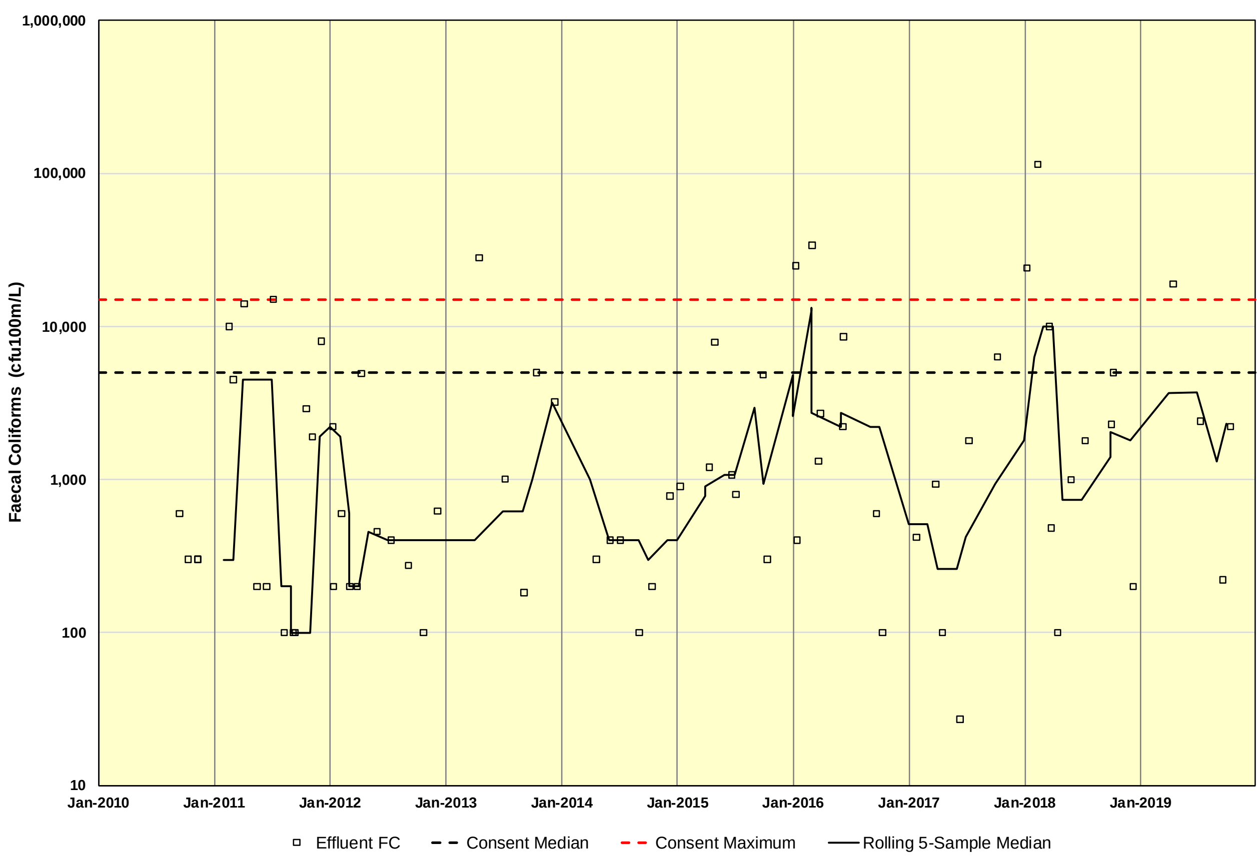

Figure 4-1: Kohukohu WWTP Effluent Faecal Coliform Concentrations 2010 – 2019

The overall median faecal coliform concentration of 800 cfu/100 mL is comfortably within the consent rolling median, however there were two periods where the rolling five sample median exceeded the consent rolling median limit (Figure 4-1). A UV disinfection system would provide more assurance of compliance going forward. However, simply thinning out the plants in the wetlands to provide more sunlight exposure may also promote disinfection.

The maximum faecal coliform limit of 15,000 cfu/100mL was exceeded on six occasions since January 2010. A percentile limit which allows a number of occasional exceedances may be more practical for consent compliance, to allow for the natural variability of effluent quality from a pond-based system.

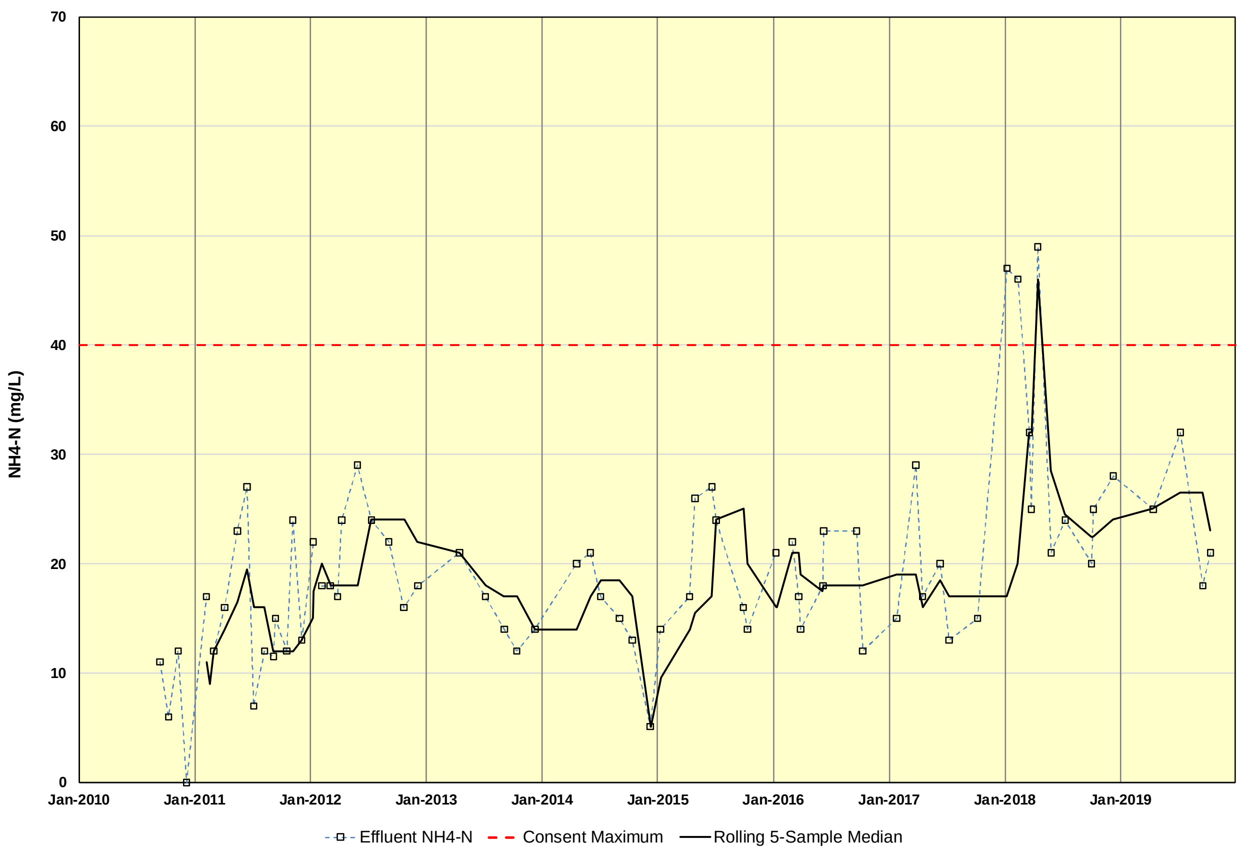

Figure 4-2: Kohukohu WWTP Effluent Ammoniacal Nitrogen Concentrations 2010 – 2019

There was a cluster of high ammonia values in 2018, prior to desludging of the ponds. Once the pond was de-sludged pond performance was restored. Similar to faecal coliforms, a median or other percentile-based consent limit for ammonia, would be more practical than a maximum value and would reduce the risk of a non-compliance.

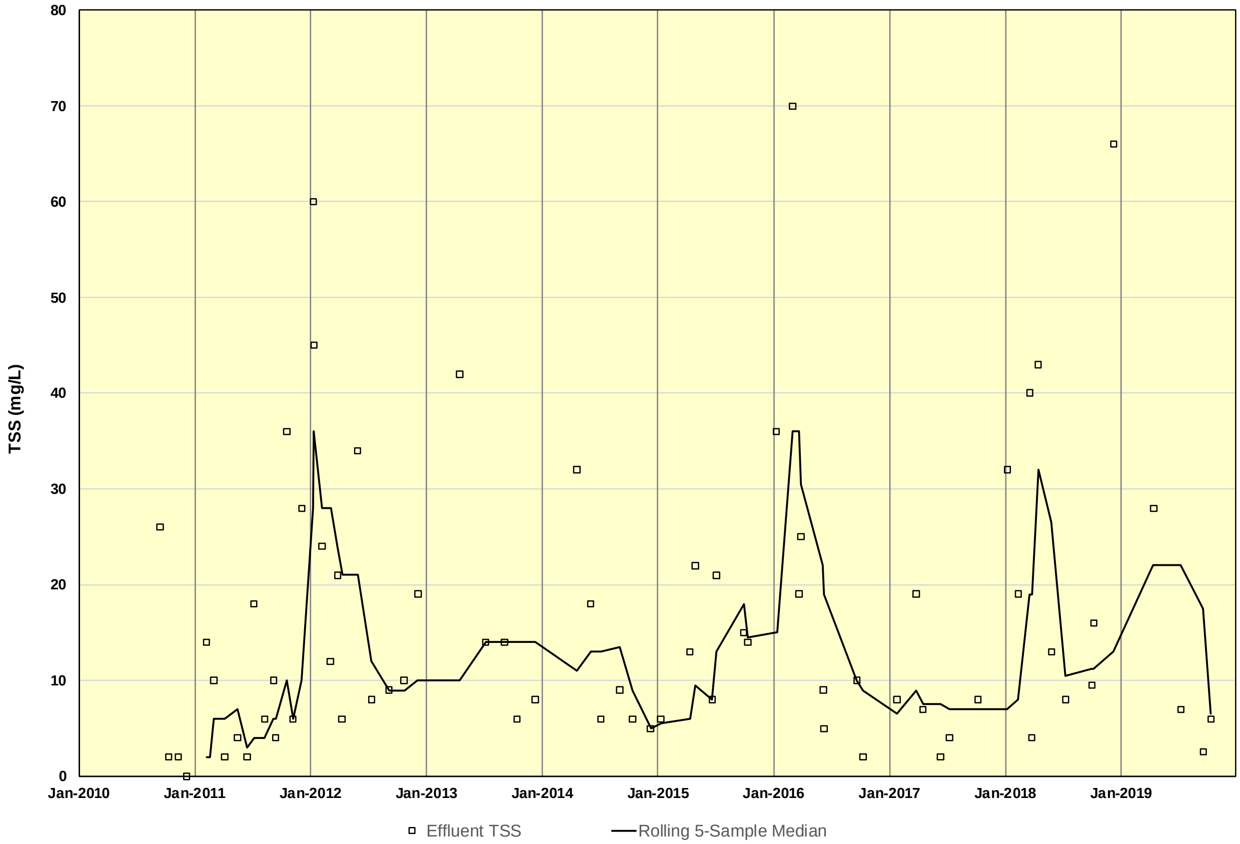

Figure 4-3: Kohukohu WWTP Effluent Suspended Solids Concentrations 2010 - 2019

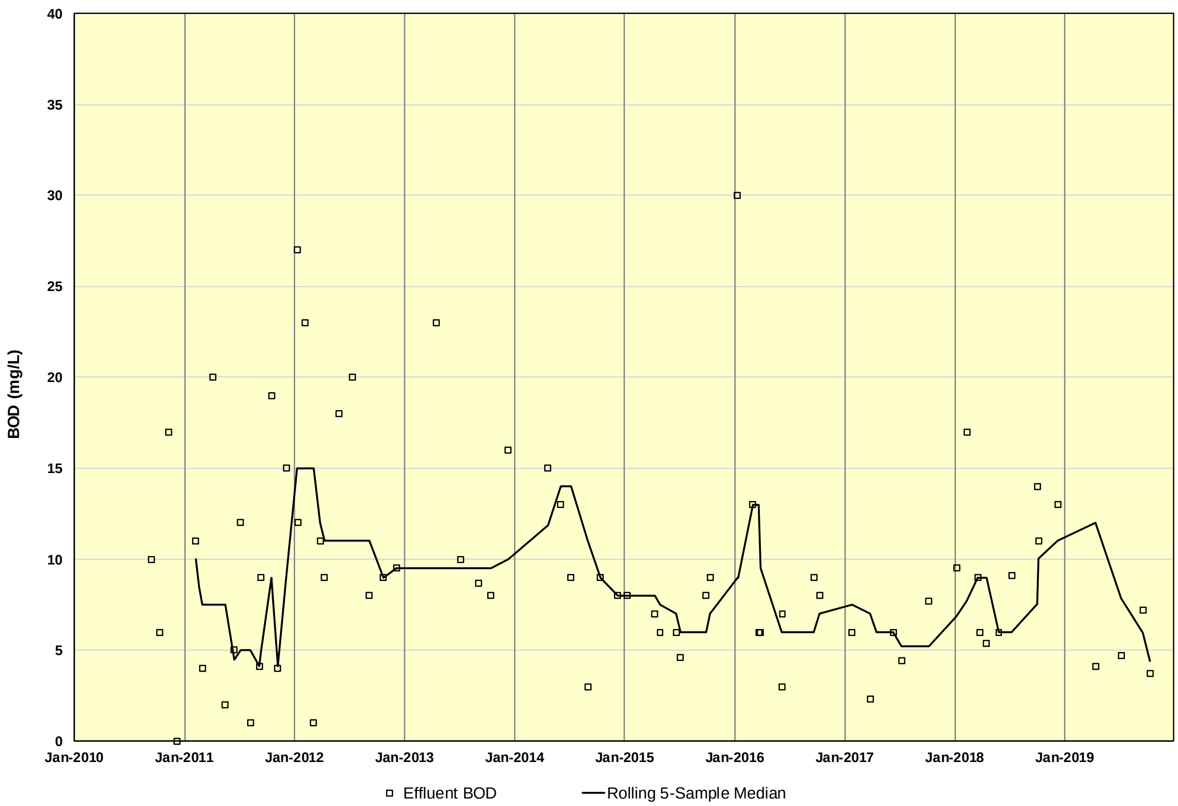

Figure 4-4: Kohukohu WWTP Effluent BOD Concentrations 2010 – 2019

Table 4-1: Kohukohu WWTP Effluent Quality Summary 2010 - 2019 summarises the effluent quality data in a tabular format. This should be considered in light of the pond desludging in late 2018.

Table 4-1: Kohukohu WWTP Effluent Quality Summary 2010 - 2019

Parameter	Units	No. of Samples	Median			Mean	Maximum		
			Consent	Overall	Compliance Rate		Consent	Overall	Compliance Rate
Faecal coliforms	cfu/100mL	75	5,000	800	91.5%	n/a	15,000	114,000	90.7%
NH_4-N	mg/L	72		18		20	40	49	95.8%
BOD	mg/L	72		8.4		9.5		30	
TSS	mg/L	73		10		16		70	

5. Receiving Environment

5.1 Harbour Values and Water Quality Standards

Values of the Hokianga Harbour intrinsically linked to water quality that can be impacted by wastewater discharges include:

- Recreation and aesthetics: Water quality should be suitable for swimming at all times and the visual and aesthetic values of the water should be maintained.
- Shellfish consumption: The Harbour should continue to support the healthy growth and survival of shellfish, and it should be safe to gather shellfish for human consumption at all times.
- Aquatic ecosystem health: The Harbour should continue to maintain the healthy functioning of aquatic ecosystems.

The Proposed Regional Plan for Northland (NRC 2019) Policy H.3.3 (Coastal water quality standards) contains coastal water quality standards that are designed to protect the recreational, aesthetic, shellfish gathering and ecosystem values of coastal waters in the region. The standards are therefore useful to assess whether the discharge could be affecting any of the important harbour values listed above. Standards in Policy H.3.3 of relevance to wastewater discharges are shown in Table 5-1: Proposed Regional Plan for Northland Coastal Water Quality Standards (Estuaries).

Table 5-1: Proposed Regional Plan for Northland Coastal Water Quality Standards (Estuaries)

Parameter	Units	Median	90th Percentile	95th Percentile
Faecal coliforms (shellfish gathering)	cfu/100mL	14	43	
Enterococci (contact recreation)	org/100mL			200
Ammoniacal nitrogen	mg/L	0.023		

The following points are noted in relation to the Kohukohu discharge:

- Phosphorus is not normally a concern in coastal waters as nitrogen is almost always the limiting nutrient (NIWA, 2018). None of the WWTP's discharging directly into the Hokianga Harbour (Opononi, Rawene, Kohukohu) contain phosphorus limits.
- Based on the Estuary Trophic Index toolbox (NIWA 2018) the Hokianga Harbour has a low physical susceptibly to nitrogen impacts and experiences minor stress from catchment nitrogen loads (FNDC 2018). None of the WWTP's discharging directly into the Hokianga Harbour contain total nitrogen limits and total nitrogen is not considered to be an issue for the Kohukohu WWTP discharge.
- A maximum ammoniacal nitrogen concentration limit is included in the current resource consent (Table 4-1) as ammonia is a toxicant to shellfish and fish species.

5.2 Dilution in Harbour

Treated wastewater from the Kohukohu WWTP is discharged into a channel running past the WWTP through tidal mangrove-covered mud flats. The channel discharges into the main Hokianga Harbour around 240 meters south of the WWTP.

The existing resource consent defines the downstream Harbour monitoring point as the Kohukohu channel beacon, located a further 170 meters from the point where the channel discharges into the main Harbour.

An aerial photo showing the WWTP, channel and downstream monitoring point, is provided in Figure 5.1.

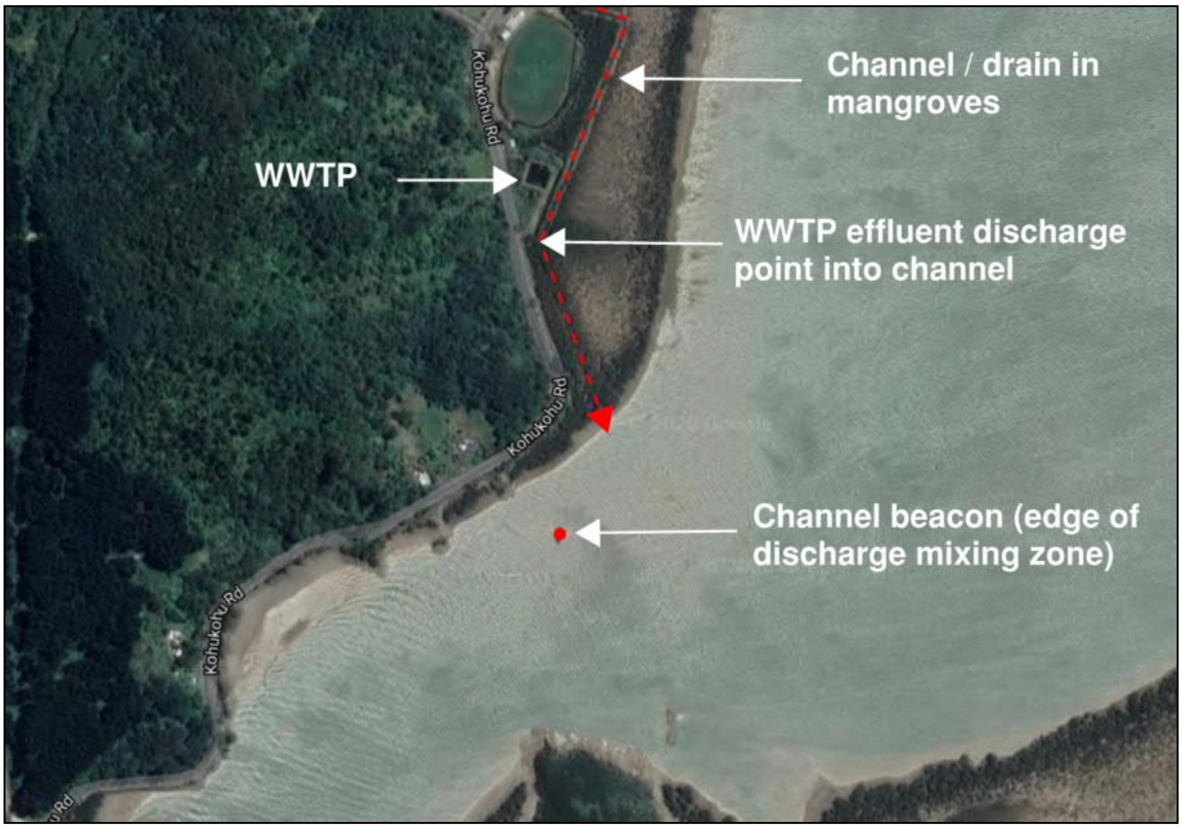

Figure 5-1: Aerial Photograph of Kohukohu WWTP Showing Discharge Location and Monitoring Point

In 2019 FNDC commissioned MetOcean Solutions to undertake a hydrodynamic study of the Hokianga Harbour and the dilution and dispersion of the four treated wastewater discharges into the Harbour (Kaikohe, Kohukohu, Rawene, Kohukohu) (MetOcean, 2020).

For the Kohukohu outfall, the modelling results showed a high level of dilution, with the discharge plume confined to the channel and not reaching the main Harbour. A 95th percentile dilution factor of 50,000 was achieved within the channel, 100 meters downstream of the discharge point.

Using the known effluent pollutant concentrations, and the dilution factors from the hydrodynamic model (MetOcean, 2020), the harbour faecal coliform and ammoniacal nitrogen concentrations near the outfall discharge location can be estimated, based on a desk top calculation. These are presented in Table 5-1. Due to the high level of dilution combined with level of treatment provided, no discernible effect is expected as a result of the Kohukohu discharge within the main body of the Hokianga Harbour.

Table 5-2 Contaminant Concentrations in the Hokianga Harbour based on 2016 - 2019 Effluent Results & Hydrodynamic Model

Parameter	Units	Effluent Results 2016 – 2019	Harbour Near Discharge Point	Harbour Near Shoreline	Harbour Water Quality Standards
Dilution factor			50,000	Not provided	
Median Effluent Quality					
E. Coli concentration	cfu/100mL	800	0.02	-	14*
NH_4-N concentration	mg/L	18	3.6E-04	-	0.023
TSS concentration	mg/L	10	2.0E-04	-	n/a
Maximum Effluent Quality					
E. Coli concentration	cfu/100mL	1.1.E+05	2.28	-	n/a
NH_4-N concentration	mg/L	49	9.8E-04	-	n/a
TSS concentration	mg/L	70	1.4E-03	-	n/a

6. WWTP Improvement Options

The Kohukohu WWTP is generally performing well with the only instances of non-compliance with the consent conditions being for faecals. Maintenance of the wetlands may be sufficient to reduce those exceedances. Some options to provide additional disinfection have been identified and are summarised in the following sections.

6.1 Pond Inlet Relocation and Baffles

The amount of disinfection provided by ponds is a function of hydraulic retention time (HRT), exposure to sunlight and ambient temperature, and can be estimated using a first-order decay model (Mara, 2010). Hence, measures that improve the average residence time in a pond will improve disinfection performance.

Plastic curtain baffles installed in the maturation pond would reduce short-circuiting and improve the disinfection performance of the pond (IWA, 2012). Baffle curtains are commonly used in New Zealand ponds as a means of improving disinfection performance (Ratsey, 2016).

In addition, to curtain baffles, the hydraulic performance of the pond would be improved by relocating the pond inlet pipe from the middle of the pond to the north-eastern corner of the pond. This would reduce the likelihood of short-circuiting from inlet to outlet and increase the HRT.

6.2 UV Disinfection

A UV disinfection system could be installed on the final effluent prior to discharge to the Harbour. UV disinfection of pond or wetland effluent is reasonably common in New Zealand due to increasing effluent bacterial standards; examples include Thames WWTP, and Woodend and Kaiapoi WWTP’s (Waimakariri District).

The variable algae content of wetland effluent will result in correspondingly variable UV disinfection performance, as algae reduces UV transmission, shields microorganisms from UV radiation and can also foul the lamp sleeves. To mitigate this, UV systems come with automatic lamp sleeve wipers and some units have a double skinned wiper with acid in the gap to provide a chemical clean of the surface as it wipes.

A 1 – 2 log removal of faecal coliforms could be achieved with a UV system treating the wetland effluent. The unit would be installed in a channel between the wetland and the outfall pipe. During periods of no effluent flow, the unit would be switched off. As the WWTP site has no power supply, a new power supply would need to be provided to the WWTP site for a UV system.

6.3 Other disinfection

Other disinfection options exist, including membrane filtration and chemical disinfection (ozone, chlorine or hydrogen peroxide).

Membrane filtration has not been considered as this has been used at other pond sites around New Zealand with mixed success. It is complicated to operate, has a high ongoing operating cost, and would likely be difficult to procure at such a small scale for the Kohukohu WWTP.

Chemical disinfection is not widely used in New Zealand due to concerns over the potential generation of disinfection by-products in the treated wastewater.

6.4 Ammonia, BOD and Total Suspended Solids

Based on the current effluent quality data and the hydrodynamic modelling study results which showed a high level of dilution in the channel and harbour, additional improvements to reduce effluent ammonia, total suspended solids or BOD concentrations are not required and therefore options to address these contaminants are not presented.

7. Treated Wastewater Disposal

7.1 Land Disposal Site Desktop Study

A desktop investigation of potential land disposal sites was carried out as part of this issues and options investigation. The following criteria were used to screen for potential land disposal sites:

Table 7-1: Kohukohu WWTP Land Disposal Screening Criteria

Criteria		Limit	Basis	Reference
1)	Proximity to WWTP	5 -7 kilometres	Ease of transport of effluent and manageable costs of installing infrastructure and operations within this distance	AECOM Taipa WWTP Upgrade Issues and Options -Land Disposal Site Selection Analysis Report
2)	Proximity to residential dwellings	>20m	Distance was selected based on previous work completed by CH2M Beca for Rawene WWTP	Rawene Issues and Options Report completed by CH2M -Beca
3)	Proximity to cultural dwellings	500m	Distance was selected based on previous work completed by AECOM for the Taipa WWTP completed with additional buffer	AECOM Taipa WWTP Upgrade Issues and Options -Land Disposal Site Selection Analysis Report
4)	Proximity to waterways	≥20m	Distance was selected based on previous work for Rawene WWTP	Rawene Issues and Options Report completed by CH2M -Beca
5)	Slope	<10%	Acceptable land slope for distribution as the risk of erosion and runoff is reduced	Metcalf & Eddy Wastewater Engineer Treatment and Reuse Table 14-51
6)	Groundwater	>1.2m	At least 1m to groundwater is preferred with seasonal fluctuations of +/- 0.5m	Metcalf & Eddy Wastewater Engineer Treatment and Reuse Section 14-17
7)	Flooding	Not on flood susceptible land	Risk to land disposal system	
8)	Tsunami zone	Yellow – Safe	Risk to land disposal system	

Based on the above screening criteria, five potential land blocks were identified as potentially suitable for land disposal (Figure 7-1).

Figure 7-1: Kohukohu WWTP: Potential Land Disposal Sites

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Table 7-2: Potential Land Disposal Sites for Kohukohu WWTP

Parameter	Unit	Site 4	Site 5
Distance from WWTP	km	1.7	0.6
Irrigatable land area	Ha	2..4	2.3
Soil type		Clay	Clay
Land slope		3% - 10%	3% - 10%

Sites 1, 2 and 3 are located within an area marked as flood susceptible in FNDC flooding maps and were therefore excluded from further consideration. Sites 4 and 5 are less than the required 3.0 hectares based on the preliminary design basis (Section 2.5.3) and were also excluded from consideration. Therefore, at this stage, land disposal is not considered viable due to a lack of suitably located and sized land in the area, and is therefore excluded from further consideration.

7.2 Other Disposal Options

The option of extending the outfall pipe 240 metres into the main harbour channel is not considered necessary due to the dilution provided in the tidal mud flat channel as reported in the hydrodynamic modelling study (see Section 5.2). In addition, the tidal mud flat channel is currently within the mixing zone of the outfall based on the downstream harbour monitoring location being in the main harbour (Section 5.2).

8. Combined Solution Options and Costs

Three options for wastewater treatment schemes for the Kohukohu WWTP are presented in the following subsections, which all include maintaining use of the existing outfall discharge into the tidal mud flat channel.

It should be noted that varying levels of risk have been applied to each item in the cost estimate. Items of greater scope and price certainty have a lower risk contingency applied to them and vice versa. The overall risk contingency for each option may be solely contain a low/high or a combination of both lower and higher contingency factors, in this case standard and low risk labels have been used for indication.

8.1 Option 1 – Do Nothing

This option does not require upgrade, and instead focusses on maintaining the existing WWTP to improve performance via emptying the pond of sludge and the removal of vegetation from the wetlands. Option 1 maintains the status quo system and is justified based on the existing WWTP performance and dilution in the harbour. The current ammonia concentrations are generally well within the current consent standard which based on the hydrodynamic modelling results, are adequate to protect the amenity and ecosystem values of the Hokianga Harbour.

There may continue to be the occasional non-compliance with the current faecal coliform maximum standard, due to natural variability. Therefore, a change from maximum to a percentile standard would be recommended. This risk of a consent breach could be further minimised by removing some of the vegetation in the wetland.

Indicative pricing for this option can be found in Table 8-1, refer to Appendix C for detailed cost estimates.

Table 8-1 Indicative Cost Estimate for Option 1

Item	Unit	Quantity	Rate	Total	Comment
Kohukohu WWTP Desludging & Dewatering and Wetland Vegetation Clearance					
Desludging and Dewatering	Item	1	$83,000	$83,000	SiteCare quote date 08/07/20. This price includes team mobilisation, dewatering and transportation to of waste to the Kaitaia landfill and contractor contingencies. There is a greater certainty on the scope of this work therefore a lower risk factor has been applied to this task.
Wetland vegetation clearance	Item	1	$28,000	$28,000	SiteCare quote for wetland maintenance 8/07/20. FNDC could execute this work under the Far North Water Alliance rather than an external contractor.
Contingency (lower risk)	%	34	$29,000	$29,000	A reduced contingency factor of 34% has been applied to this option to only the desludging work. A contingency is not necessary to be applied to the wetland vegetation clearance work. The risk allowance is based

					on the contingency stated in Table 4.4 of the IChemE Guide to capital cost estimation for power, engineering and supervision fees for a Fluid Processing Plant. The risk allowance has only been applied to the desludging and dewatering item as FNDC can control the wetland clearance cost.
Total Costs				$140,000	

8.2 Option 2 – Optimise Existing System

This option involves the maintenance work described for Option 1 as well as the following improvements works:

- Install baffles in pond
- Move pond inlet to the north-eastern corner of the pond.

This option would improve disinfection performance. However, there is a risk of future periodic non-compliances with the current consent faecal coliform maximum standard. Similar to Option 1, this risk would be minimised by removing some of the vegetation in the wetland, and a change from maximum to a percentile standard is also recommended.

Indicative pricing for this option can be found in Table 8-2 below, refer to Appendix C for detailed cost estimates.

Table 8-2 Indicative Cost Estimate for Option 2

Item	Unit	Quantity	Rate	Total	Comment
Kohukohu WWTP Desludging & Dewatering and Wetland Vegetation Clearance					
Desludging and Dewatering	Item	1	$83,000	$83,000	SiteCare quote date 08/07/20. This price includes team mobilisation, dewatering and transportation to of waste to the Kaitaia landfill and contractor contingencies.
Wetland vegetation clearance	Item	1	$28,000	$28,000	SiteCare quote for wetland maintenance 8/07/20. FNDC could execute this work under the Far North Water Alliance rather than an external contractor.
Pond Modifications					
Supply and install baffle curtains	Item	1	$25,000	$25,000	Two Permanthene baffle curtains to be installed at 20 metres in length and $165/m. Includes costs for installation quoted by SiteCare on 08/07/20.
Inlet Relocation		1	$56,000	$56,000	SiteCare quote date 08/07/20.

Contingency (standard risk)	%	54	$72,000	$72,000	The Risk allowance is based on factor recommend in Table 4.4 of the IChemE Guide to capital cost estimation for power, engineering and supervision fees for a Fluid Processing Plant (refer to Appendix C). The 54% contingency has been applied to all items with the exception of desludging and dewatering works to which a 34% contingency has been applied. The reason being that the contractor contingency being built-in to the cost. The wetland clearance works currently has no contingency applied to it as FNDC can control this cost.
Total Costs				$264,000	

8.3 Option 3 – Optimise Existing System Plus UV Disinfection

This option includes all of the items in Option 2, plus the installation of a UV disinfection system on the wetland effluent. The UV system would be specified so that the median effluent faecal coliform concentration would be 1 -2 log lower than current plant performance (i.e. less than 100 cfu/100mL). It is likely that the power supply to the WWTP would need to be upgraded in order provide sufficient power to run a UV plant.

Indicative pricing for this option can be found in Table 8-3, refer to Appendix C for detailed cost estimates. Cost estimates for upgrading the WWTP power supply have been included into the price of the contingency and UV unit supply.

Table 8-3 Indicative Cost Estimate for Option 3

Item	Unit	Quantity	Rate	Total	Comment
Kohukohu WWTP Desludging & Dewatering and Wetland Vegetation Clearance					
Desludging and Dewatering	Item	1	$83,000	$ 83,000	SiteCare quote date 08/07/20. This price includes team mobilisation, dewatering and transportation to of waste to the Kaitaia landfill and contractor contingencies.
Wetland vegetation clearance	Item	1	$28,000	$28,000	SiteCare quote for wetland maintenance 8/07/20. FNDC could execute this work under the Far North Water Alliance rather than an external contractor.
Pond Modifications					

Supply and install baffle curtains	Item	1	$25,000	$25,000	Two Permanthene baffle curtains to be installed at 20 metres in length and $165/m. Includes costs for installation quoted by SiteCare on 08/07/20.
Inlet Relocation		1	$56,000	$56,000	SiteCare quote date 08/07/20.
Further Wastewater Treatment					
UV unit	Item	1	$49,000	$49,000	Based on Xylem quote for a Wedeco LBX10 from March 2020. The total price includes installation, instrumentation and controls, piping and electrical costs.
Instrumentation costs: 1. Flowmeter 2. Turbidity meter 3. UV Transmissivity	Items	1	$53,000	$53,000	Based on quotes received in 2019 from instrumentation suppliers. The total prices includes installation, instrumentation and controls, piping and electrical costs based on factors recommended in Table 4.4 of the IChemE Guide to capital cost estimation (refer to Appendix C).
Contingency (standard risk)	%	54	$128,000	$128,000	The risk allowance is based on factors recommend in Table 4.4 of the IChemE Guide to capital cost estimation for power, engineering and supervision fees for a Fluid Processing Plant. The 54% contingency has been applied to all items with the exception of desludging and dewatering works to which a 34% contingency has been applied. The reason being that the contractor contingency being built-in to the cost. The wetland clearance works currently has no contingency applied to it as FNDC can control this cost.
Total Costs				$422,000	

9. Multi-Criteria Assessment

9.1 Criteria

The proposed criteria for the Multi Criteria Analysis (MCA) have been provided by FNDC and are outlined in Table 9-1.

The risks and benefits of each option have been identified and were considered using an MCA process in a collaborative workshop held with FNDC on the 26th August 2020. The MCA criteria used can be summarised at a high level as follows:

- Cultural acceptability: iwi/stakeholder concerns from consultation including effects on the mauri of the water, amenity and perception of a discharge to water.
- Environmental criteria: ensuring the harbour is safe for recreational activities including the gathering of kai moana, particularly close to the disposal site, and a reduction of nutrient load (N and P) going into the harbour from the WWTP, and that amenity impacts such as noise, visual aesthetics and odours are not significantly impacted
- Practicability criteria: that the option can be consented in a timely manner, and considers the complexity of the construction process, distance from networks and services and the overall time taken to construct and commission the option
- Operational Criteria: technical factors including reliability, technical feasibility, robust & proven technology, operational resilience, staging/flexibility for future upgrading, Health and Safety in design and operational complexity.
- Economic Criteria: Order of magnitude capital and operating cost estimates will inform the affordability of each option as well as the likely impact on rates.

Table 9-1: Kohukohu WWTP Assessment Criteria

Number	Category	Criteria	Description	Success Factors
1	Māori cultural values	Impacts on Māori cultural values and practices.	Gives effect to Te Mana o te Wai. Acceptability of process to local iwi	The option safeguards Māori cultural values and practices
2	Environmental values	Land Use Effects	Visual, Noise, Traffic impacts	The option can meet required discharge standards for wastewater (and carbon where applicable) The option can meet amenity standards, including odour
		Odour	The degree to which odour can be expected to be discharged beyond the property boundary.	
		Ecological Effects	The degree to which the effluent quality exceeds the minimum environmental and consent requirements.	
		Carbon Footprint	Level of energy consumption, secondary discharges and chemicals required.	

Number	Category	Criteria	Description	Success Factors
		Public Health	Impacts on mahinga kai Recreational use of the receiving environment Impact of spills and failure	
3	Practicability	Constructability	Complexity of construction process Distance from networks and services Time taken to commission option	The option can be successfully delivered
		Regulations and Planning	Complexity to obtain a consent or other authorisations	
4	Operability	The ease of operation and maintenance	Complexity of operation Required expertise Ease of access H&S risks of plant process. Sludge management Reliance on and complexity of plant consumables and replacement componentry	The option can be successfully used into the future
		Process reliability and resilience	Known performance of others with similar technologies Consistency of quality in the discharge Ability to maintain compliance with resource consents	
		Expandability/ future proofing	The potential for the site to allow for extensions to the treatment process Proofing against changes in compliance requirements	
		Hazards	Proximity to known and potential hazards, e.g., flood plains, climate change hazards	
5	Financial considerations	Capital Cost	Cost of implementation Site investigations and procurement of land Ability to reuse existing FNDC assets	The costs of the option are understood and able to be paid
		Operating and Maintenance Costs	Operations and maintenance requirements (e.g., chemical costs, sludge removal) Power cost	
		Rating impact	Impact on targeted rate relative to other options	

The weightings for the primary and sub-criteria are shown in Table 9-2. The results of the assessment are presented in Table 9-3 and

Figure 9-1.

Table 9-2: MCA Primary and sub-criteria weightings

Primary Criteria	Weighting	Secondary Criteria	Weighting
Economic Criteria	40.0%	Capital Cost	33%
		Operating and Maintenance Costs	33%
		Rating Impacts	33%
Environmental Criteria	20.0%	Land Use Effects (visual, noise and traffic impacts)	15%
		Odour (degree to which odour will be experienced beyond WWTP boundary)	15%
		Ecological Effects (does effluent quality exceed consent limits)	30%
		Carbon Footprint (level of energy and consumables required)	10%
		Public Health (protection of mahinga kai, impact on recreation, impact of spills or failure)	30%
Maori Cultural Values	20.0%	safeguards Māori cultural values and practices	100%
Practicability Criteria	10.0%	Constructability (complexity, distance from services, time to commission)	50%
		Regulations and Planning (complexity in obtaining consent)	50%
Operational Criteria	10.0%	Complexity of operation / required experience	25%
		Sludge management	25%
		Reliance on and complexity of plant consumables and replacement componentry	25%
		Health and Safety risks or plant process / access to site	25%

Table 9-3: MCA Assessment Results

	Option 1	Option 2	Option 3
Key-Criteria Summary	Maintain existing system - clear wetland vegetation overgrowth	Option 1 plus curtain baffles and move inlet pipe	Option 2 plus UV
Economic Criteria	0.40	0.34	0.00
Environmental Criteria	0.08	0.15	0.18
Maori Cultural Values	0.00	0.00	0.00
Practicability Criteria	0.05	0.06	0.05
Operational Criteria	0.08	0.08	0.03
Results	0.61	0.63	0.26
Rank	2	1	3

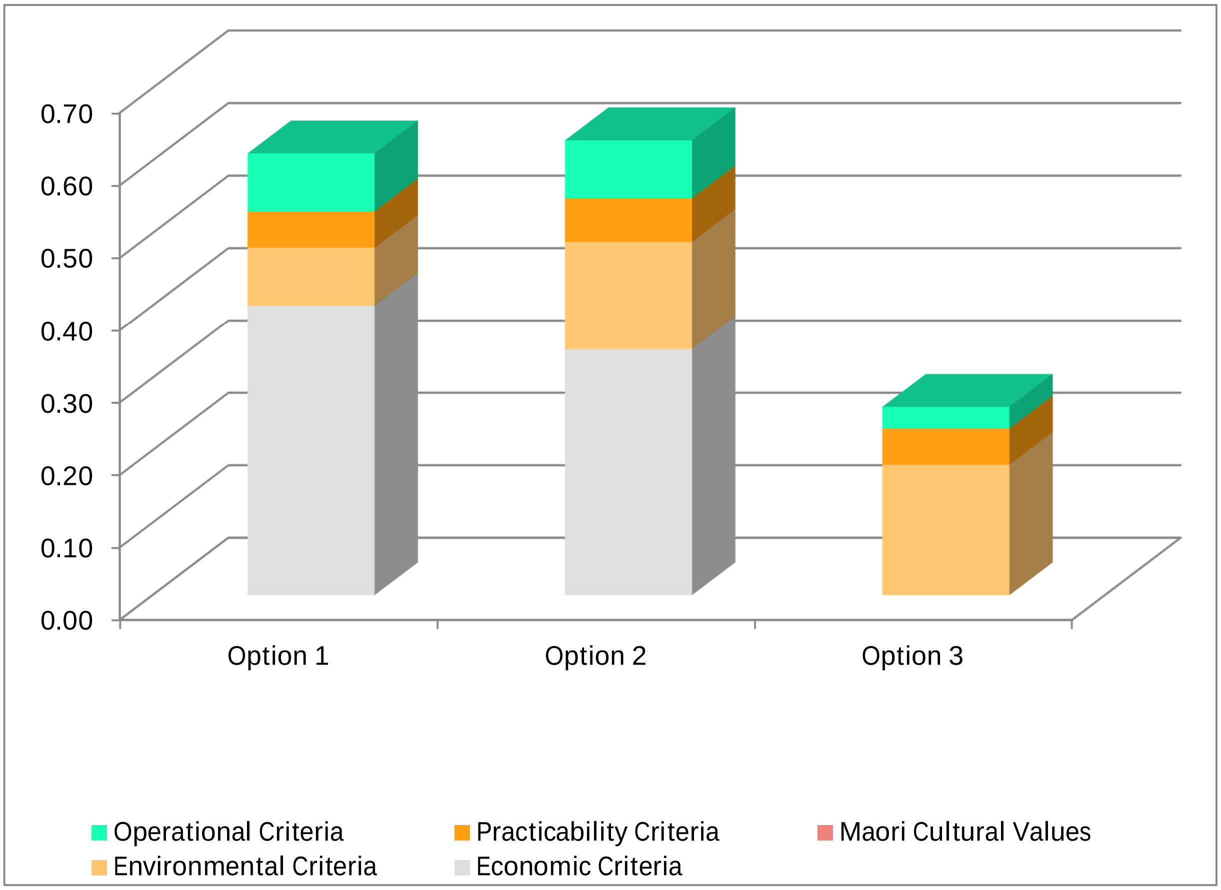


Figure 9-1: MCA Assessment Results – Graphical Representation.

The MCA results show that Options 1 and 2 score very similarly, with Option 2 scoring slightly higher overall – the key benefit being the improved treatment and robustness in the process, with very little additional cost compared to Option 1.

There was concern that if the weightings were changed, the preferred options may also change, so a number of scenarios were run on the MCA outcomes through changing the weightings (sensitivity analysis) to determine if the preferred options changed. The outcomes of the sensitivity analysis and the changes to the weighting which were adopted are summarised in Table 9-4 and Figure 9-2.

Table 9-4: Sensitivity analysis and impact of weighting changes

Primary Criteria	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Base Case
Economic Criteria	40%	80%	20%	20%	40%
Environmental Criteria	10%	5%	30%	20%	20%
Maori Cultural Values	10%	5%	30%	20%	20%
Practicability Criteria	20%	5%	10%	20%	10%
Operational Criteria	20%	5%	10%	20%	10%
	100%	100%	100%	100%	100%

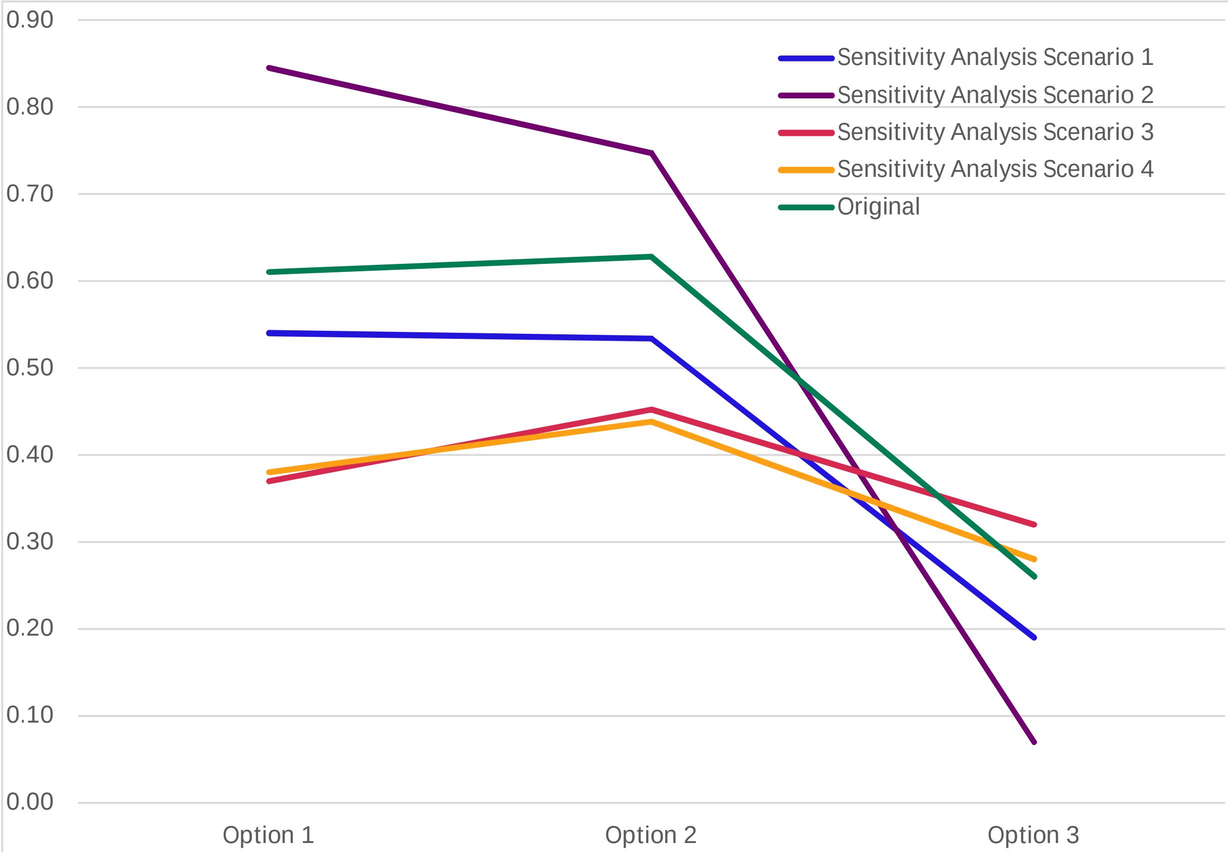


Figure 9-2: Comparison of MCA criteria scores for each scenario

The sensitivity analysis shows that the preferred options do not change under three of the scenarios, but that under Scenarios 1 and 2 Option 1 becomes preferred over Option 2. In both of these scenarios more emphasis is put on cost, and less on environmental outcomes.

10. Conclusions and Next Steps

10.1 Conclusions

- The Kohukohu WWTP is in generally good condition although the wetlands require vegetation removal.
- The median effluent faecal coliform concentration for the past 10 years is 800 cfu/100 mL which is comfortably within the consent rolling median limit of 5,000 cfu/100mL; the rolling five sample median has exceeded this limit on two occasions in the past 10 years.
- The maximum faecal coliform limit of 15,000 cfu/100mL was exceeded on six occasions in the past 10 years. A percentile limit which allows a number of exceedances is more practical for consent compliance, to allow for the natural variability of effluent quality from ponds.
- Similarly, for ammonia, a median or other percentile-based consent limit would be more practical than a maximum value, to allow for the natural variability of effluent quality from ponds.
- The recent hydrodynamic study of the wastewater discharges into the Hokianga Harbour found that a 95th percentile dilution factor of 50,000 was achieved within 100 meters of the discharge point, within the tidal mud flat channel. Based on the hydrodynamic modelling results, there is no discernible effect of the Kohukohu discharge within the main body of the Hokianga Harbour.
- Based on the effluent quality results and the hydrodynamic modelling study, there are no major drivers for upgrade of the WWTP. There are however some relatively inexpensive measures that would improve the disinfection performance of the WWTP (vegetation removal from the wetlands) and reduce the risk of future non-compliances. Any further improvements above this (such as UV disinfection), if desired, should be aimed at further improving disinfection performance, and reducing the public health risks of the discharge.
- Most of the land around Kohukohu is steep and unsuitable for land disposal; only two potentially suitable sites were located within the 5 km radius, however, the footprint of these sites were less than the required 3.0 hectares. At this stage, land disposal is not considered feasible.
- Three options have been identified to take forward for consultation:

  1. Option 1: Maintain the existing system (including vegetation removal from the wetlands)
  2. Option 2: Option 1 above, plus optimise pond performance by installing curtain baffles and moving the pond inlet pipe to the north-eastern corner of the pond
  3. Option 3: Option 2 above plus installation of a UV disinfection system downstream of the wetland.

- Indicative cost estimates for the three options have been prepared and summarised in Table 10-1.

Table 10-1 Summarised Indicative Costs for upgrade options

Option	Indicative Cost Estimate
Option 1	$140,000
Option 2	$264,000
Option 3	$422,000

An MCA has been completed at a collaborative workshop held with FNDC on the 26th August which identified Option 2 as preferred. A sensitivity analysis was also completed, which identified that Option 2 is preferred under most scenarios, although if cost becomes a higher weighted criterion, then Option 1 becomes preferred. It should be noted that there is additional risk of short-circuiting with Option 1, therefore installation of curtain baffles and adjusting the inlet to reduce this risk is recommended. Our recommendations is that Option 2 be implemented for the Kohukohu WWTP based on this issues and options assessment, and the MCA outcomes, given the minimal cost difference and the minimal difference in scores overall.

Therefore, it is recommended that Option 2 be implemented for the Kohukohu WWTP.

11. References

AS/NZS 1547:2012 On-site domestic wastewater management

Auckland Regional Council (2004) On-site Wastewater Systems: Design and Management Manual. Technical Publication Number 58 (TP58).

FNDC (May 2019) Application to Renew Resource Consents for the Opononi Wastewater Treatment Plant.

IWA (2012) Pond Treatment Technology. Shilton (ed). IWA Publishing

Jacobs (2019) Wellsford Treatment Wetland Pilot Study Assessment and Design Recommendations. Technical Memo prepared for Watercare.

MetOcean (January 2020) Hokianga Harbour Hydrodynamic Study of Wastewater Discharges

NIWA (2013) The Climate and Weather of Northland. Third ed. NIWA Science and Technology Series No 59.

NIWA (2018) Assessment of the eutrophication susceptibility of New Zealand Estuaries

Opus (2016) Resource Consent Application Kohukohu Wastewater Treatment Plant

Ratsey (2016) Upgrading Waste Stabilization Ponds: Reviewing the Options. Water NZ Conference Paper

USEPA (2006) Process Design Manual Land Treatment of Municipal Wastewater Effluents

Appendix A. Existing Resource Consent

CON20010383901

Received:

24 JUN 2002

ENV 6/1356

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,
C/O V K CONSULTING, ENVIRONMENTAL ENGINEERS LTD, P O BOX 10022, TE MAI, WHANGAREI 0130,

To undertake the following activities associated with the treatment and disposal of wastewater from Kohukohu township and environs on Pt Sec 86 Blk X Mangamuka SD in the catchment of the Hokianga Harbour at Map Reference O05: 598 475:

01 To discharge treated wastewater to an unnamed tributary of the Hokianga Harbour.

02 To discharge contaminants to ground from an oxidation pond and a surface flow wetland.

03 To discharge contaminants to air.

subject to the following conditions:

01 & 02: Discharge to Water and Land

1) The quantity of treated wastewater discharged to the unnamed tributary shall not exceed 40 cubic metres per day, based on dry weather flows.

2) The Consent Holder shall, by the 1 December 2002, increase the planted area of at least two cells within the surface flow wetland with appropriate plant species to the extent that there is 80% cover and the plants are at no more than 0.5 metre spacings. The cells to be planted shall include the last cell but not the first cell.

3) The Consent Holder shall, by the 1 December 2002, remove all pampas grass from the embankments around and within the surface flow wetland and replant the embankments with appropriate species.

4) The Consent Holder shall maintain easy access to the NRC Sampling Sites 322, 323 and 2051 at all times.

5) If the median concentration of faecal coliforms, based on the five most recent samples collected from the NRC Sampling Site 323, exceeds 5,000 per 100

millilitres or if the concentration of faecal coliforms in any one sample collected from NRC Sampling Site 323 exceeds 15,000 per 100 millilitres, then additional monitoring shall be carried out in accordance with the **attached** monitoring Schedule B.

6) Notwithstanding Condition 5, if the concentration of total ammoniacal nitrogen in any sample taken from NRC Sampling Site 323 exceeds 40 grams per cubic metre, then additional monitoring shall be carried out in accordance with the **attached** monitoring Schedule B.

7) Notwithstanding any other conditions of this consent, the discharge shall not cause the water quality of the Hokianga Harbour at NRC Sampling Site 231 to fall below the following standards:

(a) The natural pH of the water shall not be changed by more than 0.2 units.

(b) The median concentration of the faecal coliform bacteria in the water shall not exceed 14 per 100 millilitres, and the 90 percentile concentration shall not exceed 43 per 100 millilitres, based on not fewer than 10 (ten) samples taken over any 30 day period.

(c) The visual clarity of the water shall not be reduced by more than 20%.

(d) There shall be no production of significant oil or grease films, scums or foams, floatable or suspended materials, or emissions of objectionable odour

(e) The dissolved oxygen concentration shall not be reduced below 80% of saturation.

(f) The concentration of total ammoniacal nitrogen shall not exceed the following:

Water Quality Criteria for Saltwater Aquatic Life based on Total Ammoniacal Nitrogen [(NH_4 + NH_3)-N] (milligrams per litre) Criteria - Continuous Concentrations

	Salinity - 10 g/kg				
pH	**10°C**	**15°C**	**20°C**	**25°C**	**30°C**
7.0	16	12	7.7	5.4	3.6
7.2	9.9	7.2	4.9	3.4	2.3
7.4	6.4	4.4	3.0	2.1	1.5
7.6	4.1	2.8	2.0	1.4	0.99
7.8	2.6	1.8	1.2	0.91	0.62
8.0	1.6	1.2	0.80	0.57	0.39
8.2	1.1	0.72	0.51	0.36	0.26
8.4	0.67	0.46	0.34	0.24	0.17
8.6	0.44	0.30	0.22	0.16	0.12
8.8	0.28	0.21	0.15	0.12	0.09
9.0	0.19	0.14	0.11	0.08	0.07

Salinity - 20 g/kg					
pH	10°C	15°C	20°C	25°C	30°C
7.0	17	12	8.0	5.4	3.9
7.2	11	7.4	5.1	3.6	2.5
7.4	6.7	4.6	3.4	2.2	1.6
7.6	4.4	2.8	2.1	1.4	0.99
7.8	2.8	1.9	1.3	0.91	0.64
8.0	1.7	1.2	0.82	0.59	0.41
8.2	1.1	0.77	0.54	0.39	0.26
8.4	0.69	0.49	0.36	0.25	0.18
8.6	0.46	0.34	0.23	0.16	0.12
8.8	0.30	0.21	0.16	0.12	0.09
9.0	0.20	0.15	0.11	0.08	0.07

Salinity - 30 g/kg					
pH	10°C	15°C	20°C	25°C	30°C
7.0	18	12	9.1	6.0	4.5
7.2	12	8.0	5.4	3.9	2.6
7.4	7.2	4.9	3.4	2.4	1.6
7.6	4.6	3.0	2.6	1.5	1.1
7.8	2.8	2.0	1.4	0.99	0.67
8.0	1.8	1.3	0.91	0.62	0.44
8.2	1.2	0.82	0.57	0.41	0.28
8.4	0.74	0.51	0.36	0.26	0.19
8.6	0.49	0.34	0.25	0.18	0.13
8.8	0.30	0.22	0.16	0.12	0.09
9.0	0.21	0.16	0.12	0.09	0.07

03: Discharge to Air

8) The Consent Holder shall maintain a concentration of at least one gram per cubic metre of dissolved oxygen in the oxidation pond at all times, as measured in accordance with the **attached** monitoring Schedule A.

9) The Consent Holder's operations shall not give rise to any discharge of contaminants, which in the opinion of an Enforcement Officer of the Regional Council is noxious, dangerous, offensive or objectionable at or beyond the property boundary.

General

10) The Consent Holder shall submit 2 copies of a Site Management Plan that covers all aspects of the operation and maintenance of the Kohukohu wastewater treatment system to the Regional Council by the 30 December 2002. A draft of this Site Management Plan shall be submitted to the Regional Council not later than 1 November 2002 for approval. The Site Management Plan shall cover, but not be restricted to, the operation and maintenance of:

- All septic tanks that contribute to the wastewater volume
- The oxidation pond, including mitigation measures to deal with low concentrations of dissolved oxygen e.g. temporary mechanical surface aeration.
- The surface flow wetland. This section should include a programme that covers how the Consent Holder will retain the vegetative cover that has been established within the cells planted in accordance with Condition 2. It should also include measures to prevent the re-establishment of pampas grass on any of the embankments around and within the wetland.
- Contingency measures for unforeseen or emergency situations.

11) The operation and maintenance of the Kohukohu wastewater treatment system shall be carried out in accordance with the Site Management Plan approved in Condition 10.

12) Changes may be made to the Site Management Plan approved in accordance with Condition 10 with the prior written approval of the Regional Council.

13) The Kohukohu wastewater treatment system shall be correctly operated and maintained in an effective and workmanlike manner. Any maintenance work, which in the opinion of the Regional Council is necessary for the effective operation of the Kohukohu wastewater treatment system, shall be done by the date stated by the Regional Council in writing.

14) The Consent Holder shall monitor the exercise of these consents in accordance with the **attached** monitoring Schedule A.

15) The results of any monitoring carried out in accordance with the **attached** monitoring Schedules A and/or B shall be forwarded to the Regional Council within one month of each monitoring visit.

16) The 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 this consent. Such notice may be served annually during the month of May. The review may be initiated for any one or more of the following purposes:

(a) To deal with and mitigate any adverse effects on the environment that may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or to deal with any such effects 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 in the area.

(b) To provide for compliance with rules in any regional plan that has been made operative since the commencement of the consent.

(c) To deal with any inadequacies or inconsistencies the Regional Council considers there to be in the conditions of the consent, following the establishment of the activity the subject of the consent.

(d) To deal with any material inaccuracies that may in future be found in the information made available with the application. (Notice may be served at any time for this reason.)

The Consent Holder shall meet all reasonable costs of any such review.

EXPIRY DATE: **31 August 2016**

ISSUED at Whangarei this Nineteenth day of June 2002

Consents Manager

SCHEDULE A

MONITORING PROGRAMME – RESOURCE CONSENT 3839 (01 – 03)

The Consent Holder or its agent shall monitor the exercise of these consents in accordance with the following monitoring programme:

1 MONITORING OF KOHUKOHU WASTEWATER TREATMENT SYSTEM

At not more than four monthly intervals the following sampling and analyses shall be undertaken. The time of sampling is to vary for each sampling visit.

At NRC Sampling Site 322 (Map Reference O05: 598 476), a composite* sample of wastewater will be taken and analysed for the following:

Determinand
Total Ammoniacal Nitrogen
Faecal Coliforms

At NRC Sampling Site 323 (Map Reference O05: 598 475), a composite* sample of wastewater will be taken and analysed for the following:

Determinand
Total Ammoniacal Nitrogen
Faecal Coliforms
Five Day Biochemical Oxygen Demand
Suspended Solids

**A sample made up of equal volumes from three samples taken at least five minutes apart during the same sampling event.*

Temperature, pH and dissolved oxygen concentration are to be recorded at NRC Sampling Site 323 using an appropriate meter, and in accordance with standard procedures.

2 AIR QUALITY

Dissolved oxygen concentration and temperature are to be measured using an appropriate meter at three points, which are at approximately equal intervals around the edge of the oxidation pond. Measurements shall be taken at least 60 cm from the water edge and between 5 cm and 8 cm below the water surface. The median of these values shall be used to determine compliance with Consent Condition 8. Any odours at the site should be noted.

NOTE:
The objective of analysing a composite sample made up from triplicate samples, and sampling at different times of the day, is to ensure that the data gathered is representative of the conditions at the site.

Q

All samples taken are to be analysed at a laboratory with registered quality assurance procedures, and all analyses are to be undertaken using standard methods. Registered Quality Assurance Procedures are procedures which ensures that the laboratory meets good management practices and would include registrations such as ISO 9000, ISO Guide 25, Ministry of Health Accreditation, amongst others.

The monitoring specified above is the minimum amount of monitoring that is required.

3 THE HOKIANGA HARBOUR

Once every five years the Hokianga Harbour shall be monitored in accordance with the **attached** monitoring **Schedule B**. The first monitoring visit should take place within three months of the consent being granted.

R

SCHEDULE B

MONITORING PROGRAMME – RESOURCE CONSENT 3839 01

The Consent Holder or its agent shall monitor the exercise of this consent in accordance with the following monitoring programme:

Sampling at NRC Sampling Sites (see attached map)

231; Map Reference O05 2559843 6647261
323; Map Reference O05 2559775 6647500
2051; Map Reference O05 2559783 6647503
2052; Map Reference O05 2559711 6647660
5815; Map Reference O05 2560017 6647564

is to occur on the same day and is to be undertaken on the ebb tide as close to low tide as is practicable.

To determine the most appropriate sampling point and depth at NRC Sampling Site 231, a sufficient quantity of tracer dye (or another suitable tracer material) should be introduced at NRC Sampling Site 323 that results in a visible dye plume at NRC Sampling Site 231. The samples should then be collected from within the tracer dye plume.

Prior to the introduction of tracer dye at NRC Sampling Site 323, an assessment of water clarity should be made at NRC Sampling Sites 5185 and 231. If a conspicuous change in clarity is apparent between the waters at NRC Sampling Sites 5185 and 231, then a standard Black Disk shall be used to measure this difference in clarity.

At NRC Sampling Site 323 a composite* sample shall be taken. At NRC Sampling Sites 2051 and 2052, three samples of equal volume shall be taken at least five minutes apart. All samples taken at NRC Sampling Sites 323, 2051 and 2052 shall be analysed for the following:

Determinand
Total Ammoniacal Nitrogen
Faecal Coliforms

**A sample made up of equal volumes from three samples taken at least five minutes apart during the same sampling event.*

Temperature, pH and dissolved oxygen concentration are to be recorded at NRC Sampling Sites 323, 2051 and 2052 using an appropriate meter, and in accordance with standard procedures.

At NRC Sampling Sites 231 and 5815, ten samples of equal volume shall be taken at least five minutes apart. All samples taken at NRC Sampling Site 231 and 5815 shall be analysed for the following:

Determinand

Total Ammoniacal Nitrogen

Faecal Coliforms

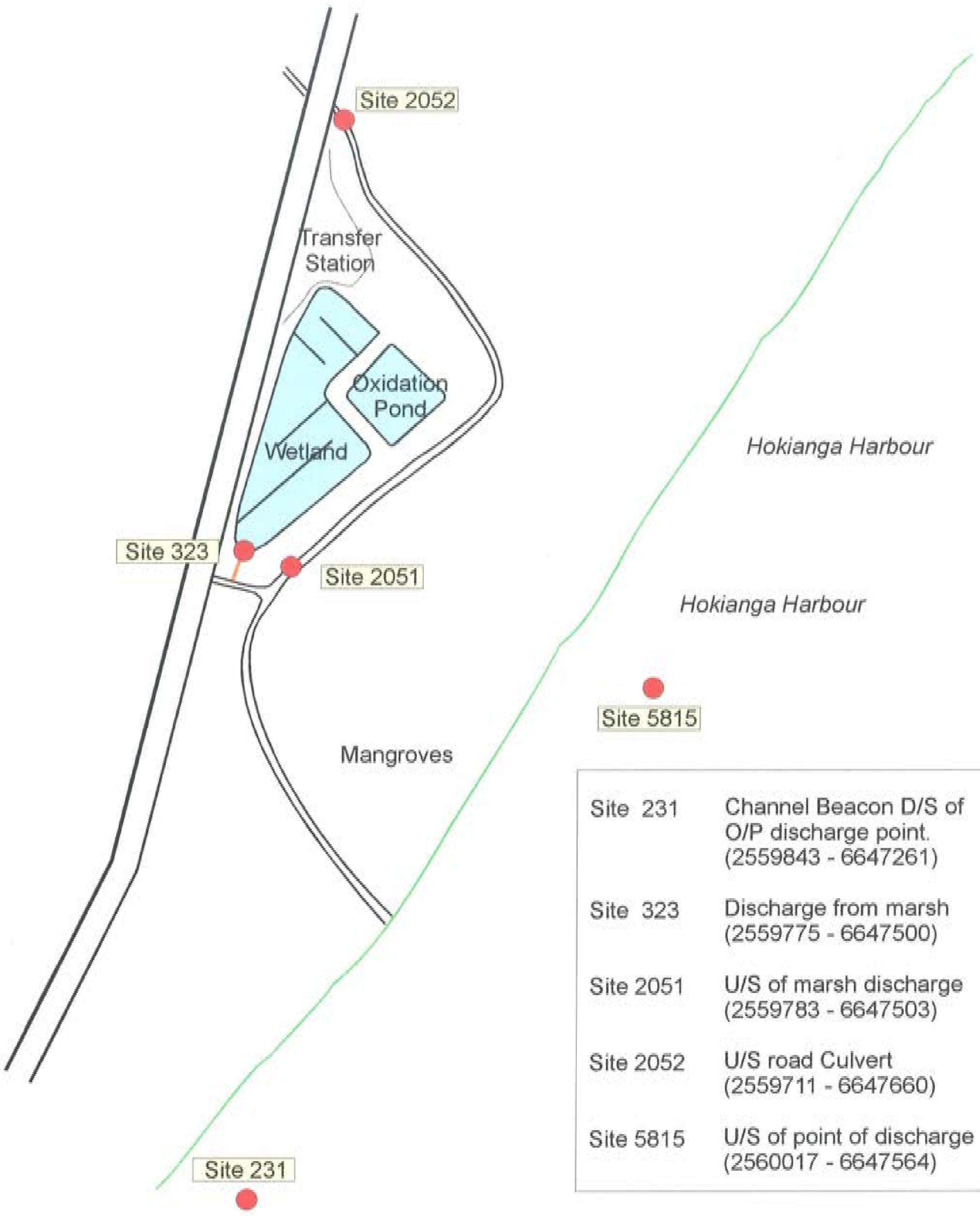
Temperature, pH, dissolved oxygen concentration and salinity are to be measured at NRC Sampling Sites 231 and 5815 using an appropriate meter, and in accordance with standard procedures.

NOTE:
All samples taken are to be analysed at a laboratory with registered quality assurance procedures, and all analyses are to be undertaken using standard methods. Registered Quality Assurance Procedures are procedures which ensures that the laboratory meets good management practices and would include registrations such as ISO 9000, ISO Guide 25, Ministry of Health Accreditation, amongst others.

The monitoring specified above is the minimum amount of monitoring that is required.

R

(01) 3839



Site 231	Channel Beacon D/S of O/P discharge point. (2559843 - 6647261)
Site 323	Discharge from marsh (2559775 - 6647500)
Site 2051	U/S of marsh discharge (2559783 - 6647503)
Site 2052	U/S road Culvert (2559711 - 6647660)
Site 5815	U/S of point of discharge (2560017 - 6647564)

	By	Date
Dwn.	C N Anderson	03/02
App'd		
Amendment		
No.	By	Date

RESOURCE CONSENT NLD 01 3839 01
for
Far North District Council
Sampling Sites
Kohukohu Waste Treatment Plant

NORTHLAND REGIONAL COUNCIL

Scale	Plan No.
N.T.S.	3316

Appendix B. Kohukohu Land Disposal Desktop Site Selection Report

Jacobs

Kohukohu WWTP

Land Disposal Site Selection Analysis Report

Document No. | A

February 17, 2020

Far North District Council

Client Reference

Kohukohu WWTP

Project No: IZ134400
Document Title: Land Disposal Site Selection Analysis Report
Document No.: Document No.
Revision: A
Document Status: Draft
Date: February 17, 2020
Client Name: Far north District Council
Project Manager: Project Manager
Author: Jessica Daniel
File Name: 02.03.20 Kohukohu Land Disposal Site Selection Report

Jacobs New Zealand Limited

Level 8, 1 Grey Street,
PO Box 10-283
Wellington, 6143
New Zealand
T +64 4 473 4265
F +64 4 473 3369
www.jacobs.com

Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
A	17/2/2020	Draft Report	JD	TB	BM	KS

Contents

Executive Summary

This report presents the results of a desktop GIS analysis to identify potentially suitable sites for land disposal of treated wastewater from the Kohukohu wastewater treatment plant (WWTP).

This report assumes an annual average flow of 30m^3/day and an average hydraulic loading rate of 2.0 mm/day. A total area of 3.0 hectares is required, including an allowance for 100% disposal buffer area and a storage pond.

A number of constraints were applied to the area of interest, which is sites located within a 7 km radius of the WWTP including:

Table 0-1 Screening Criteria for Land Disposal Sites

Parameter	Constraint	Unit
Proximity to WWTP	7 km	Km
Slope	<10	%
Proximity to waterways	≥20	m
Proximity to residential dwellings	>20	m
Proximity to cultural dwellings	500	m
Groundwater	>1.2	m
Elevation	>2m	m
Tsunami zone	Yellow – Safe	Zone
Flood risk	Preferably outside flood risk zone.	
Irrigation rate	3	mm/day

GIS spatial mapping using data sets from FNDC and Northland Regional Council (NRC) were used. Sites 1, 2 and 3 are located within an area marked as flood susceptible in FNDC flooding maps and were therefore excluded from further consideration. Sites 4 and 5 are less than the required 3.0 hectares based on the preliminary flow estimates and have also been excluded from consideration. Therefore, at this stage, land disposal is not considered viable due to a lack of suitable land area within 7km of the site, and is therefore excluded as an option for further consideration.

1. Introduction

Land disposal of municipal wastewater is a reasonably common method of wastewater disposal in New Zealand and is the preferred method from a Maori cultural perspective

The Kohukohu wastewater treatment plant (WWTP) discharges treated wastewater into the Hokianga Harbour. The Far North District Council (FNDC) are currently renewing the WWTP's resource consent which expired in 2016. As part of the consent renewal process, FNDC wish to investigate the feasibility of a land disposal option which would remove the discharge from the harbour. If potentially feasible, a land disposal option would be presented to the community along with continuing the harbour discharge and a decision made on an agreed strategy for the WWTP.

There are several factors which must be considered in the selection of a land disposal site, including:

- The volume and quality of wastewater to be applied
- Land use
- Soil types and quality
- Flooding and tsunami classifications
- Site elevation and topography

This report presents the site selection analysis completed for land disposal of effluent produced by the Kohukohu WWTP. Analysis has been completed using GIS spatial software and the datasets in the table below. Analysis and data processing were completed using Feature Manipulation Engine (FME) and the edited maps have been created in ArcGIS.

GIS Dataset	Source
Property Parcels	Land Information New Zealand
District Plan Zones	Far North District Council
Elevation (from 15m Digital Elevation Model)	University of Otago - National School of Surveying
Slope (from 15m Digital Elevation Model)	University of Otago - National School of Surveying
Watercourses	Land Information New Zealand
100-year flood plain extents	Northland Regional Council
Tsunami evacuation zones	Northland Regional Council
Marae locations	Maori Maps

2. GIS Screening for Potential Sites

2.1 Flow Summary

The flow data for the Kohukohu WWTP has been provided by FNDC for the period between 1st January 2010 and 8th December 2019. Figure 2-1 Kohukohu WWTP Flow Data shows the data over the past five years. The orange line depicts the average dry weather flow (ADWF) of 19m^3/day.

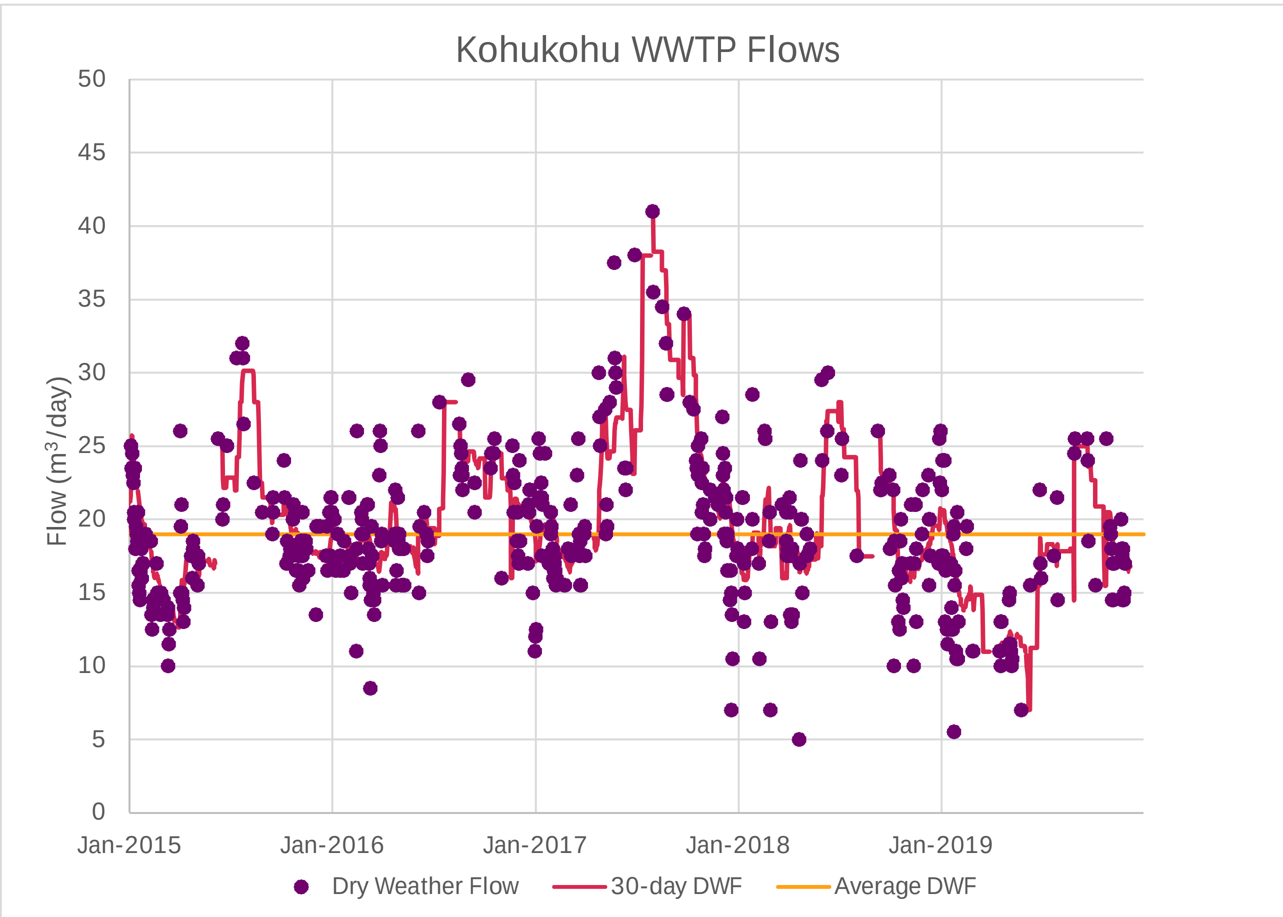


Figure 2-1 Kohukohu WWTP Flow Data

2.2 Required Land Area

For the purposes of this study, the land area requirement has been calculated based on an estimated annual average flow of 30m^3/day. A hydraulic loading rate of 2.0mm/day has been used, based on the poorly draining clay soils in the vicinity of the WWTP, and a water balance which considers evaporation, percolation and rainfall (USEPA Process Design Manual for Land Treatment of Municipal Wastewater Effluents (USEPA, 2006). At the aforementioned hydraulic loading rate and annual average flow, 0.9 hectares is required for land-based disposal as a minimum. In addition, a 50% buffer is required for spacing between the disposal trenches. A total land requirement of 3.0 Ha is recommended which would include a 100% redundancy buffer (typically required in Northland for land based disposal from septic tanks),water storage and a safety factor. This value would need to be confirmed following site-specific testing as part of the design of the land disposal system.

2.3 Site Selection Basis

2.3.1 Site Selection Criteria

The parameters outlined in Error! Reference source not found. contain the constraints applied on sites to assess their suitability for land disposal. The succeeding sections will discuss the application of the screening criteria in Error! Reference source not found. to identify suitable sites for land disposal.

Table 2-1 Site Selection Criteria

Constraint No.	Criteria	Criteria requirement	Basis
1	Proximity to WWTP	5 -7 kilometers	Ease of transport of effluent and manageable costs of installing infrastructure and operations within this distance (1)
2	Proximity to residential dwellings	>20m	Distance was selected based on previous work completed by CH2M Beca for Rawene WWTP (2)
3	Proximity to cultural dwellings	500m	Distance was selected based on previous work completed by AECOM for the Taipa WWTP completed with additional buffer (1)
4	Proximity to waterways	≥20m	Distance was selected based on previous work for Rawene WWTP (2)
6	Slope	<10%	Acceptable land slope for distribution as the risk of erosion and runoff is reduced (3)
7	Groundwater	>1.2m	At least 1m to groundwater is preferred with seasonal fluctuations of +/- 0.5m (3)
8	Elevation	>2m	Elevation was selected based on previous work completed by AECOM for the Taipa WWTP (1)
9	Tsunami zone	Yellow – Safe	Ideal zone.

2.4 Land Use

Figure 2-2 shows the location of the Kohukohu WWTP and the land use of the surrounding area within five and seven-kilometer radii from the Kohukohu WWTP and the Mangamuku River.

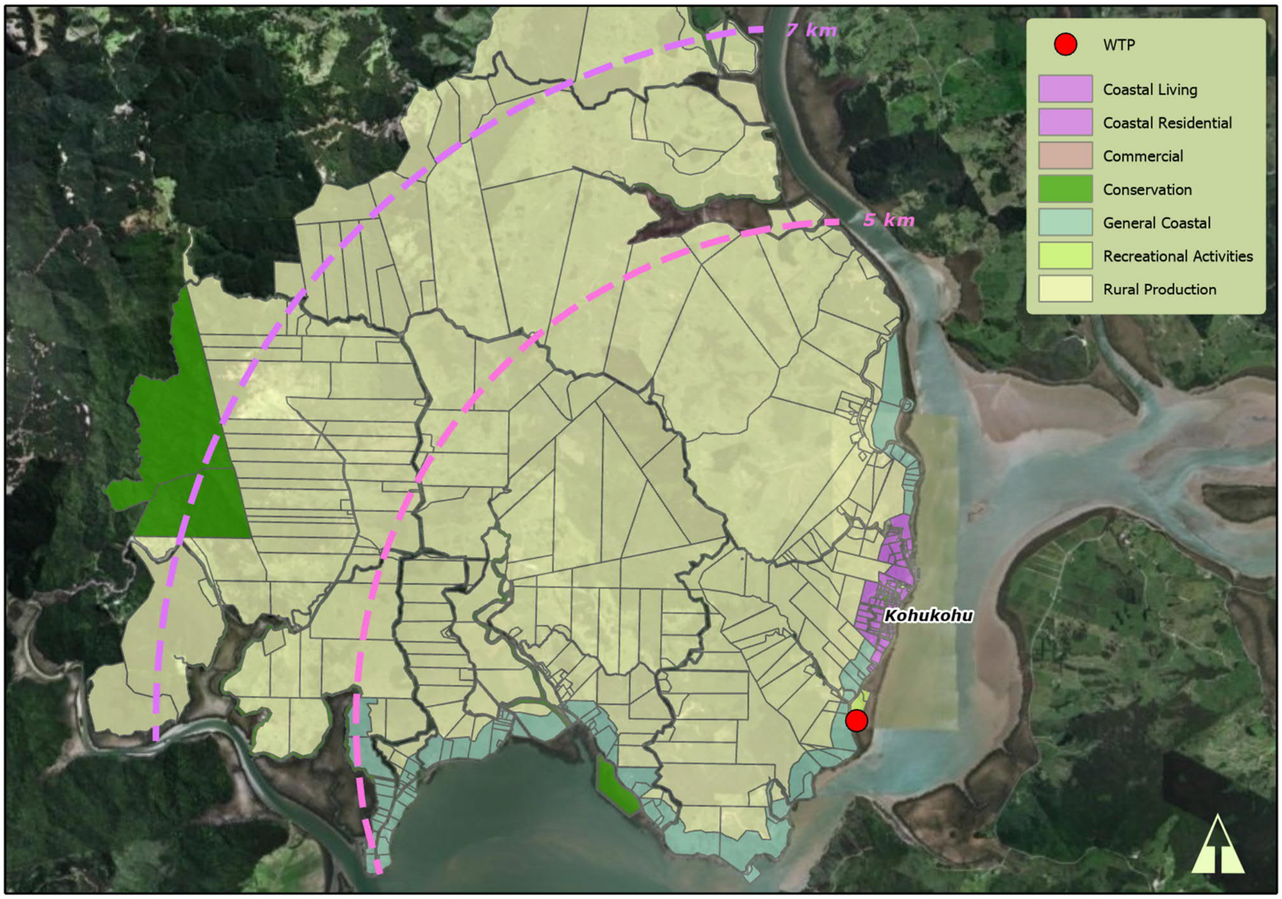


Figure 2-2 Kohukohu WWTP land uses within radius of interest

2.5 Proximity to Residential Dwellings and Conservation Land

A 20 meter minimum buffer distance between a land disposal site and residential dwellings has been applied. The likelihood for travel of effluent aerosols and runoff, which could adversely impact residents should they come into direct contact is diminished using this buffer distance. The same constraint has been applied to conservation land. Figure 2-3 Excluded residential and conservation land within 7 km radius from Kohukohu

WWTPshows the exclusion of residential and conservation land areas with the application of the buffer.

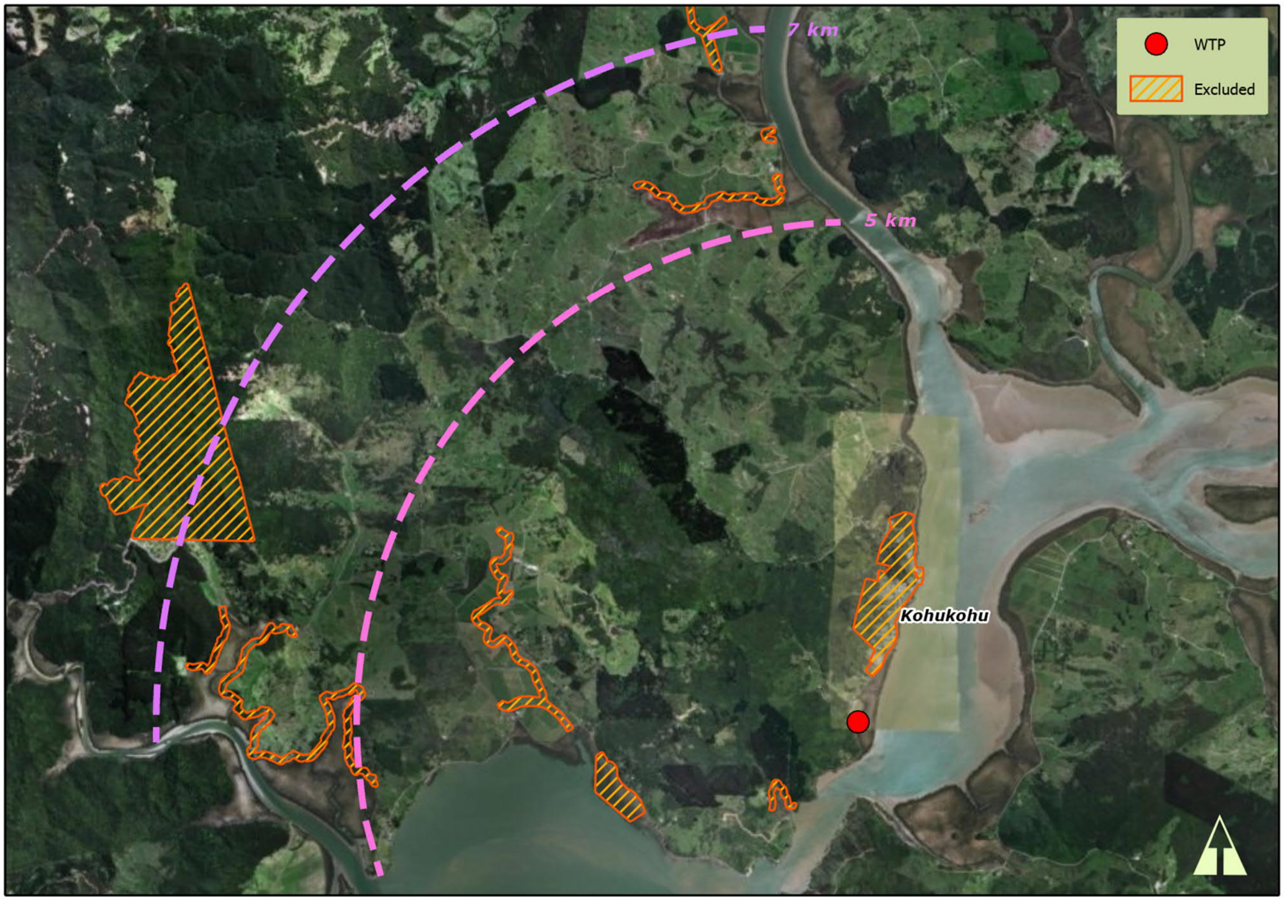


Figure 2-3 Excluded residential and conservation land within 7 km radius from Kohukohu WWTP

2.6 Proximity to Cultural Landmarks

The Ngai Taupoto, Tauteihiihi and Pikiparia maraes are located within 5km of the WWTP as seen in Figure 2-4 Maraes within the 7km boundary from the Kohukohu WWTP. The Ngai Taupoto Marae lies on Motukaraka Point Road at a distance of 7.4 km, Tauteihiihi Marae lies on Kohukohu Road at a distance of 230m and Pikiparia marae lies on Smith Deviation Road at a distance of 3.6 km from the Kohukohu WWTP. The maraes are culturally significant sites for the Kohukohu Maori tangata whenua and the local community, areas within the 500m buffer may also be heritage land and have archaeological significance. Figure 2-5 Excluded residential, conservation and culturally signifcant areas within a 7km boundary identifies maraes and other culturally significant areas and adds to the previously excluded area for residential and conservation land.

Figure 2-4 Maraes within the 7km boundary from the Kohukohu WWTP

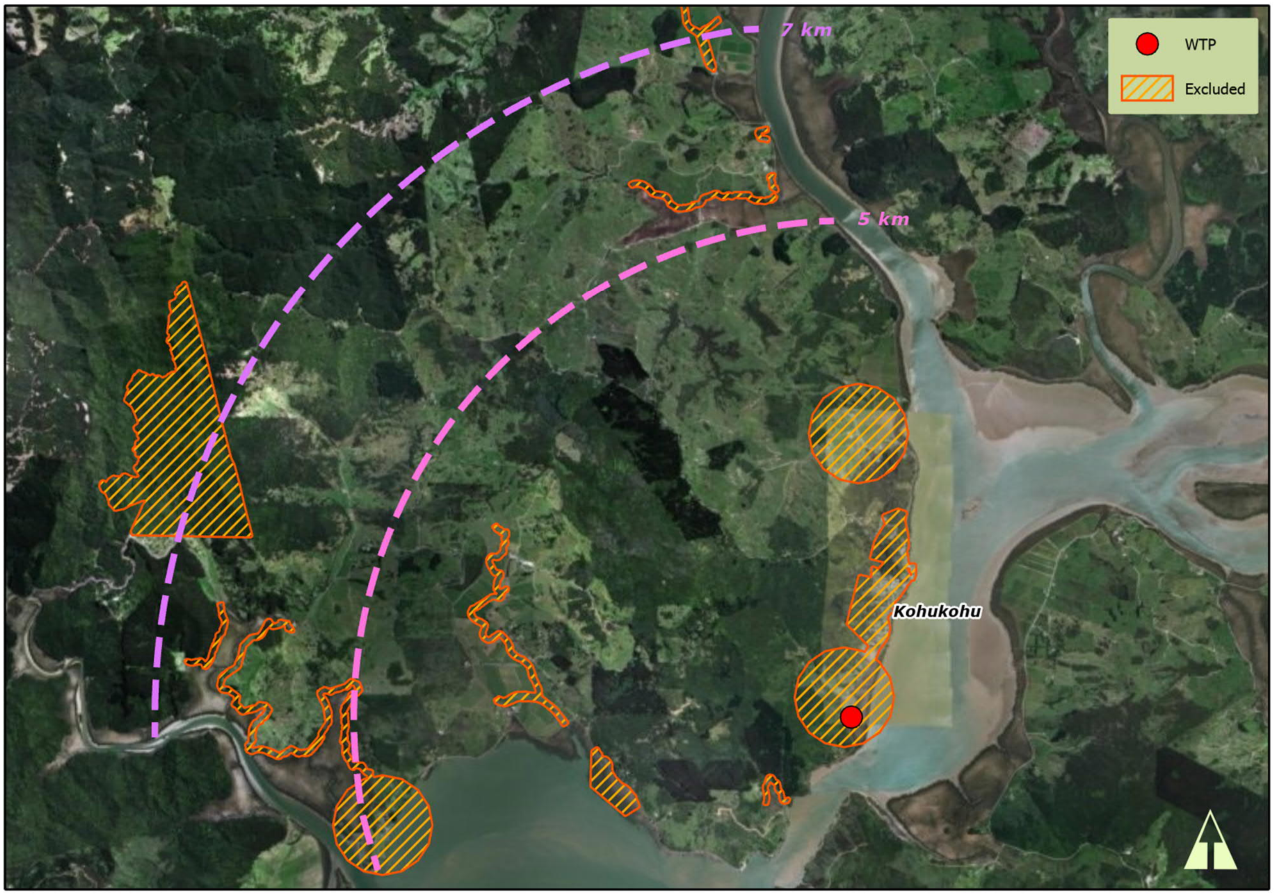


Figure 2-5 Excluded residential, conservation and culturally signifcant areas within a 7km boundary

2.7 Proximity to Watercourses

Watercourses flowing within the 7-kilometer radius from the Kohukohu WWTP have been highlighted and excluded from potential areas of use in Figure 2-6 Excluded residential dwellings, conservation land, cultural landmarks and water courses within a 7km boundary. A minimum buffer distance of 20m has been selected from each side of the waterway to avoid direct contamination of the Hokianga Harbour or the Mangamuka River by runoff of the treated effluent. Watercourses identified include all branches from the Mangamuka river and land drains located within the 7km radius from the Kohukohu WWTP.

Figure 2-6 Excluded residential dwellings, conservation land, cultural landmarks and water courses within a 7km boundary

2.8 Land Slope

The recommended maximum slope for disposal to pasture is below 10% (3). Metcalf and Eddy specifies that slopes below 12% are generally acceptable for land-based disposal with slopes greater than 6% performing better with direct injection measures e.g. Subsoil/ drip-feed irrigation refer to Error! Reference source not found. for detail. Slopes higher than this are unacceptable due to the lack of deep infiltration occurring into the soil, generation of runoff and erosion. Higher slope levels will contribute to the generation of runoff and he logistics of installation will prove to be a challenge.

Table 2-2 Land Disposal Slope Criteria

Slope Percentage	Land Disposal Performance
0 – 3%	Ideal slope range (3)
3 – 6%	Acceptable with minor erosion risks (3)
6 – 12%	Acceptable with direct injection methods, runoff development issues
12 – 15%	Greater runoff development and erosion issues.
15% ++	May be suitable for areas with excellent soil permeability

Using the slope and elevation level datasets from the University of Otago the FME tool was used to identify land with a slope level less than 10°. Figure 2-7 Slope levels within a 5 - 7 km radius from the Kohukohu WWTPidentifies all the slope percentages of land within a five to seven-kilometer radius from the Kohukohu WWTP. The lighter areas indicate sites that have a slope percentage between 1.5 – 10% which lie within the preferable area for irrigation as specified in Table 2-2.

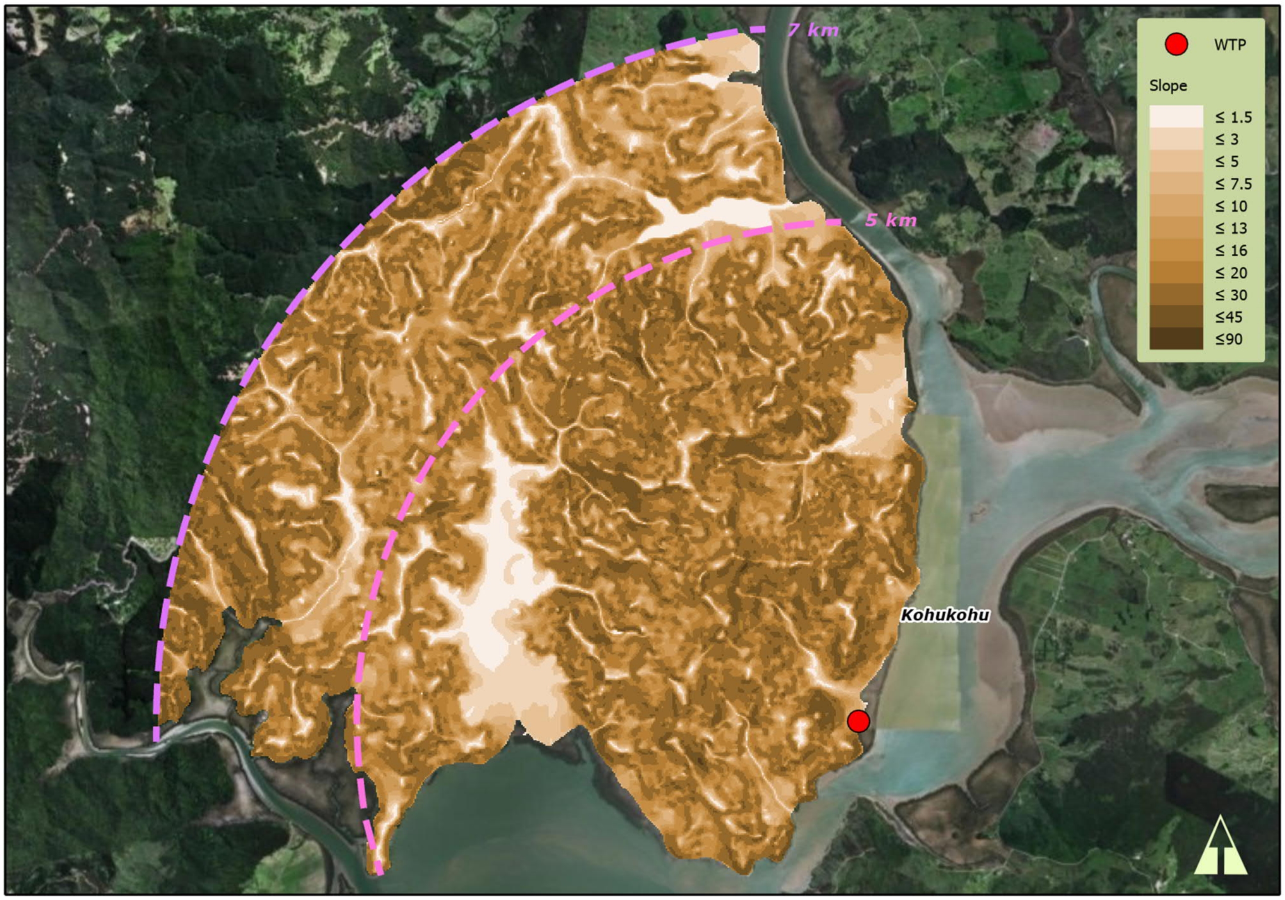


Figure 2-7 Slope levels within a 5 - 7 km radius from the Kohukohu WWTP

2.9 Soil Permeability

The Northland Regional Council Soil factsheet viewer tool was used to estimate the types of soils that are within the 7km radius of interest surrounding the Kohukohu WWTP. Table 2-3 Soil types within 7km of the Kohukohu WWTP identifies the soil types and the drainage properties of each soil below:

Table 2-3 Soil types within 7km of the Kohukohu WWTP

Soil type	Description	Drainage Class	Soil permeability (m/s) (4)
AEH	Young Sandstone Soils - Autea clay loam/silty clay loam	3 – moderately drained (5)	$10^{-8} – 10^{-11}$
TC	Recent Estuarine Soils – Takahiwai clay	1 – Poorly drained (6)	$10^{-11}– 10^{-12}$
TFH	Young mudstone soils - Te Tio clay loam	2 – Imperfectly to poorly drained (7)	$10^{-11} – 10^{-12}$

WF	Whakapara silt loam and clay loam	4-3 Moderately to well drained (8)	$10^{-8} – 10^{-11}$

The soil surrounding the WWTP are generally clay type soils which are moderate to poorly drained. Loamy soils with slow to moderate permeabilities and moderate drainage are preferable for land-based disposal methods (3).

3. Second Stage Analysis of Potential Sites

Applying the criteria outlined in Error! Reference source not found., the areas outlined in Figure 3-1 Available Sites within a 7km radius from the Kohukohu WWTPare valid sites which meet the screening criteria and the total land requirement area of 2 hectares.

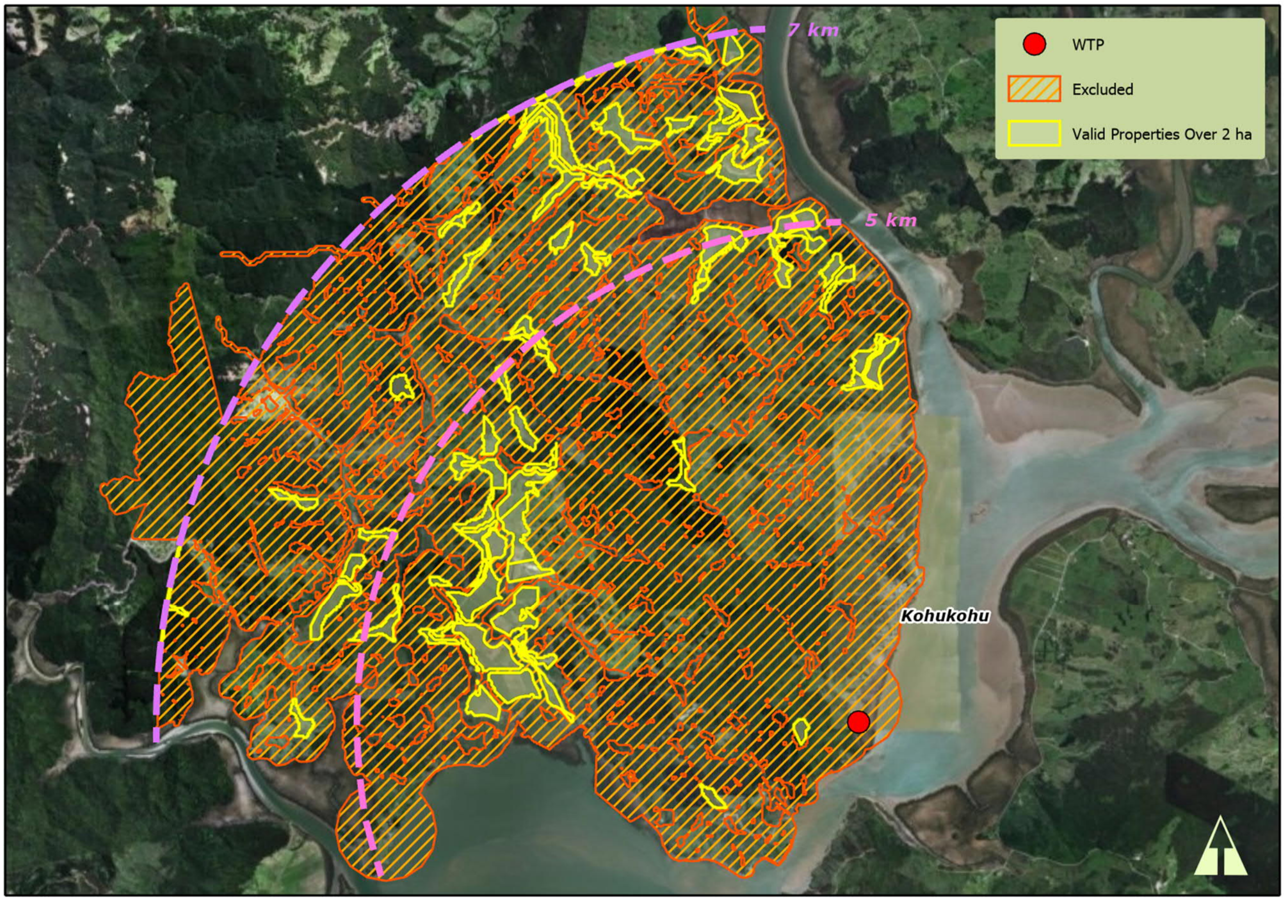


Figure 3-1 Available Sites within a 7km radius from the Kohukohu WWTP

Due to the large number of valid sites which are within a 5km radius, the sites outside this radius will not be discussed any further. The remaining sites were screened further in terms of existing land cover, number of lots affected, ownership of lots and distance from the WWTP. Five sites were chosen for further investigation, these can be seen in Figure 3-2 Selected Sites for Land Disposal, the sites have been investigated further to determine the optimum site.

Figure 3-2 Selected Sites for Land Disposal

3.1 Site 1, 2 and 3

Sites 1, 2 and 3 were assessed in conjunction due to similarities in topography and location. Site 1 lies at a distance of 3071 m from the Kohukohu WWTP. Pipe access for all sites will be along established roadways, access for all sites will be along Kohukohu Road and West Coast Road. Piping for Site 3 would need to travel further along Hawkins Road to reach the site. Site 1 has all four soil types stated in Table 2-3 Soil types within 7km of the Kohukohu WWTP, a majority of the site is the well-drained Whakapara clay (61%), a sizeable portion is the Takahiwai clay (27%) and a smaller portion is the Autea clay (12%). The Whakapara and Autea clays have moderate to well soil permeability however the presence of Takahiwai clay would reduce soil permeability and irrigation levels of the site.

Site 2 lies at a distance of ~3409m from the Kohukohu WWTP. The site contains the Takahiwai clay 96% and the Whakapara clay (4%) soil types. The Takahiwai clay type has poor permeability, is prone to pugging and is have poor soil structure and don't support subsoil drainage systems. This would decrease the levels of infiltration into the soil greatly, though the Whakapara soil type has generally good soil characteristics. Similarly, site 3 is located at a distance of ~3669m from the Kohukohu WWTP. The site soil type is comprised of 91% Takahiwai clay and 9% Te Tio clay loam. Like Site 2, a large percentage of the Takahiwai clay type with poor drainage characteristics would reflect in poor drainage of the soil and poor permeability of treated effluent for irrigation.

Table 3-1 Sites 1, 2 and 3 Property Information

Site	Legal Description	Address	Area Suitable for Land Disposal (Ha)	Total Property Area (Ha)	No. of Landowners
1	Section 121 Blk X Mangamuka SD	26 Hawkins Road Kohukohu 0491	4.3	5.0100	1
2	Section 98 Blk X Mangamuka SD	190 Hawkins Road Kohukohu 0491	11.0	16.4909	1
3	Lot 2 DP 175963	26 Hawkins Road Kohukohu 0491	6.3	6.7262	1

Sites 1-3 are relatively flat, pasture land with slope levels ranging between 1.5 – 5% (1° - 3°), which is positive for irrigation purposes with respect to infiltration to the desired area and minimize runoff.

Sites 1 – 3 lie within the tsunami yellow zone Figure 3-3 Tsunami Zones surrounding the Kohukohu WWTP. The tsunami yellow is indicative of areas which may need to be evacuated should an earth quake of magnitude higher than 9 take place. Remaining areas of sites 1 – 3 lie within the green zones which would be unaffected in a tsunami scenario. Site 3 primarily lies within the yellow and green zones.

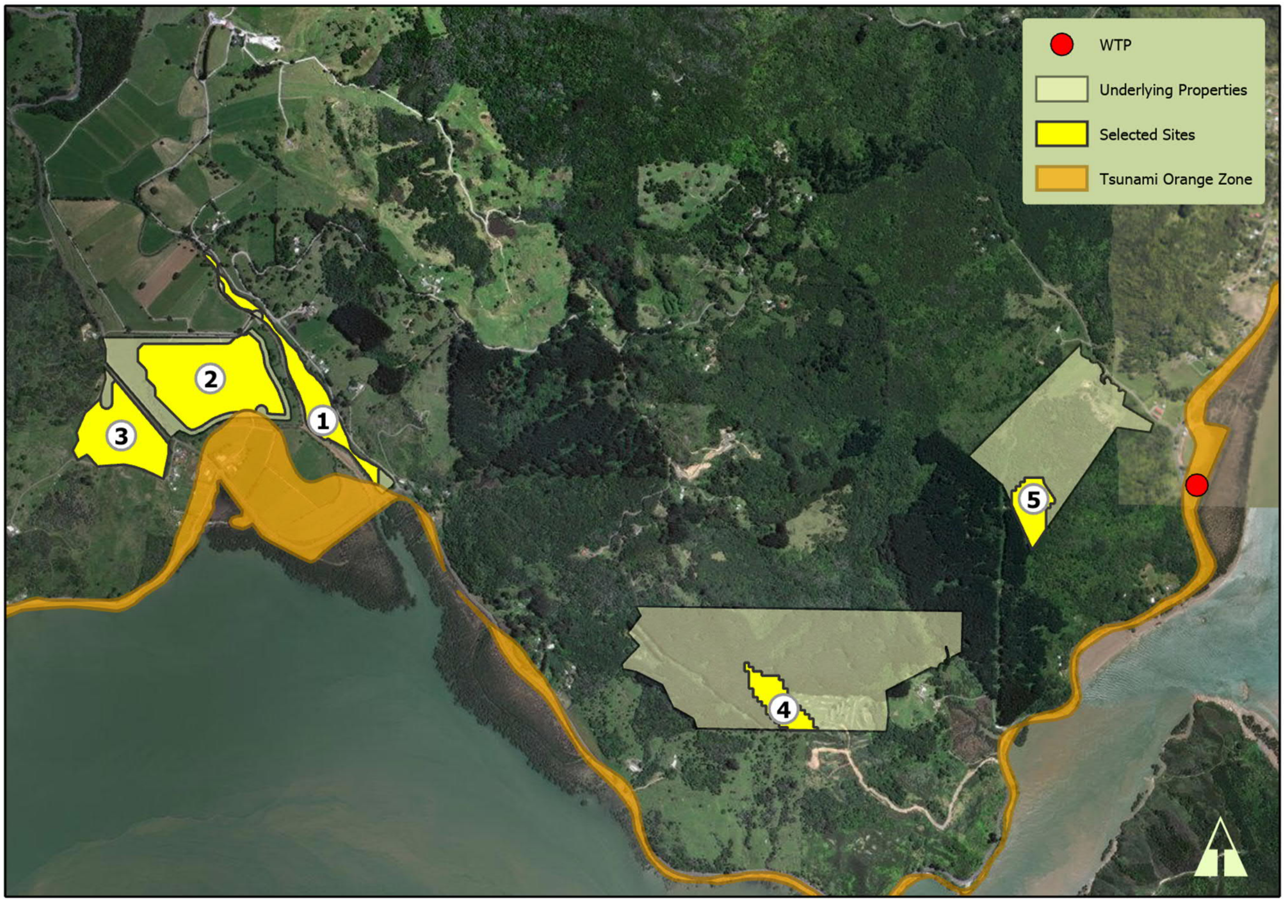


Figure 3-3 Tsunami Zones surrounding the Kohukohu WWTP

The flood risk of the sites was assessed using the Far North District Plan Potential Flooding Maps. (Figure 3-4 Sites 1-3 Flood Risk Map). Sites 1 to 3 were found to be susceptible to flooding and are therefore excluded from consideration due to flood risk.

Figure 3-4 Sites 1-3 Flood Risk Map

3.2 Site 4

Site 4 is located at a distance of 1,7km from the Kohukohu WWTP. Pipe access for the site will be along Kohukohu Road followed by private road RD SO 4196. Consultation with the landowner will need to be sought in order to obtain approvals to install pipe instruction. The Autea clay type soil dominates this site which has moderate drainage properties, the soil is also retains wetness during winter and is prone to pugging which would cause difficulties in terms of irrigation during winter and provision for storage would be required.

The property details for Site 4 have seen summarized in Table 3-2 Site 4 Property Informationbelow.

Table 3-2 Site 4 Property Information

Site	Legal Description	Address	Area Suitable for Land Disposal (Ha)	Total Area (hectares)	Capital Value	Land Value	No. of Landowners
4	Pt Sec 22 Blk X Mangamuka SD	Kohukohu Road Kohukohu 0491	2.4	40.50	$155,000	$145,000	1

Site 4 slope varies between 3% – 10%, Site 4 lies in the green zone and likely to be unaffected by a tsunami event. The site also has not been found to be situated in a flood risk zone. However, Site 4 does not provide sufficient land area for disposal of the full flow, therefore excluded from consideration on this basis.

3.3 Site 5

Site 5 is located at a distance of 578m from the Kohukohu WWTP. The site is located at the top of a hill opposite the WWTP. There is no road access to the site, and a new access road would need to be constructed. The property details of Site 5 can be seen in Table 3-3 Site 5 Property Information below. The irrigation pipe access route will be along Tauteihiihi Road and across the site to reach the disposal area of in Figure 3-2 Selected Sites for Land Disposal located at the south-eastern corner of the property.

Table 3-3 Site 5 Property Information

Site	Legal Description	Address	Area Suitable for Land Disposal (ha)	Total Area (hectares)	Capital Value	Land Value	No. of Landowners
5	Tauteihiihi 2B 3B ML 422722	33 Tauteihiihi Road Kohukohu 0491	2.3	186,653	$123,500.00	$114,000.00	1

Similar to the features of Site 4, the site is covered by forestation and vegetation. The property is also primarily of the Autea clay soil type and the slope level is within 3% - 10%. Site 5 does not provide sufficient land area for disposal of the full flow, therefore excluded from consideration on this basis.

3.4 Summary of GIS Analysis

Error! Reference source not found. summarizes all the key information on each of the proposed sites and the recommendations for further investigations. It has been concluded that none of the sites are considered feasible for land disposal.

Table 3-4Site Selection Analysis Summary

Parameter	Site 1	Site 2	Site 3	Site 4	Site 5
Distance from WWTP	3071 m	~3409m	~3669m	1697m	578m

Area Suitable for Land Disposal (Ha)	4.3	11.0	6.3	2.4	2.3
Property Area (Ha)	5.0100	16.49	6.73	40.5	18.7
Land ownership	1	1	1	1	1
Soil type	Whakapara clay, Autea clay, Takahiwai clay	Autea clay, Takahiwai clay	Takahiwai clay, Te Tio clay	Autea clay	Autea clay
Soil Permeability	Well - moderate	Poor	Poor	Moderate	Moderate
Tsunami zone	Yellow,	Yellow,	Yellow	Green	Green
Flood risk	Yes	Yes	Yes	No	No
Recommended for further investigation	No	No	No	Yes	Yes

4. Conclusions

Spatial analysis has been performed to find an appropriate land-based disposal of effluent produced at the Kohukohu WWTP. No sites have been identified that meet the required criteria for land disposal, therefore, at this stage land disposal is not considered feasible for the Kohukohu WWTP.

5. References

1. AECOM. Taipa WWTP Upgrade Issues and Options Land Disposal Site Analysis Report. 2018.

2. CH2M Beca Ltd. Rawene Issues and Options Report. 2020.

3. Metcalf & Eddy. Wastewater Engineering Treatment and Reuse. Fourth. 2003.

4. Look, Burt. Handbook of Geotechnical Investigation and Design Tables. London : Taylor & Francis, 2007.

5. Northland Regional Council. 3.2.1 Young Sandstone Soils. Northland Soils Factsheet Viewer. [Online] 2020. https://nrcgis.maps.arcgis.com/apps/webappviewer/index.html?id=fd6bac88893049e1beae97c3467408a9.

6. —. 1.1.3 Recent Estuarine Soils. Northland Soils Factsheet Viewer. [Online] 2020. https://nrcgis.maps.arcgis.com/apps/webappviewer/index.html?id=fd6bac88893049e1beae97c3467408a9.

7. —. 3.3.1 Young Mudstone Soils. Northland Soils Factsheet Viewer. [Online] 2020. https://nrcgis.maps.arcgis.com/apps/webappviewer/index.html?id=fd6bac88893049e1beae97c3467408a9.

8. —. 1.1.1 & 1.1.2 Recent Alluvial Soils. Northland Regional Council. [Online] 2020. https://nrcgis.maps.arcgis.com/apps/webappviewer/index.html?id=fd6bac88893049e1beae97c3467408a9.

9. Sydney Catchment Authority. Surface Irrigation. [book auth.] Sydney Catchment Authority. Design and Installation of On-site Wastewater Systems.

Appendix C. Kohukohu WWTP Options Cost Estimates and Supplier Information

Jacobs	CALCULATION SHEET			Ref no.	IZ134400-GN-SCH-001
	Project	Kohukohu WWTP Options Assessment		Date	15-10-20
	Client	Far North District Council		Project no.	IZ134400
	Page	1 of 1		Designer	JD
	Subject	Kohukohu Options Cost Estimates		Checked	BM

Item	Unit	Quantity	Rate	Total	Comment
Option 1 - Desludging and Vegetation Clearance Services					
Kohukohu WWTP Desludging & Dewatering and Wetland Vegetation Clearance					
Desludging and Dewatering	Item	1	$ 82,426	$ 83,000	SiteCare quote date 08/07/20. This price includes team mobilisation,dewatering and transportation to of waste to the Kaitaia landfill and contractor contingencies. There is a greater certainty on the scope of this work therefore a lower risk factor has been applied to this task.
Wetland vegetation clearance	Item	1	$ 27,400	$ 28,000	SiteCare quote for wetland maintenance 8/07/20. No contingency is to be applied to this task as it is not required. Additionally FNDC could execute this work in house without needing an external contractor.
Risk Allowance (reduced)	%	34	$ 28,024.84	$ 29,000	A reduced risk factor has been applied for this option as only the desludging work will require a contigency and the quote provided has inbuilt contractor contingencies. The risk allowance is based on the contingency stated in Table 4.4 of the IChemE Guide to capital cost estimation for power, engineering and supervision fees for a Fluid Processing Plant. The risk allowance has only been applied to the desludging and dewatering item.
Total Costs				140,000	
Option 2 - Optimise Existing System					
Kohukohu WWTP Desludging & Dewatering and Wetland Vegetation Clearance					
Desludging and Dewatering	Item	1	$ 82,426	$ 83,000	SiteCare quote date 08/07/20. This price includes team mobilisation,dewatering and transportation to of waste to the Kaitaia landfill and contractor contingencies.
Wetland vegetation clearance	Item	1	$ 27,400	$ 28,000	SiteCare quote for wetland maintenance 8/07/20. No contingency is to be applied to this task as it is not required. Additionally FNDC could execute this work in house without needing an external contractor.
Pond Modifications					
Supply and install baffle curtains	Item	1	$ 24,754	$ 25,000	Two Permanthene baffle curtains to be installed at 20 metres in length and $165/m. Includes costs for installation quoted by SiteCare on 08/07/20.
Inlet Relocation		1	$ 55,700	$ 56,000	SiteCare quote date 08/07/20. Total cost also includes
Risk Allowance (standard)	%	54	$ 71,960.00	$ 72,000	The Risk allowance is based on factor recommend in Table 4.4 of the IChemE Guide to capital cost estimation for power, engineering and supervision fees for a Fluid Processing Plant.
Total Costs				$ 264,000	

Jacobs	CALCULATION SHEET		Ref no.	IZ134400-GN-SCH-001
	Project	Kohukohu WWTP Options Assessment	Date	15-10-20
	Client	Far North District Council	Project no.	IZ134400
	Page	1 of 1	Designer	JD
	Subject	Kohukohu Options Cost Estimates	Checked	BM

Item	Unit	Quantity	Rate	Total	Comment
Option 3 - Optimise Existing System Plus UV Disinfection					
Kohukohu WWTP Desludging & Dewatering and Wetland Vegetation Clearance					
Desludging and Dewatering	Item	1	$ 82,426	$ 83,000	SiteCare quote date 08/07/20. This price includes team mobilisation,dewatering and transportation to of waste to the Kaitaia landfill and contractor contingencies. There is a greater certainty on the scope of this work therefore a lower risk factor has been applied to this task.
Wetland vegetation clearance	Item	1	$ 27,400	$ 28,000	SiteCare quote for wetland maintenance 8/07/20. No contingency is to be applied to this task as it is not required. Additionally FNDC could execute this work in house without needing an external contractor.
Pond Modifications					
Supply and install baffle curtains	Item	1	$ 24,754	$ 25,000	Two Permanthene baffle curtains to be installed at 20 metres in length and $165/m. Includes costs for installation quoted by SiteCare on 08/07/20.
Inlet Relocation		1	$ 55,700	$ 56,000	SiteCare quote date 08/07/20.
Further Wastewater Treatment					
UV unit	Item	1	$ 19,920	$ 49,000	Xylem quote for a Wedeco LBX10 from March 2020. The total price includes installation, instrumentation and controls, piping and electrical costs.
Instrumentation costs: 1. Flowmeter 2. Turbidity meter 3. UV Transmissivity	Items	1	$ 21,590	$ 53,000	Based on quotes received in 2019 from instrumentation suppliers. The total prices includes installation, instrumentation and controls, piping and electrical costs based on factors recommended in Table 4.4 of the IChemE Guide to capital cost estimation.
Risk Allowance (standard)	%	54	$ 127,040.00	$ 128,000	The Risk allowance is based on factor recommend in Table 4.4 of the IChemE Guide to capital cost estimation for power, engineering and supervision fees for a Fluid Processing Plant.
Total Costs				$ 422,000	