KAITAIA AND KAIKOHE WWTP OPTIONS ASSESSMENT

Kaikohe WWTP Options Assessment

Far North District Council

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1.0 INTRODUCTION

Far North District Council (FNDC) currently hold a resource consent to discharge treated effluent from the Kaikohe Wastewater Treatment Plant (WWTP) to the Wairoro Stream. This consent expires in November 2021. In preparation for the renewal of the consent, FNDC are undertaking an investigation into the various options available to upgrade the Kaikohe WWTP and meet the new discharge standards of the Proposed Regional Plan (PRP). Although the PRP is yet to become operative, the effluent quality requirements are likely to be more stringent. This options assessment aims to provide documentation required for the renewal of the resource consent and inform the investment planning under the 2021-2031 Long-Term Plan (LTP) process.

The preferred option to upgrade the Kaikohe WWTP has been derived through an extensive options evaluation process. This process started with the identification of a wide range of potential options, the long list of options. This included historic options considered in previous reports. The options from the long list were then narrowed down to the short list using a qualitative application of the Multi Criteria Analysis (MCA). The shortlisted options were developed to a concept level to allow for a more detailed assessment using a quantitative MCA.

This report presents the basis of design, evaluation methodology and criteria, and evaluation of the long list and short list options. This includes a sensitivity analysis and a risk assessment. Based on this a recommendation of the preferred option has been provided.

2.0 EXISTING PLANT

The Kaikohe WWTP is located adjacent to Wairoro Stream and can be accessed from Cumber Road. The treatment system services the local Kaikohe community in addition to Ngawha and the Northland Region Corrections Facility. The WWTP consists of an inlet screen, an anaerobic pond, an oxidation pond and a series of four constructed wetland (CWL) cells. The final wetland cell contains a notched weir from which treated wastewater discharges to a natural wetland (NWL) prior to discharging into the nearby Wairoro Stream (see Figure 1). The plant also has a sludge lagoon (to the north) and a geobag storage area (to the east of the oxidation pond). There are four sampling points; after the CWL, after the NWL, upstream (US) of the discharge to Wairoro Stream and downstream (DS) of the discharge to Wairoro Stream.

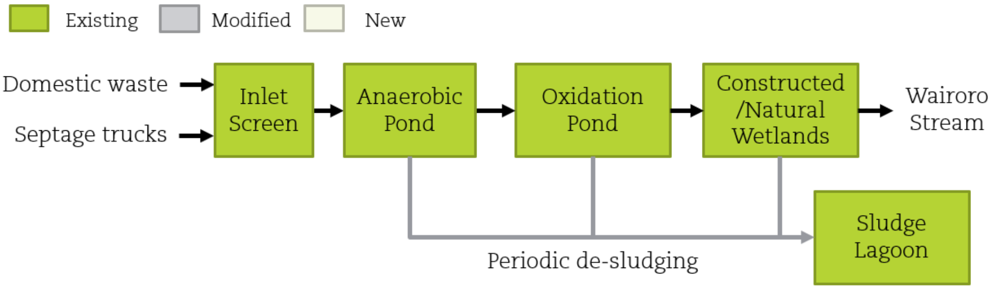


FIGURE 1. BLOCK DIAGRAM FOR THE EXISTING KAIKOHE WWTP

Figure 2 below provides an aerial view of the plant with various treatment steps and sampling points labeled.

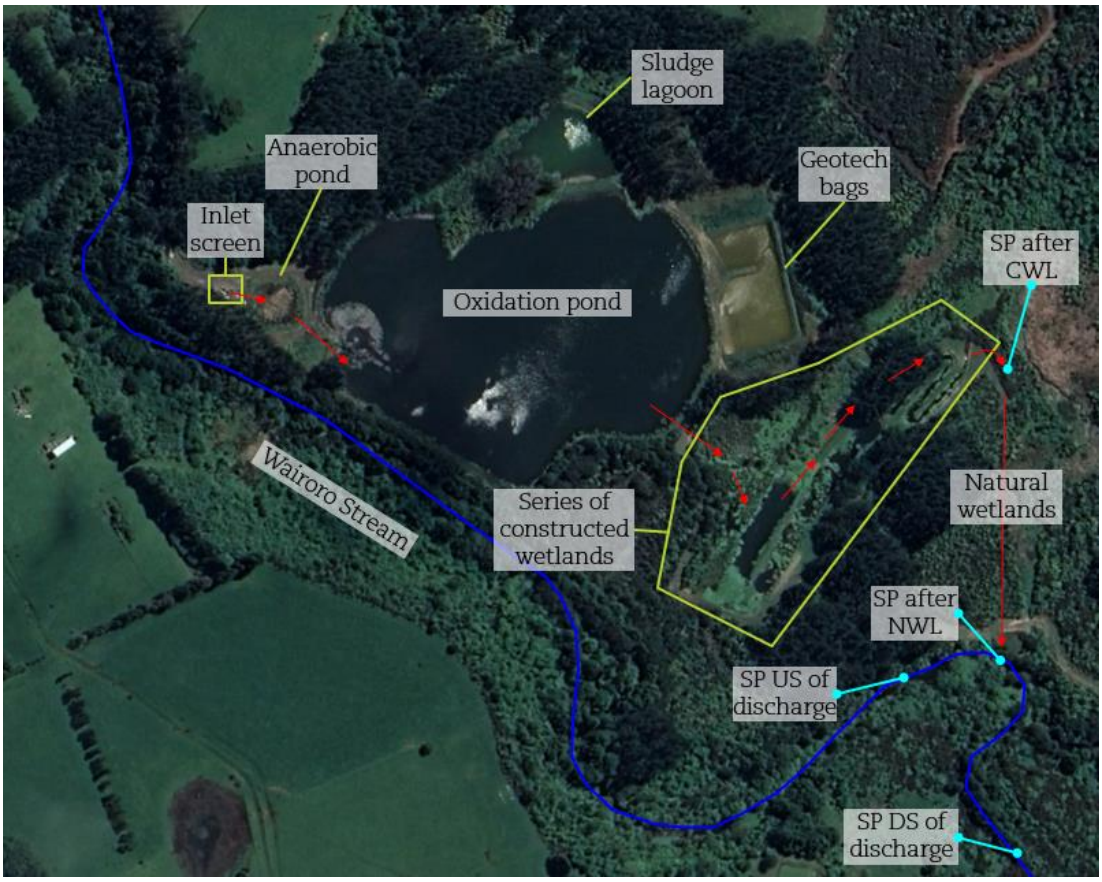


FIGURE 2. SCHEMATIC OF WWTP LAYOUT

3.0
BASIS OF DESIGN

3.1 POPULATION AND GROWTH

The current (2020) and future (2055) residential growth estimates are based on .id population projections[1]. The key assumptions are:

- From 2043 to 2055, there is an average annual population change of 1.52%;
- The industrial growth rate is the same as the residential growth rate.

TABLE 1: KAIKOHE CURRENT AND FUTURE POPULATION

YEAR	2020	2043	2055
Population	4,371	5,949	7,129

These assumptions and projections will be used to estimate future flows and loads to the plant (see Section 3.2).

3.2 INFLUENT FLOWS AND LOADS

3.2.1 INFLUENT FLOWS

The current (2020) and future (2055) influent flow estimates are summarised in Table 2. Current flows are based on plant log data from April 2017 to April 2020 and include both residential and industrial wastewater. The future (2055) influent flows have been estimated using the current influent flows and forecasted population growth in Table 1. It was assumed that industrial waste flows will grow at the same rate as domestic waste flows.

TABLE 2: ESTIMATE OF CURRENT AND FUTURE INFLUENT FLOW

PARAMETER	2020	2055
Average Flow (m^3/day)	1,862	3,036
Median Flow (m^3/day)	1,611	2,628
90th Percentile Flow (m^3/day)	2,983	4,865
Max Flow (m^3/day)	9,235	15,062
Average Dry Weather Flow (ADWF)* (m^3/day)	1,707	2,785

**Based on consent condition which states that a "dry weather discharge day" is any day which there is less than 1 millimetere of rainfall, and that day occurs after three consecutive days either without rainfall or with rainfall of less than 1 millimeter on each day. .*

10% of the influent flows are attributed to industrial waste[2]. Therefore, it is assumed 171m^3/day of the ADWF is from industrial waste and 1,537m^3/day is domestic waste. The current domestic ADWF wastewater production rate of 352 L/capita/day is higher than typical values observed in New Zealand. Generally, the ADWF is around 220 L/capita/day. The high per capita rates could be due to inflow and infiltration into the wastewater network, or additional connections.

[1] https://forecast.idnz.co.nz/far-north/population-households-dwellings?WebID=130
[2] WaterNZ, *2018-19 Combined WWTP Data: WWA7f Proportion of Trade Waste 2015-16 in Kaikohe* (2020) https://www.waternz.org.nz/WWTPInventory

3.2.2 INFLUENT LOADS

An estimate of the current and future influent loads to the WWTP are shown in Table 3. Loads have been calculated based on the observed concentrations at the plant, except were assumptions have been made for parameters that are not sampled.

TABLE 3: CURRENT AND FUTURE INFLUENT LOAD (FEB '17 – FEB '20)

PARAMETER	AVERAGE CONCENTRATION (g/m^3)	CURRENT 2020 LOAD (kg/day)**	FUTURE 2055 LOAD (kg/day)***
$cBOD_5$	282	482	786
TSS	430	734	1,197
TN*	46	79	128
NH_3-N*	41	70	114
TP*	8	13	21

**Loads based on typical New Zealand production values:*

TN – 18g/capita/day

NH_3-N – 16g/capita/day

TP – 3g/capita/day

***Calculated using the current influent ADWF of 1,707m^3/day as shown in Table 2.*

****Calculated using the future influent ADWF of 2,785m^3/day as shown in Table 2.*

It is assumed that the current industrial influent water quality remains unchanged as there is no major change in the type of industries serviced by the WWTP. Therefore, the industrial growth is attributed to the existing industrial facilities.

3.3 EFFLUENT QUALITY AND DISCHARGE STANDARD

3.3.1 CURRENT DISCHARGE CONSENT LIMITS

The existing discharge consent limits the 30-day rolling average of dry weather flow (DWF) discharges from the WWTP to 1,710m^3/day. Compliance is based on the average daily discharge volume of the 30 most recent "dry weather discharge days". A "dry weather discharge day" is any day on which there is less than 1mm of rainfall, and that day occurs after three consecutive days either without rainfall or with rainfall of less than 1mm on each day. The discharge volume is measured from the outlet of the final constructed wetland. No quality limits apply to the wastewater discharge, instead quality limits apply instream after mixing 80m downstream of the discharge point into Wairoro Stream (as per Condition 7 of the consent)

Figure 3 below compares the 30-day rolling average of DWF discharges against the discharge limit. Exceedances of the discharge limit are likely attributed to rainfall followed by the delay in discharge due to the pond buffering capacity. Between May 2018 and October 2019, only 25% of the discharge flows over the 525-day period were included in the calculation for the 30-day rolling average.

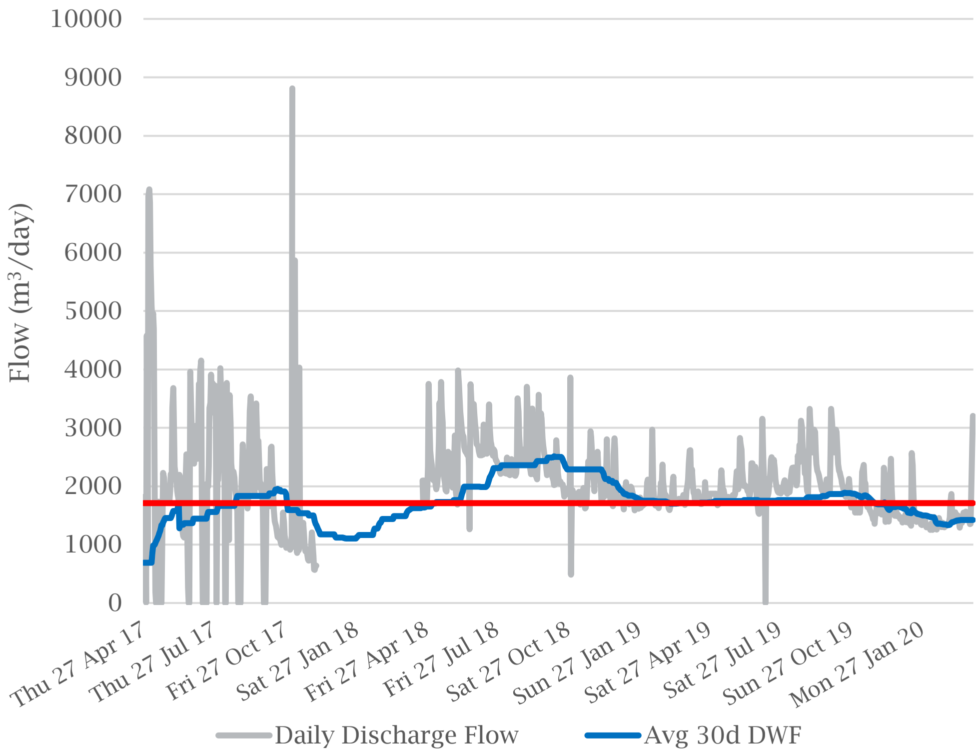


FIGURE 3. COMPARISON OF DAILY DISCHARGE FLOW, AVG 30-DAY DWF, AND DISCHARGE LIMIT

3.3.2 CURRENT EFFLUENT QUALITY

The current influent and effluent loads are shown in Table 4. Kaikohe WWTP is a pond-based treatment system that targets BOD and solids removal with limited nitrogen and phosphorus removal.

TABLE 4: AVERAGE INFLUENT AND EFFLUENT LOADING

PARAMETER	AVERAGE INFLUENT LOAD (KG/DAY)	AVERAGE EFFLUENT LOAD (KG/DAY)**	PERCENTAGE REMOVED
$cBOD_5$	482	40	92%
TSS	734	111	85%
TN*	79	73	7%
NH_3-N*	70	69	1%
TP*	13	11	18%
DRP	-	8	-

**Loads based on typical New Zealand production values:*

TN – 18g/capita/day

NH_3-N – 16g/capita/day

TP – 3g/capita/day

***Calculated based on the wastewater quality data collected between Aug '17 and July '20 from the constructed wetland (CWL) sampling point and the current average effluent flow of 2,028m³/day.*

Table 5 compares the E.coli count from the four WWTP sampling points. A decrease in E. coli from the constructed wetland (CWL) to the natural wetland (NWL) and an increase from upstream (U/S) to downstream (D/S) of the discharge can be observed.

TABLE 5: EFFLUENT MEDIAN AND 95TH PERCENTILE E. COLI (MPN/100ML)				
E. COLI	**AFTER CWL**	**AFTER NWL**	**U/S OF DISCHARGE**	**D/S OF DISCHARGE**
Median	7,700	2,100	460	620
95th Percentile	24,200	19,900	3,600	3,900

3.3.3 PRP WATER QUALITY STANDARDS

A comparison of the Northland Regional Council Proposed Regional Plan (PRP) water quality standards against water quality samples of the Wairoro Stream is shown in Table 6. The water quality values U/S and D/S of the discharge are calculated over a three-year period whereas the PRP standards are assessed on an annual basis.

TABLE 6: COMPARISON OF NORTHLAND PROPOSED REGIONAL PLAN WATER QUALITY STANDARDS AGAINST CURRENT WAIRORO STREAM SAMPLING LOCATIONS

PARAMETER	UNITS	COMPLIANCE METRIC	PRP STANDARDS	U/S OF DISCHARGE*	D/S OF DISCHARGE*
Nitrate**	mg/L	Annual Median	≤ 1.0	0.3	0.5
		Annual 95th percentile	≤ 1.5	0.4	2.9
Ammonia***	mg/L	Annual median	≤ 0.24*	0.01	1.8
		Annual maximum	≤ 0.40*	0.30	21
Temperature***	˚C	CRI averaged over 5 hottest days	≤ 24˚C	21.1˚C	20.7˚C
DO	mg/L	7-day minimum	≥ 5.0	7	8
		1-day minimum	≥ 4.0	0.5	1.4
pH	-	Annual minimum	6.0 < pH	6.3	5.8
		Annual maximum	pH <9.0	8.1	8.0
E. coli	%	% exceedances over 540	<5%	44%	57%
		% exceedances over 260	<20%	77%	91%
	cfu/ 100mL	Median	≤130	460	620
		95th percentile	≤540	3,600	3,900

**The values shown are calculated over the three-year period from August 2017 to July 2020 as opposed to the PRP annual compliance metric.*

***Assuming nitrates = the difference between DIN and NH_3.*

****The PRP standards for ammonia are based on pH 8 and temperature of 20˚C. Upstream and downstream results have not been adjusted.*

Temperature results are based on discontinuous temperature monitoring.

Under the current water reform, there is an emphasis on improving discharge quality to freshwater bodies. The current water quality D/S of the discharge is worse than the proposed standards. Therefore, it is likely upgrades are required at Kaikohe WWTP if FNDC intend to comply with the proposed quality standards. This would involve upgrades to improve organics removal, nitrogen removal (total nitrogen, nitrate and ammonia), and disinfection to meet E. coli limits.

3.3.4 EFFLUENT QUALITY REQUIREMENTS

The effluent quality requirements for Kaikohe WWTP were calculated based on publicly available Wairoro Stream quality data and flow estimations, future plant effluent flow estimations, and the PRP standards (see Table 7 below). It is important to note that the Wairoro Stream flow assumptions are key assumptions to determine the effluent quality requirements for the Kaikohe WWTP. Therefore, these assumptions should be confirmed by the FNDC.

The complete calculations and assumptions can be found in Appendix 1.

TABLE 7: REQUIRED EFFLUENT QUALITY FORKAIKOHE WWTP.

AMMONIA (NH_3)			
PARAMETER	**UPSTREAM OF DISCHARGE**	**DOWNSTREAM OF DISCHARGE**	**WWTP REQUIREMENT**
Flow (m^3/day)	120,960	124,000	3,036
Concentration (g/m^3)	0.1	0.24	**6**
Load (kg/day)	12	30	18
NITRATES			
PARAMETER	**UPSTREAM OF DISCHARGE**	**DOWNSTREAM OF DISCHARGE**	**WWTP REQUIREMENT**
Flow (m^3/day)	120,960	124,000	3,036
Concentration (g/m^3)	0.6	1	**17**
Load (kg/day)	73	124	51

4.0 OPTIONS EVALUATION

4.1 MULTI CRITERIA ANALYSIS (MCA)

The options analysis for Kaikohe wastewater scheme was based on a MCA using a number of weighted criteria. The MCA considered each of the options in terms of the following categories:

1. Māori cultural values;
2. Environmental values;
3. Practicability;
4. Operability; and
5. Financial.

The criteria and weightings under each of these categories are presented in Table 8 below.

The options evaluation process included rating the long list options against these criteria using a 'traffic light' system, where each option was given a rating of low, medium, or high based on a qualitative assessment. Four of the most favourable options from this assessment were taken forward to the short list to be further developed and evaluated. Following discussions with FNDC on the MCA, it was requested to explore an additional option of a full BNR option (100% of the flow). Therefore, in total, five options were evaluated.

The short-listed options were assessed using the same criteria but with a quantitative approach. The options were rated from 1-5 against each criterion. An overall score was then developed for each option based on the scores and weighting of the criteria. The highest scoring option was selected as the preferred option for upgrading Kaikohe WWTP.

TABLE 8: OPTIONS EVALUATION CRITERIA

CATEGORY	CRITERIA	WEIGHTING	DESCRIPTION	SUCCESS FACTORS
Māori cultural values	• Impacts on Māori cultural values and practices.	20%	• Gives effect to Te Mana o te Wai • Acceptability of process to local iwi	• The option safeguards Māori cultural values and practices
Environmental values	• Land Use Effects	2%	• 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	3%	• The degree to which odour can be expected to be discharged beyond the property boundary	
	• Ecological Effects	10%	• The degree to which the effluent quality exceeds the minimum environmental and consent requirements	
	• Carbon Footprint	3%	• Level of energy consumption, secondary discharges and chemicals required	
	• Public Health	4%	• Impacts on mahinga kai • Recreational use of the receiving environment • Impact of spills and failure	
Practicability	• Constructability	4%	• Complexity of construction process • Distance from networks and services • Time taken to commission option	• The option can be successfully delivered
	• Regulations and Planning	7%	• Complexity to obtain a consent or other authorisations	
	• Staging	3%	• Can the option be staged?	
Operability	• The ease of operation and maintenance	6%	• 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 in the future
	• Process reliability and resilience	6%	• Known performance of others with similar technologies • Consistency of quality in the discharge	

			• Ability to maintain compliance with resource consents	
Operability	• Expandability/ future proofing	5%	• The potential for the site to allow for extensions to the treatment process • Proofing against changes in compliance requirements	
	• Hazards	3%	• Proximity to known and potential hazards, e.g., flood plains, climate change hazards	
Financial	• Capital Cost	9%	• 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	9%	• Operations and maintenance requirements (e.g., chemical costs, sludge removal) • Power cost	
	• Rating impact	6%	• Impact on targeted rate relative to other options	

4.2 LONG LIST OPTIONS

The long list was developed considering the following:

- Continued effluent discharge to Wairoro Stream (we understand land disposal options are being considered outside of this project);
- Effluent quality requirements to meet the new discharge standards within the PRP;
- Historical issues experienced at the plant; and
- Review of past plant options assessments of upgrade options.

The proposed long list of options is shown in Table 9 below.

TABLE 9: PROPOSED LONG LIST OF OPTIONS

OPTIONS	DETAILS
Do Nothing (Status Quo)	No changes to the WWTP
Minor Upgrades	Mechanical mixers + Baffle curtains + Chemical dosing + Rock filter + UV
	Additional aerators + Baffle curtains + Chemical dosing + Sand filter + UV
	Mechanical mixers + Baffle curtains + Chemical dosing + Rock filter + UV + Remove constructed wetlands
Major Upgrades	Floating wetland + Chemical dosing + Clarifier + Surface mixers + UV + Upgrade constructed wetlands
	Bioreef/Aquamats + Chemical dosing + Actiflo + UV
	Bioreef/Aquamats + Chemical dosing + DAF + UV
	Intermittent Decanting Aerated Lagoon (IDAL)
	Sequencing Batch Reactor (SBR)
	Biological Nutrient Removal Plant (BNR)
	Membrane Aerated Biofilm Reactor (MABR)
Side Stream Treatment Plant	Portion of the flow treated by a mechanical plant (smaller size with higher effluent quality) and the remaining flow treated through the existing pond system. The final effluents are then blended before discharge.
Industrial Re-use	Portion of the flow treated by a mechanical plant and re-used by industry close by that is willing to take wastewater (none identified at this stage). Remaining wastewater treated through existing pond system.
Alternative Upgrades	Following oxidation pond, electrocoagulation and clarifier.

Notes:

- De-sludging the ponds should be considered for all the minor and major upgrade options based on pond systems.

- It is assumed that mechanical plants would require disinfection and a sludge processing facility.

A high-level qualitative MCA matrix for the long list options was presented to FNDC in a teleconference on the 21/09/20. After discussing the options and receiving feedback from the Council, a final MCA matrix was prepared (see Appendix 2).

A preliminary long list of options can be found in Appendix 3. This contains a comprehensive list of all the historic options which were considered in previous assessments.

4.3 SHORT LIST OPTIONS

Based on the MCA evaluation and short-listing discussions with FNDC, the following options have been taken forward to the short list:

- **Option 1:** In Pond Upgrades (Additional Aerators + Baffle Curtains) + Chemical Dosing + Tertiary Treatment (Sand Filter + UV);
- **Option 2:** Bioreef/Aquamats + Chemical Dosing + Actiflo + UV + Remove Wetlands;
- **Option 3**: IDAL;
- **Option 4A:** Side Stream Treatment Plant (BNR); and
- **Option 4B:** BNR.

These options have been developed to a concept level to allow a more detailed and informed assessment to select the preferred option. This included developing infrastructure upgrade requirements; risks and capital and operating costs for each of the options.

4.3.2 OPTION 1 – ADDITIONAL AERATORS + BAFFLE CURTAINS + CHEMICAL DOSING + SAND FILTER + UV

This option will utilise the inlet screen, anaerobic pond, oxidation pond, wetlands, and sludge lagoons of the existing Kaikohe WWTP. The treatment process at the plant will be upgraded to include aeration and baffle curtains in the oxidation pond, chemical dosing, and tertiary treatment which will consist of sand filtration, and UV disinfection.

A block diagram of the upgraded treatment process is shown in Figure 4.

The treatment process upgrades will include:

- De-sludging of the anaerobic and oxidation ponds to improve performance and enable the installation of the aerators and baffle curtains.
- Installing pond surface aerators and baffle curtains in the oxidation pond to maximise ammonia removal.
- Installing a new tertiary treatment system. This will involve:
  - installing a sand filter for solids removal; and
  - constructing one or more buildings for a chemical dosing system (phosphorus removal) and UV units.
- Pipeline modifications to connect the new treatment processes.

- Potential modifications to the plant access road to provide the required turning circle for a chemical delivery truck, and a chemical delivery pad alongside the building.

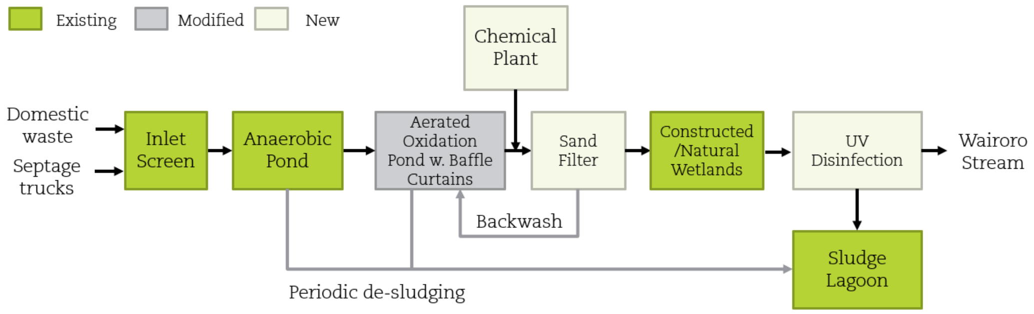


FIGURE 4. BLOCK DIAGRAM FOR OPTION 1

4.3.3 OPTION 2 – BIOREEF/AQUAMATS + CHEMICAL DOSING + ACTIFLO + UV + REMOVE WETLANDS

This option will utilise the inlet screen, anaerobic pond, oxidation pond, and sludge lagoons of the existing Kaikohe WWTP. The treatment process at the plant will be upgraded to include diffused aeration combined with an attached growth system in the oxidation pond (Bioreef or Aquamats), chemical dosing, and tertiary treatment which will consist of Actiflo, and UV disinfection.

An in pond attached growth system consists of fabric curtains that provide surface area for bacterial growth. Aeration is provided between the curtains via diffused aeration pipes. This system achieves longer sludge residence times hence improving nitrogen removal.

A block diagram of this treatment process is shown in Figure 5.

The treatment process upgrades will include:

- De-sludging of the anaerobic and oxidation ponds to improve performance and enable the installation of the baffle curtains, aeration, and attached growth system.
- Decommissioning the wetlands.
- Installing baffle curtains for separation, diffused aeration, and the attached growth system (Bioreef/Aquamat) in the oxidation pond to create nitrification and de-nitrification zones.
- Installing a solids separation process unit (Actiflo).
- Constructing one or more buildings for blowers, chemical dosing system (phosphorus removal) and UV units.
- Pipeline modifications to connect the new treatment processes and bypass the wetlands.
- Installing a new discharge pipeline and discharge structure.
- Potential modifications to the plant access road to provide the required turning circle for a chemical delivery truck, and a chemical delivery pad alongside the building.

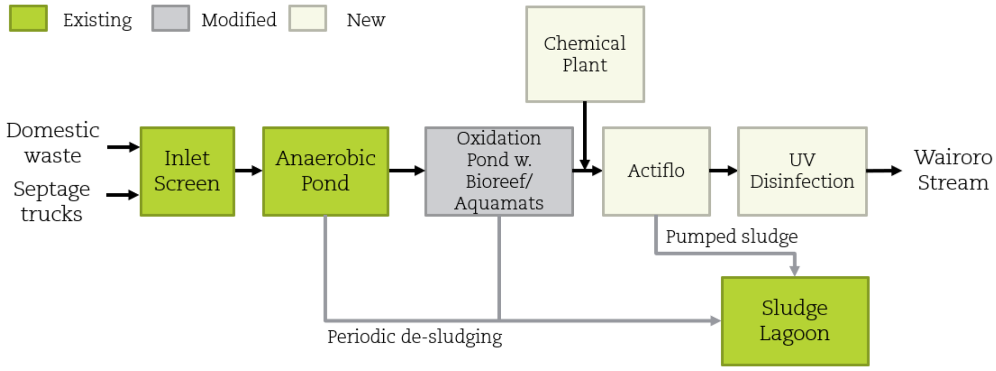


FIGURE 5. BLOCK DIAGRAM FOR OPTION 2

4.3.4 OPTION 3 – IDAL

This option will utilise the anaerobic pond and oxidation pond of the existing Kaikohe WWTP. The treatment process at the plant will be upgraded to include a new screening and grit removal package plant, IDAL, filtration, UV disinfection, and a sludge de-watering system.

An IDAL is a pond based activated sludge process where secondary settled wastewater is decanted in batches instead of continuously. Aeration and settling are time-phased in the IDAL and occur in the same pond. The IDAL system will be constructed in the oxidation pond.

A block diagram of this treatment process is shown in Figure 6.

The treatment process upgrades will include:

- Decommissioning the inlet screen and installing a screening and grit removal package plant.
- De-sludging of the anaerobic pond to improve performance.
- Decommissioning the wetlands.
- Re-purposing part of the oxidation pond as the buffer pond and part as the new IDAL with ancillary systems.
- Constructing one or more buildings for the blowers, UV units, and the sludge de-watering system.
- Pipeline modifications to connect the new treatment processes and bypass the wetlands.
- Installing a new discharge pipeline and discharge structure.
- Potential modifications to the plant access road to provide the required turning circle for a chemical delivery truck, and a chemical delivery pad alongside the building.

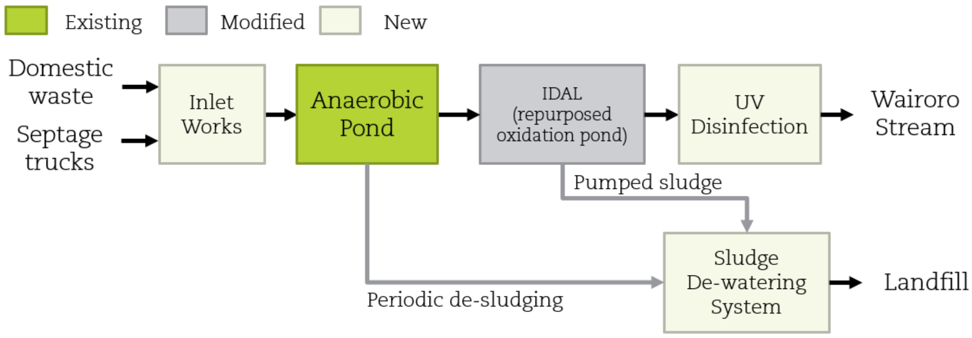


FIGURE 6. BLOCK DIAGRAM FOR OPTION 3

4.3.5 OPTION 4A – SIDE STREAM TREATMENT PLANT (BNR)

This option will utilise the anaerobic pond, oxidation pond, wetlands, and sludge lagoons of the existing Kaikohe WWTP. The treatment process at the plant will be upgraded to include a new screening and grit removal package plant, flow splitter, a side stream treatment plant (BNR), filtration, UV disinfection, and a sludge de-watering system.

BNR is a process used for nitrogen and phosphorus removal. It consists of an anaerobic zone, an anoxic zone, and an aeration zone. The nitrates produced in the aerobic zone are recycled to the anoxic zone for denitrification, resulting in nitrogen removal. In the anaerobic zone, Phosphorus Accumulating Organisms (PAOs) release phosphorus which is subsequently taken up in large quantities in the aerobic zone. Intracellular phosphorus is removed from the wastewater as the sludge is removed.

The BNR plant will be sized to treat 88% of the influent flow. This percentage was calculated based on the effluent quality requirements estimated in Section 3.3.4. Table 10 below summarises these mass balance calculations.

TABLE 10: COMBINED EFFLUENT QUALITY.

PARAMETER		BNR PLANT	EXISTING POND-BASED WWTP	COMBINED FLOW
Effluent Quality	NH_3 (g/m³)	2	34	6
	BOD (g/m³)	5	20	7
	NO_3 (g/m³)	7.5	5	7
Flows	Effluent Flow (m³/day)	2,672	364	3,036
	% Total Effluent Flow	88%	12%	100%

Notes:

Effluent concentrations for the BNR plant are target values. Effluent concentrations for the current WWTP are based on effluent data.

NH_3 concentration for the combined effluent should be < 6 g/m³. See Section 3.3.4.

NO_3 concentration for the combined effluent should be < 17 g/m³. See Section 3.3.4.

Recommended BOD concentration for the comvined effluent: < 25 g/m³.

The effluent of the BNR plant and the pond system will be combined before going through UV disinfection and being discharged to the Wairoro Stream. A block diagram of this treatment process is shown in Figure 7.

The treatment process upgrades will include:

- De-sludging of the anaerobic and oxidation ponds to improve performance.

- Decommissioning the inlet screen and installing a screening and grit removal package plant.
- Installing a flow splitter.
- Installing the side stream plant (BNR).
- Constructing one or more buildings for the blowers, UV units, and the sludge de-watering system.
- Pipeline modifications to connect the new treatment processes.
- Potential modifications to the plant access road to provide the required turning circle for a chemical delivery truck, and a chemical delivery pad alongside the building.

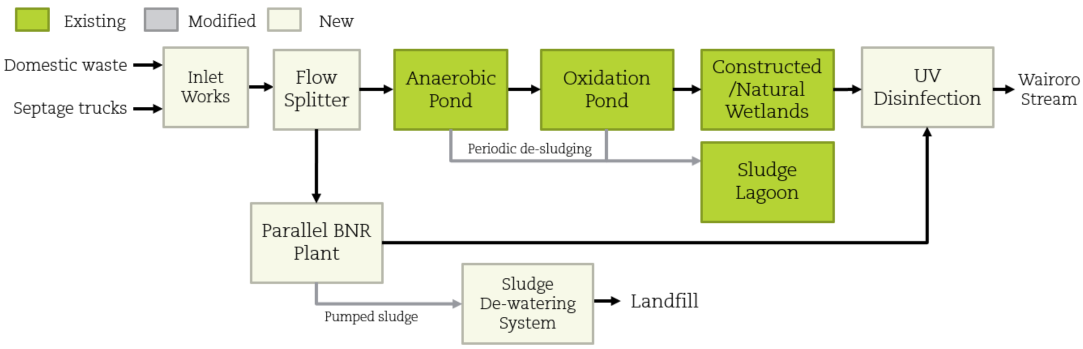


FIGURE 7. BLOCK DIAGRAM FOR OPTION 4A

4.3.6 OPTION 4B – BNR

This option will not utilise any of the infrastructure and equipment of the existing Kaikohe WWTP. A new plant will be built in the WWTP site including a new screening and grit removal package plant, BNR, filtration, UV disinfection, and a sludge de-watering system.

A block diagram of this treatment process is shown in Figure 8.

The treatment process upgrades will include:

- De-sludging and decommissioning of the anaerobic and oxidation ponds. The ponds have to be de-sludged before being decommissioned to avoid algae growth and odour issues.
- Decommissioning the inlet screen and installing a screening and grit removal package plant.
- Constructing concrete reactors for the BNR system.
- Constructing one or more buildings for the blowers, UV units, and the sludge de-watering system.
- Pipeline modifications to connect the new treatment processes.
- Potential modifications to the plant access road to provide the required turning circle for a chemical delivery truck, and a chemical delivery pad alongside the building.

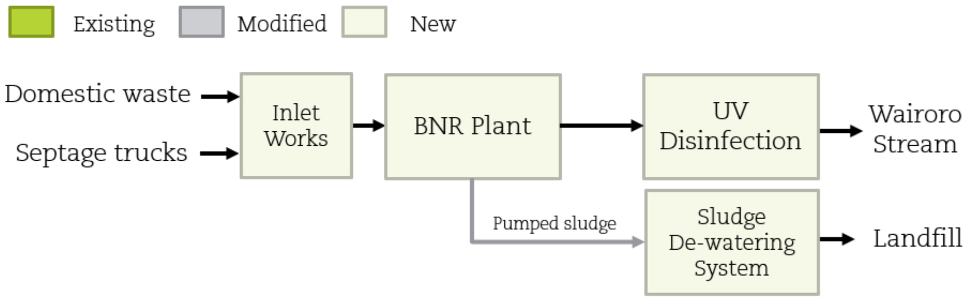


FIGURE 8. BLOCK DIAGRAM FOR OPTION 4B

4.3.7 CAPEX AND OPEX ESTIMATIONS

Table 11 shows a comparison among the estimated capital and operation cost ranges for Options 1 to 4B. The assumptions and exclusions related to these cost estimations are detailed below.

TABLE 11: CAPEX AND OPEX FOR OPTIONS 1 TO 4B.

OPTIONS		CAPEX (-5 TO +30%)	OPEX (-5 TO +30%)
NO	DESCRIPTION		
1	Additional Aerators + Baffle Curtains + Chemical Dosing + Sand Filter + UV	\$3.1M - \$4.3M	\$400K - \$550K
2	Bioreef/Aquamats + Chemical Dosing + Actiflo + UV + Remove Wetlands	\$12.6M - \$17.2M	\$730K - \$1M
3	IDAL	\$6.5M - \$8.9M	\$580K - \$800K
4A	Side Stream Treatment Plant (BNR)	\$15.0M - \$20.6M	\$670K - \$920K
4B	BNR	\$17.5M - \$24.0M	\$700K - \$950K

<u>**Assumptions and Exclusions**</u>

- The following items have been excluded from the capital cost estimations to upgrade the Kaikohe WWTP:
  - Decommissioning and disposal of current infrastructure and equipment that are not included in the upgraded system;
  - Major earthworks and piling;
  - New consents or renewing existing consents;
  - Geotechnical and survey studies;
  - Ground remediation;
  - Alarms, camera systems and fire protection systems;
  - Transformers, generators and power upgrades; and
  - Access roads.
- Any equipment to be used as part of the upgrade, is considered to be in good operational condition;

- De-sludging costs are based on a total of 730 tons of wet sludge (20% of dry solids) for both ponds (Options 1, 2, 4A, and 4B) or 45 tons of wet sludge for the anaerobic pond only (Option 3).
- Operational cost estimates do not include interest on capital and depreciation.
- A unit energy charge of $0.10/kWhr has been used to estimate the power costs. The cost estimate does not include any fixed charges paid by the site.
- Cost estimates exclude GST.

4.3.8 SHORT LIST OPTIONS MCA

The MCA scoring of each short-listed option is shown in Table 12 below. These options were evaluated according to the criteria and weightings presented in Table 8 (see Section 4.1).

The complete short list options MCA can be found in Appendix 4.

TABLE 12: SHORT LIST OPTIONS EVALUATION.

OPTIONS		SCORE
NO	**DESCRIPTION**	
1	Additional Aerators + Baffle Curtains + Chemical Dosing + Sand Filter + UV	56.0
2	Bioreef/Aquamats + Chemical Dosing + Actiflo + UV + Remove Wetlands	45.5
3	IDAL	60.2
4A	Side Stream Treatment Plant (BNR)	51.2
4B	BNR	55.0

4.4 SENSITIVITY ANALYSIS

The weighting given to each of the criteria influences the overall score given to each of the short-listed options. It is therefore important to test the sensitivity of the MCA to the weightings to ensure that it remains as unbiased as possible. For this analysis, the various criteria were grouped according to the categories shown in Table 13.

TABLE 13: SENSITIVITY ANALYSIS CATEGORIES

CATEGORY	CRITERIA
Non-Technical	Māori cultural values
	Environmental values
Technical	Practicability
	Operability
Management	Financial

The weighting of each of these categories were inflated at the expense of the others in different scenarios to determine the effect of the weighting on the overall rating of the options. A total of nine weighting scenarios were applied to the MCA. These followed the methodology outlined below in the table below.

TABLE 14: SENSITIVITY ANALYSIS OUTCOMES.

CATEGORY	SCENARIOS WEIGHTING								
	1	**1A**	**1B**	**2**	**2A**	**2B**	**3**	**3A**	**3B**
Non-Technical	+20%	+20%	+20%	-10%	-20%	-	-10%	-20%	-
Technical	-10%	-20%	-	+20%	+20%	+20%	-10%	-	-20%
Management (Financial)	-10%	-	-20%	-10%	-	-20%	+20%	+20%	+20%

A visual representation of the allocated weightings for all nine scenarios is presented in Figure 9.

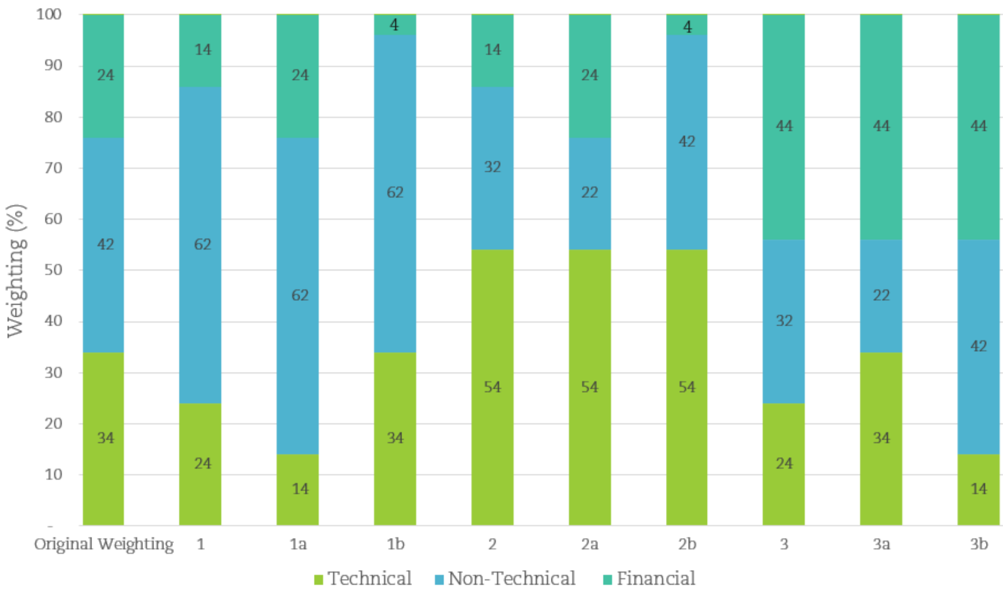


FIGURE 9. WEIGHTINGS OF SENSITIVITY SCENARIOS

The outcome of the sensitivity analysis is summarised in Table 15 below. For each of the scenarios, the highlighted value indicates the highest scoring option. The full sensitivity analysis can be found in Appendix 4.

TABLE 15: SENSITIVITY ANALYSIS OUTCOMES.

OPTIONS		SCENARIOS									
NO	DESCRIPTION	ORIGINAL WEIGHTING	1	1A	1B	2	2A	2B	3	3A	3B
1	Additional Aerators + Baffle Curtains + Chemical Dosing + Sand Filter + UV	56.00	50.50	54.90	46.10	52.50	58.20	47.50	65.30	66.70	64.80
2	Bioreef/Aquamats + Chemical Dosing + Actiflo + UV + Remove Wetlands	45.50	45.10	45.40	44.40	45.20	45.90	44.60	46.80	46.90	46.60
3	IDAL	60.20	57.20	58.60	54.80	59.00	60.80	56.20	65.00	64.60	63.80
4A	Side Stream Treatment Plant (BNR)	51.20	49.50	47.60	50.50	54.70	54.60	54.40	50.60	51.40	48.30
4B	BNR	56.00	50.50	54.90	46.10	52.50	58.20	47.50	65.30	66.70	64.80

The sensitivity analysis outcomes indicate that the main factor influencing the choice of Option 1 or Option 3 as the preferred option is costs. Option 3 was the preferred option for all the scenarios where the weighting of the management (or financial) category was kept under 24%. On the other side, Option 1 was the preferred option for the three scenarios (3, 3a, and 3b) where the management category weighting was inflated to 44%. This is because the capital and operational costs of Option 3 are significantly above the costs of Option 1.

Options 2 and 4 were not the preferred options for any of the tested scenarios. This indicates that Options 1 and 3 are the most favourable options from cultural, environmental, technical, and financial perspectives.

The sensitivity analysis has demonstrated that the weightings used for the short list evaluation did not show a strong bias to any particular criteria. This analysis indicates that Option 3 is the preferred option according to the MCA.

4.5 RISK ANALYSIS

The risks associated with each short list option were assessed using a quantitative risk matrix (as per AS/NZ 4360:2004). The risk framework shown in Table 16 was used to derive a risk score for each of the options. The higher the total score, the riskier the option is. The risk scores of the short-listed options must be taken into consideration when selecting the preferred option.

Risk scores are derived by evaluating the likelihood of a risk occurring and the consequence if it does occur. A risk score is given by multiplying the value associated with the likelihood by the value associated with the consequence.

TABLE 16: RISK FRAMEWORK.

LIKELIHOOD		CONSEQUENCES				
Parameter	**Value**	**Severe**	**Major**	**Moderate**	**Minor**	**Negligible**
		5	4	3	2	1
Almost certain	5	Extreme	Extreme	Extreme	High	High
Likely	4	Extreme	Extreme	High	High	Medium
Possible	3	Extreme	Extreme	High	Medium	Low
Unlikely	2	Extreme	High	Medium	Low	Low
Rare	1	High	High	Medium	Low	Low

The full list of risks is presented in the risk matrix included in Appendix 5. The overall risk scores for the four shortlisted options have been summarised in Table 17 below.

TABLE 17: SHORT LIST OPTIONS RISK ASSESSMENT.

OPTION		SCORE
NO	**DESCRIPTION**	
1	Additional Aerators + Baffle Curtains + Chemical Dosing + Sand Filter + UV	116
2	Bioreef/Aquamats + Chemical Dosing + Actiflo + UV + Remove Wetlands	123
3	IDAL	107
4A	Side Stream Treatment Plant (BNR)	106
4B	BNR	106

As presented in Table 17, the risk assessment indicates that Options 3, 4A and 4B currently present the same level of risk, which is significantly lower than the level of risk of Options 1 and 2.

5.0 RECOMMENDATION

The options evaluation process indicates that Option 3 (IDAL) is the preferred option for upgrading the Kaikohe WWTP. This option has scored highest in the MCA and presented a low risk score. Measures can be put into place to reduce the likelihood (and consequently further reduce the risk scores) of the risks associated with this option.

5.1 NEXT STEPS

The following next steps are recommended:

1. FNDC to confirm the Wairoro Stream flow assumptions, as these are key assumptions to determine the required effluent quality of the Kaikohe WWTP. This includes:
   - Mean river flow;
   - MALF and Q5 values; and
   - Typical low flow values (flows below the mean value) and duration of low flow periods.
2. FNDC to confirm their preferred option; and
3. Refine costs to provide higher level of certainty for budgeting purposes, and during this process consider staging options to establish the costs to ratepayers over time.

6.0 LIMITATIONS

6.1 GENERAL

This report is for the use by Far North District Council only, and should not be used or relied upon by any other person or entity or for any other project.

This report has been prepared for the particular project described to us and its extent is limited to the scope of work agreed between the client and Harrison Grierson Consultants Limited. No responsibility is accepted by Harrison Grierson Consultants Limited or its directors, servants, agents, staff or employees for the accuracy of information provided by third parties and/or the use of any part of this report in any other context or for any other purposes.

6.2 ESTIMATES

Should this report contain estimates for future works or services, physical or consulting, those estimates can only be considered current and will only reflect the extent to which the detail of the project is known to the consultant (feasibility, concept, preliminary, detailed, tender etc) at the time given.

The client is solely responsible for obtaining updated estimates from the consultant as the detail of the project evolves and/or as time elapses.

APPENDICES

APPENDIX 1
EFFLUENT QUALITY REQUIREMENTS CALCULATIONS

KAIKOHE WWTP OPTIONS

Required Effluent Quality Calculations

N:\1014\147856_01-Kaikohe and Kaitaia WWTP\400 Tech\420 Calculations\Kaitaia\[Copy of KatS - Logbook-gcb.xlsx]Main

DATE: 30/09/20 10/06/2020

HG PROJECT NUMBER: 1014-147856-01

Assumptions

Wairoro Stream

Mean flow	1.4	m3/s	
Catchment Area	47	km2	Note: Based on Table 9 from Vol2: Water Resources Analysis, Northland Water Storage and Use Project (March 2020)
Normalised 7day MALF	0.004	m3/s/km2	
7day MALF	0.19	m3/s	
Daily flow	120,960	m3/day	Based on mean flow
Future WWTP effluent	3,036	m3/day	Average flow from influent (data received from FNRC)

Median Concentrations

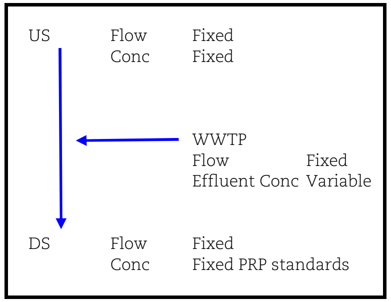
Notes:
Effluent concentrations are based on WWTP logbook data
Median effluent, US and DS values have been used to align with the PRP evaluation standards
Assuming Nitrates = DIN - NH3
See graphs for assumed US values for NH3 and DIN

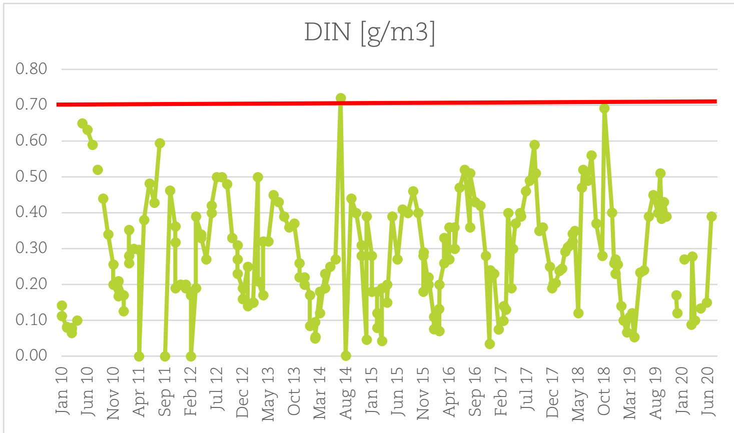
Parameter	Effluent	US	DS	PRP Limit
cBOD5	19			
TSS	49			
TN*	36			
NH3-N*	34	0.1	1.8	0.24 annual median
TP*	5			
DRP	4			
DIN	40	0.7		
Nitrates	6	0.6	0.53955	1 annual median

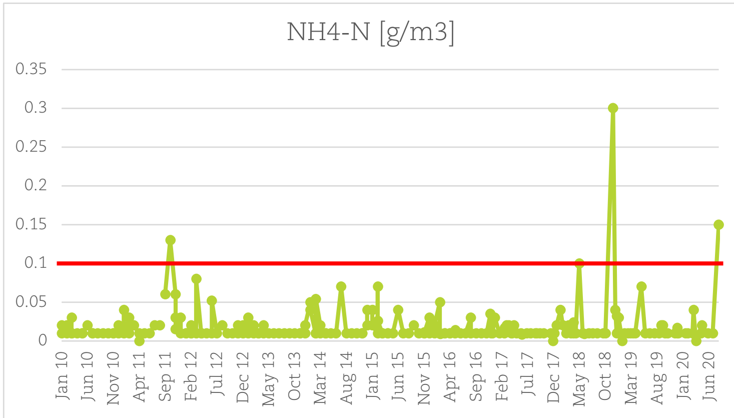
NH3	US	DS	Target WWTP	
Flow (m3/day)	120,960.0	123,996.2	3,036	
Concentration (g/m3)	0.1	0.24	**5.8**	g/m3
Load (kg/day)	12.1	29.8	17.7	

Nitrates	US	DS	Target WWTP	
Flow (m3/day)	120,960.0	123,996.2	3,036	
Concentration (g/m3)	0.6	1	**16.9**	g/m3
Load (kg/day)	72.6	124.0	51.4	

Note: Loads are median conc * average flows







APPENDIX 2
MCA (LONG LIST OF OPTIONS)

KAIKOHE WWTP OPTIONS - Long List

Multi Criteria Analysis

N:\1014\147856_01-Kaikohe and Kaitaia WWTP\400 Tech\421 MCA\[Kaikohe Long List MCA-v3.0 - PDF printing version.xlsx]Print 1

DATE: 17/09/2020

HG PROJECT NUMBER: 1014-147856-01

No	Category	Criteria	Description	1 Status Quo: Do Nothing – Score	Comment	2 Minor Upgrades: Mechanical mixers + Baffle curtains + Chemical dosing + Rock filter + UV – Score	Comment	3 Minor Upgrades: Additional aerators + Baffle curtains + Chemical dosing + Sand filter + UV – Score	Comment	4 Minor Upgrades: Mechanical mixers + Baffle curtains + Chemical dosing + Rock filter + UV + Remove constructed wetlands – Score	Comment	5 Major Upgrades: Floating wetland + Chemical dosing + Clarifier + Surface mixers + UV + Upgrade constructed wetlands – Score	Comment
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	R	Maintaining existing wetland aligns with cultural values. No improvements in the quality of the effluent being discharged to the waterbody. Location of WWTP was potentially contentious. Discharge to waterbody does not reflect cultural values.	R	Maintaining existing wetland, introducing rock filter to treatment process and making minor improvement in the quality of the effluent being discharged to the waterbody. Location of WWTP was potentially contentious. Discharge to waterbody does not reflect cultural values.	R	Maintaining existing wetland and some improvement in the quality of the effluent being discharged to the waterbody. Location of WWTP was potentially contentious. Discharge to waterbody does not reflect cultural values.	R	Introducing rock filter to treatment process and making minor improvement in the quality of the effluent being discharged to the waterbody. Removing existing constructed wetlands but natural wetlands still remain. Location of WWTP was potentially contentious. Reflects some cultural values. Discharge to waterbody does not reflect cultural values.	R	Additional floating wetlands, upgrade of constructed wetlands with some improvement in the quality of the effluent being discharged to the waterbody. Location of WWTP was potentially contentious. Discharge to waterbody does not reflect cultural values.
2	Environmental values	Land Use Effects	·Visual, Noise, Traffic impacts	G	No visual, noise and traffic impact.	G	Minimum visual, noise and traffic impact. The Kaikohe WWTP is in a remote rural area with few nearby farms.	G	Minimum visual, noise and traffic impact. The Kaikohe WWTP is in a remote rural area with few nearby farms.	G	Minimum visual, noise and traffic impact. The Kaikohe WWTP is in a remote rural area with few nearby farms.	O	Small visual, noise and traffic impact. Construction of new clarifier and UV may result in some disruption to the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.
		Odour	·The degree to which odour can be expected to be discharged beyond the property boundary.	O	Historical odour complaints from adjacent farm.	O	Historical odour complaints from adjacent farm.	O	Historical odour complaints from adjacent farm.	O	Historical odour complaints from adjacent farm.	O	Historical odour complaints from adjacent farm.
		Ecological Effects	·The degree to which the effluent quality exceeds the minimum environmental and consent requirements.	R	High risk of exceeding the nitrate, ammonia, DO and E. coli limits of the PRP. Additional may also exceed guidelines in NPS-FM for phosphorus limits.	R	Potential for insufficient nitrification. High risk of exceeding the nitrate, ammonia and DO limits of the PRP. Risk of exceeding NPS-FM guidelines for phosphorus.	O	Risk of exceeding the nitrate, ammonia and DO limits of the PRP.	R	Potential for insufficient nitrification. High risk of exceeding the nitrate, ammonia and DO limits of the PRP. Risk of exceeding NPS-FM guidelines for phosphorus.	R	Potential for insufficient nitrification. High risk of exceeding the nitrate, ammonia and DO limits of the PRP. Risk of exceeding NPS-FM guidelines for phosphorus.
		Carbon Footprint	·Level of energy consumption, secondary discharges and chemicals required.	G	No change from current system. Power requirements of pond based treatment system are relatively low.	O	Additional power requirements for mechanical mixers, UV unit and other equipment.	O	Additional power requirements for aerators, sand filter, UV units, and other equipment.	O	Additional power requirements for mechanical mixers, UV unit and other equipment.	O	Some power requirements for mechanical mixers, UV units, and other equipment.
		Public Health	·Impacts on mahinga kai ·Recreational use of the receiving environment ·Impact of spills and failure	R	Risk to public health due to pathogens and viruses in the treated effluent. High concentrations of nutrients in the effluent can impact on food gathering activities.	R	Risk to public health will be significantly reduced with UV disinfection treatment. Potential high concentrations of nutrients in the effluent can impact on food gathering activities.	O	Risk to public health will be significantly reduced with UV disinfection treatment. Improved effluent quality with minor control is unlikely to have major impacts on food gathering activities.	R	Risk to public health will be significantly reduced with UV disinfection treatment. Potential high concentrations of nutrients in the effluent can impact on food gathering activities.	R	Risk to public health will be significantly reduced with UV disinfection treatment. Potential high concentrations of nutrients in the effluent can impact on food gathering activities.
3	Practicability	Constructability	·Complexity of construction process ·Distance from networks and services ·Time taken to commission option	G	No construction/commissioning required.	O	Will require small scale construction works. Easy to commission.	O	Will require small scale construction works. Easy to commission.	O	Will require small scale construction works. Easy to commission.	O	Will require medium scale construction works. Moderate to high difficulty to commission.
		Regulations and Planning	·Complexity to obtain a consent or other authorisations	R	No additional consents required. Challenging consent process as does not achieve freshwater target standards.	R	Building consent required (chemical plant and tertiary treatment). Chemicals might require a compliance certificate. Challenging consent process as does not achieve freshwater target standards.	O	Building consent required (chemical plant and tertiary treatment). Chemicals might require a compliance certificate.	R	Building consent required (chemical plant and tertiary treatment). Chemicals might require a compliance certificate. Challenging consent process as does not achieve freshwater target standards.	R	Building consent required (chemical plant and tertiary treatment). Chemicals might require a compliance certificate. Challenging consent process as does not achieve freshwater target standards.
		Staging	Can the option be staged?	G	No construction required.	O	Only minor upgrades are required which could be staged. It is likely to be more cost-effective to build them in one stage.	O	Only minor upgrades are required which could be staged. It is likely to be more cost-effective to build them in one stage.	O	Only minor upgrades are required which could be staged. It is likely to be more cost-effective to build them in one stage.	R	Major upgrades are required. It is cost-effective to build them in one stage.
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	G	No change from current system. De-sludging ponds is a laborious task. Poor-quality sludge.	G	Simple operation. Additional equipment would have to be maintained. De-sludging ponds is a laborious task. Poor-quality sludge.	G	Simple operation. Additional equipment would have to be maintained. De-sludging ponds is a laborious task. Poor-quality sludge.	G	Simple operation. Additional equipment would have to be maintained. De-sludging ponds is a laborious task. Poor-quality sludge. Removing the wetland would eliminate the current heavy maintenance requirements.	G	Simple operation. De-sludging ponds is a laborious task. Poor-quality sludge. Excess of sludge would also be removed from clarifier.
		Process reliability and resilience	·Known performance of others with similar technologies ·Consistency of quality in the discharge ·Ability to maintain compliance with resource consents	R	No change from current system. Compliance issues related to nutrients and E.coli removal.	R	Very limited process control with pond-based treatment system. Consistency in effluent quality may have some improvements as a result of the treatment upgrade.	O	Limited process control with pond-based treatment system with aeration. Consistency in effluent quality will improve as a result of the treatment upgrade.	R	Very limited process control with pond-based treatment system. Consistency in effluent quality may have some improvements as a result of the treatment upgrade.	O	Limited process control with pond-based treatment system. Consistency in effluent quality will improve as a result of the treatment upgrade.
		Expandability/ future proofing	·The potential for the site to allow for extensions to the treatment process ·Proofing against changes in compliance requirements	R	Pond-based technology is land intensive. Low flexibility to deal with changes in compliance requirements or to expand the plant.	R	Pond-based technology is land intensive. Low flexibility to deal with changes in compliance requirements or to expand the plant.	R	Pond-based technology is land intensive. Aerators and chemical dosing add limited flexibility to deal with changes in compliance requirements.	R	Pond-based technology is land intensive. Low flexibility to deal with changes in compliance requirements or to expand the plant.	R	Pond-based technology is land intensive. Low flexibility to deal with changes in compliance requirements or to expand the plant.
		Hazards	·Proximity to known and potential hazards, e.g., flood plains, climate change hazards	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.
5	Financial	Capital Cost	·Cost of implementation ·Site investigations and procurement of land ·Ability to reuse existing FNDC assets	G	No additional costs associated with this option.	O	Medium comparative capital costs.	O	Medium comparative capital costs.	O	Medium comparative capital costs.	O	Medium comparative capital costs.
		Operating and Maintenance Costs	·Operations and maintenance requirements (e.g., chemical costs, sludge removal) ·Power cost	G	No additional costs associated with this option.	O	Medium comparative O&M costs.	R	Medium to high comparative O&M costs.	O	Medium comparative O&M costs.	G	Low comparative O&M costs.
		Rating impact	·Impact on targeted rate relative to other options	G	No additional costs associated with this option.	O	Medium comparative rate impact.	O	Medium comparative rate impact.	O	Medium comparative rate impact.	O	Medium comparative rate impact.

Total Score	1	2	3	4	5
G	8	2	2	2	2
O	2	8	11	8	8
R	6	6	3	6	6

KAIKOHE WWTP OPTIONS - Long List

Multi Criteria Analysis

N:\1014\147856_01-Kaikohe and Kaitaia WWTP\400 Tech\421 MCA\[Kaikohe Long List MCA-v3.0 - PDF printing version.xlsx]Print 1

DATE: 17/09/2020

HG PROJECT NUMBER: 1014-147856-01

				6		7	
				Major Upgrades		Major Upgrades	
				Bioreef/Aquamats + Chemical dosing + Actiflo + UV + Remove all wetlands		Bioreef/Aquamats + Chemical dosing + DAF + UV + Remove all wetlands	
No	**Category**	**Criteria**	**Description**	**Score**	**Comment**	**Score**	**Comment**
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	R	Some improvement in the quality of the effluent being discharged to the waterbody. Removal of all wetlands. Minimal upgrade with cultural impact. Location of WWTP was potentially contentious. Discharge to waterbody does not reflect cultural values.	R	Some improvement in the quality of the effluent being discharged to the waterbody. Removal of all wetlands. Minimal upgrade with cultural impact. Location of WWTP was potentially contentious. Discharge to waterbody does not reflect cultural values.
2	Environmental values	Land Use Effects	·Visual, Noise, Traffic impacts	O	Small visual, noise and traffic impact. Installation and construction of bioreef/aquamats, Actiflo and UV may result in some disruption to the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.	O	Small visual, noise and traffic impact. Installation and construction of bioreef/aquamats, DAF and UV may result in some disruption to the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.
		Odour	·The degree to which odour can be expected to be discharged beyond the property boundary.	O	Historical odour complaints from adjacent farm.	O	Historical odour complaints from adjacent farm.
		Ecological Effects	·The degree to which the effluent quality exceeds the minimum environmental and consent requirements.	O	Risk of exceeding the nitrate, ammonia and DO limits of the PRP. Ability to denitrify through denitrification zone.	O	Risk of exceeding the nitrate, ammonia and DO limits of the PRP. Ability to denitrify through denitrification zone.
		Carbon Footprint	·Level of energy consumption, secondary discharges and chemicals required.	R	Additional power requirements for bioreef/aquamats aerations, Actiflo, UV units, and other equipment.	R	Additional power requirements for bioreef/aquamats aerations, DAF, UV units, and other equipment. Power upgrade likely to be required.
		Public Health	·Impacts on mahinga kai ·Recreational use of the receiving environment ·Impact of spills and failure	O	Risk to public health will be significantly reduced with UV disinfection treatment. Improved effluent quality with minor control is unlikely to have major impacts on food gathering activities.	O	Risk to public health will be significantly reduced with UV disinfection treatment. Improved effluent quality with minor control is unlikely to have major impacts on food gathering activities.
3	Practicability	Constructability	·Complexity of construction process ·Distance from networks and services ·Time taken to commission option	R	Will require medium scale construction works. Moderate to high difficulty to commission.	R	Will require medium scale construction works. Moderate to high difficulty to commission. Plant is in a valley. Challenging for construction works due to narrow, windy and steep access.
		Regulations and Planning	·Complexity to obtain a consent or other authorisations	O	Building consent required (chemical plant and tertiary treatment). Chemicals might require a compliance certificate.	O	Building consent required (chemical plant and tertiary treatment). Chemicals might require a compliance certificate.
		Staging	Can the option be staged?	R	Major upgrades are required. It is cost-effective to build them in one stage.	R	Major upgrades are required. It is cost-effective to build them in one stage.
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	O	Additional equipment (e.g. Actiflo) would have to be maintained. De-sludging ponds is a laborious task. Poor-quality sludge. Excess of sludge would also be removed from Actiflo.	O	Additional equipment (e.g. DAF) would have to be maintained. De-sludging ponds is a laborious task. Poor-quality sludge. Excess of sludge would also be removed from DAF.
		Process reliability and resilience	·Known performance of others with similar technologies ·Consistency of quality in the discharge ·Ability to maintain compliance with resource consents	O	Limited process control with pond-based treatment system. Consistency in effluent quality will improve as a result of the treatment upgrade.	O	Limited process control with pond-based treatment system. Consistency in effluent quality will improve as a result of the treatment upgrade.
		Expandability/ future proofing	·The potential for the site to allow for extensions to the treatment process ·Proofing against changes in compliance requirements	O	Pond-based technology is land intensive. Potential to add growth media as required. Low flexibility to deal with changes in compliance requirements or to expand the plant.	O	Pond-based technology is land intensive. Potential to add growth media as required. Low flexibility to deal with changes in compliance requirements or to expand the plant.
		Hazards	·Proximity to known and potential hazards, e.g., flood plains, climate change hazards	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.
5	Financial	Capital Cost	·Cost of implementation ·Site investigations and procurement of land ·Ability to reuse existing FNDC assets	O	Medium comparative capital costs.	O	Medium comparative capital costs.
		Operating and Maintenance Costs	·Operations and maintenance requirements (e.g., chemical costs, sludge removal) ·Power cost	R	Medium to high comparative O&M costs.	R	Medium to high comparative O&M costs.
		Rating impact	·Impact on targeted rate relative to other options	O	Medium comparative rate impact.	O	Medium comparative rate impact.
				Total Score		**Total Score**	
				0		0	
				11		11	
				5		5	

		8		9		10	
		Mechanical Plant		Mechanical Plant		Mechanical Plant	
		SBR		MABR		IDAL	
No	**Criteria**	**Score**	**Comment**	**Score**	**Comment**	**Score**	**Comment**
1	Impacts on Māori cultural values and practices.	R	Ponds (incl. wetland) are decommissioned. Significant improvement in the quality of the effluent being discharged to the waterbody. High quality effluent would be unlikely to effect potential food gathering activities and flora and fauna. Location of WWTP was potentially contentious therefore major land changes could be opposed. Discharge to waterbody does not reflect cultural values.	R	Ponds (incl. wetland) are decommissioned. Significant improvement in the quality of the effluent being discharged to the waterbody. High quality effluent would be unlikely to effect potential food gathering activities and flora and fauna. Location of WWTP was potentially contentious therefore major land changes could be opposed. Discharge to waterbody does not reflect cultural values.	R	Ponds (incl. wetland) are decommissioned. Significant improvement in the quality of the effluent being discharged to the waterbody. High quality effluent would be unlikely to effect potential food gathering activities and flora and fauna. Location of WWTP was potentially contentious. Discharge to waterbody does not reflect cultural values.
2	Land Use Effects	O	Small visual, noise and traffic impact. Installation and construction of the mechanical plant may result in some disruption for the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.	O	Small visual, noise and traffic impact. Installation and construction of the mechanical plant may result in some disruption for the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.	O	Small visual, noise and traffic impact. Installation and construction of the mechanical plant may result in some disruption for the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.
	Odour	O	Historical odour complaints from adjacent farm.	O	Historical odour complaints from adjacent farm.	O	Historical odour complaints from adjacent farm.
	Ecological Effects	G	Low risk of exceeding the nitrate, ammonia and E. coli limits of the PRP and NPS-FM guidelines for phosphorus. Ability to denitrify.	G	Low risk of exceeding the nitrate, ammonia and E. coli limits of the PRP and NPS-FM guidelines for phosphorus. Ability to denitrify.	G	Low risk of exceeding the nitrate, ammonia and E. coli limits of the PRP and NPS-FM guidelines for phosphorus. Ability to denitrify.
	Carbon Footprint	R	Significant additional power requirements for mechanical plant. Significant power upgrade likely to be required.	R	Significant additional power requirements for mechanical plant. Significant power upgrade likely to be required.	R	Significant additional power requirements for mechanical plant. Significant power upgrade likely to be required.
	Public Health	G	Public health risks will be significantly reduced with tertiary treatment.	G	Public health risks will be significantly reduced with tertiary treatment.	G	Public health risks will be significantly reduced with tertiary treatment.
3	Constructability	R	Will require large scale construction works. High difficulty to commission. Plant is in a valley. Challenging for construction works due to narrow, windy and steep access.	R	Will require large scale construction works. High difficulty to commission. Plant is in a valley. Challenging for construction works due to narrow, windy and steep access.	O	Will require medium scale construction works. Medium difficulty to commission. Plant is in a valley. Challenging for construction works due to narrow, windy and steep access.
	Regulations and Planning	O	Building consent required (sludge de-watering system and tertiary treatment).	O	Building consent required (sludge de-watering system and tertiary treatment).	O	Building consent required (sludge de-watering system and tertiary treatment).
	Staging	o	Additional SBR units can be staged as required.	R	MABR modules likely to be installed in one stage.	R	IDAL installation cannot be staged.
4	The ease of operation and maintenance	R	Operating and maintaining the mechanical plant adds complexity to the process. Mechanical plant is likely to require more intensive operator involvement. May cause resourcing issues. Removing the wetland would eliminate the current difficulties to maintain it. Medium level complexity sludge management.	R	Operating and maintaining the mechanical plant adds complexity to the process. Mechanical plant is likely to require more intensive operator involvement. May cause resourcing issues. Removing the wetland would eliminate the current difficulties to maintain it. Medium level complexity sludge management.	O	Operating and maintaining the mechanical plant adds complexity to the process. Mechanical plant is likely to require more intensive operator involvement. May cause resourcing issues. Removing the wetland would eliminate the current difficulties to maintain it. Medium level complexity sludge management.
	Process reliability and resilience	G	Consistency in effluent quality will improve as a result of the treatment upgrade. Known technology with reliable performance.	G	Consistency in effluent quality will improve as a result of the treatment upgrade. Limited references of this technology.	G	Consistency in effluent quality will improve as a result of the treatment upgrade. Known technology with reliable performance.
	Expandability/ future proofing	O	Smaller footprint of mechanical plant will increase options for future expansion of the treatment system compared to a pond-based system. Limited land availability required removal of trees. Geotechnical risks associated with plant site.	O	Modularity and smaller footprint of mechanical plant will increase options for future expansion of the treatment system compared to a pond-based system. Limited land availability required removal of trees. Geotechnical risks associated with plant site.	O	Pond-based technology is land intensive. Limited flexibility to expand system. Some flexibility to adjust treatment according to new compliance requirements.
	Hazards	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.
5	Capital Cost	R	Medium to high comparative capital costs.	R	High comparative capital costs.	R	Medium to high comparative capital costs.
	Operating and Maintenance Costs	R	High comparative O&M costs.	R	High comparative O&M costs.	R	High comparative O&M costs.
	Rating impact	O	Medium comparative rate impact.	R	High comparative rate impact.	O	Medium comparative rate impact.
		Total Score		**Total Score**		**Total Score**	
		3		3		3	
		7		5		8	
		6		8		5	

KAIKOHE WWTP OPTIONS - Long List

Multi Criteria Analysis

N:\1014\147856_01-Kaikohe and Kaitaia WWTP\400 Tech\421 MCA\[Kaikohe Long List MCA-v3.0 - PDF printing version.xlsx]Print 1

DATE: 17/09/2020

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				11		12		13		14	
				Mechanical Plant		Side Stream Treatment Plant		Industrial Re-use		Alternative Upgrades	
				BNR		Portion of effluent treated through a mechanical plant. Remaining effluent treated through existing pond system. Final effluents are blended for discharge.		Portion of effluent treated by mechanical plant and re-used by industry close by that is willing to take wastewater. Remaining wastewater treated through existing pond system.		Following oxidation pond, Electrocoagulation + Clarifier	
No	**Category**	**Criteria**	**Description**	**Score**	**Comment**	**Score**	**Comment**	**Score**	**Comment**	**Score**	**Comment**
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	R	Ponds (incl. wetland) are decommissioned. Significant improvement in the quality of the effluent being discharged to the waterbody. High quality effluent would be unlikely to effect potential food gathering activities and flora and fauna. Location of WWTP was potentially contentious therefore major land changes could be opposed. Discharge to waterbody does not reflect cultural values.	R	Maintaining existing wetland and some improvement in the quality of the effluent being discharged to the waterbody. Location of WWTP was potentially contentious therefore major land changes could be opposed. Discharge to waterbody does not reflect cultural values.	R	Ponds (incl. wetland) are decommissioned. Effluent would not be discharged to the water body. No effect on food gathering activities and flora and fauna of the Wairoro River. Location of WWTP was potentially contentious therefore major land changes could be opposed. Discharge to waterbody does not reflect cultural values.	R	Wetland is maintained, but in poor conditions. Minimal evidence of technology used for treatment of municipal wastewater therefore uncertain regarding the quality of the effluent being discharged to the waterbody. Location of WWTP was potentially contentious therefore major land changes could be opposed. Discharge to waterbody does not reflect cultural values.
2	Environmental values	Land Use Effects	·Visual, Noise, Traffic impacts	O	Small visual, noise and traffic impact. Installation and construction of the mechanical plant may result in some disruption for the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.	O	Small visual, noise and traffic impact. Installation and construction of the mechanical plant may result in some disruption for the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.	R	Medium visual, noise and traffic impact, mostly related to building a pipeline from the WWTP to the industry.	O	Small visual, noise and traffic impact. The Kaikohe WWTP is in a remote rural area with few nearby farms.
		Odour	·The degree to which odour can be expected to be discharged beyond the property boundary.	O	Historical odour complaints from adjacent farm.	O	Historical odour complaints from adjacent farm.	O	Part of wastewater still treated through existing pond system. Historical odour complaints from adjacent farm.	O	Part of wastewater still treated through open treatment system. Options doesn't resolve odour issue.
		Ecological Effects	·The degree to which the effluent quality exceeds the minimum environmental and consent requirements.	G	Low risk of exceeding the nitrate, ammonia and E. coli limits of the PRP and NPS-FM guidelines for phosphorus. Ability to denitrify.	O	Low risk of exceeding the nitrate, ammonia and E. coli limits of the PRP and NPS-FM guidelines for phosphorus. Part of treatment undertaken through pond system which may impact final effluent quality. Ability to denitrify in part.	O	A portion of discharge will still go to the river. Therefore, may lead to some ecological effects.	R	High risk of exceeding the nitrate, ammonia and E. Coli limits of the PRP. Plant is likely to do not have enough BOD removal capacity to deal with increasing loads in the future. Algae blooms in Summer.
		Carbon Footprint	·Level of energy consumption, secondary discharges and chemicals required.	R	Significant additional power requirements for mechanical plant. Significant power upgrade likely to be required.	R	Significant additional power requirements for mechanical plant. Significant power upgrade likely to be required.	R	Significant additional power requirements for mechanical plant and pump station. Significant power upgrade likely to be required.	R	Significant additional power requirements for mechanical plant. No chemical dosing required. Significant power upgrade likely to be required.
		Public Health	·Impacts on mahinga kai ·Recreational use of the receiving environment ·Impact of spills and failure	G	Public health risks will be significantly reduced with tertiary treatment.	O	Public health risks will be reduced with partial tertiary treatment.	O	Risk to public health will be significantly reduced with UV disinfection treatment. A portion of the effluent will still be discharged to the river. Therefore, some effect on food gathering activities.	R	Risk to public health due to pathogens and viruses in the treated effluent. High concentrations of nutrients in the effluent and algae blooms can impact on food gathering activities.
3	Practicability	Constructability	·Complexity of construction process ·Distance from networks and services ·Time taken to commission option	R	Will require large scale construction works. High difficulty to commission.	R	Will require medium to large scale construction works. High difficulty to commission. Plant is in a valley. Challenging for construction works due to narrow, windy and steep access.	R	Will require large scale construction works. High difficulty to commission. Plant is in a valley. Challenging for construction works due to narrow, windy and steep access.	R	Will require medium scale construction works. High difficulty to commission due to limited experience or exposure of technology in NZ
		Regulations and Planning	·Complexity to obtain a consent or other authorisations	O	Building consent required (sludge de-watering system and tertiary treatment).	O	Building consent required (sludge de-watering system and tertiary treatment).	R	Building consent required (sludge de-watering system). Consents will be required for the construction of pipeline and pump station. FNDC would need to obtain permission of owners to cross private land (if required).	O	No additional consents required. Potentially challenging consent process due to freshwater target standards and limited examples of technology adopted in NZ for municipal wastewater treatment.
		Staging	Can the option be staged?	O	BNR streams can be added to the system as required.	O	Modular mechanical plants can be added to the system as required.	R	Modular mechanical plants can be added to the system as required. Due to pipeline construction likely to be completed in one stage.	R	Electrocoagulation cannot be staged.
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	R	Operating and maintaining the mechanical plant adds complexity to the process. Mechanical plant is likely to require more intensive operator involvement. May cause resourcing issues. Removing the wetland would eliminate the current difficulties to maintain it. Medium level complexity sludge management.	R	Operating and maintaining the mechanical plant adds complexity to the process. Mechanical plant is likely to require more intensive operator involvement. May cause resourcing issues. O&M of two WWTPs. Removing the wetland would eliminate the current difficulties to maintain it. Medium level complexity sludge management.	R	Operating and maintaining the mechanical plant and long pipeline adds complexity to the process. Mechanical plant is likely to require more intensive operator involvement. May cause resourcing issues. Removing the wetland would eliminate the current difficulties to maintain it. Medium level complexity sludge management.	R	Operating and maintaining the electrocoagulation system adds complexity to the process. This system is likely to require more intensive operator involvement. May cause resourcing issues. Medium to high level complexity sludge management especially with chemical sludge.
		Process reliability and resilience	·Known performance of others with similar technologies ·Consistency of quality in the discharge ·Ability to maintain compliance with resource consents	G	Consistency in effluent quality will improve as a result of the treatment upgrade. Known technology with reliable performance.	G	Consistency in effluent quality will improve as a result of the treatment upgrade. Known technology with reliable performance.	G	Resource consent to discharge treated effluent to the Wairoro River could be surrendered. Known technology with reliable performance.	R	Limited knowledge on technology and performance for large scale municipal wastewater treatment in NZ.
		Expandability/ future proofing	·The potential for the site to allow for extensions to the treatment process ·Proofing against changes in compliance requirements	O	Modularity and smaller footprint of mechanical plant will increase options for future expansion of the treatment system compared to a pond-based system. Limited land availability required removal of trees. Geotechnical risks associated with plant site.	O	Modularity and smaller footprint of mechanical plant will increase options for future expansion of the treatment system compared to a pond-based system. Limited land availability required removal of trees. Geotechnical risks associated with plant site.	O	Modularity and smaller footprint of mechanical plant will increase options for future expansion of the treatment system compared to a pond-based system. Limited land availability required removal of trees. Geotechnical risks associated with plant site.	R	Smaller footprint of electrocoagulation plant. Uncertain on sizing due to proprietary design.
		Hazards	·Proximity to known and potential hazards, e.g., flood plains, climate change hazards	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.
5	Financial	Capital Cost	·Cost of implementation ·Site investigations and procurement of land ·Ability to reuse existing FNDC assets	R	Medium to high comparative capital costs.	O	Medium comparative capital costs.	R	High comparative capital costs.	R	High comparative capital costs. Would require high effluent quality requirements for re-use
		Operating and Maintenance Costs	·Operations and maintenance requirements (e.g., chemical costs, sludge removal) ·Power cost	R	High comparative O&M costs.	O	Medium comparative O&M costs.	R	High comparative O&M costs.	R	High comparative O&M costs.
		Rating impact	·Impact on targeted rate relative to other options	O	Medium comparative rate impact.	O	Medium comparative rate impact.	R	High comparative rate impact.	R	High comparative rate impact.
				Total Score		**Total Score**		**Total Score**		**Total Score**	
				3		1		1		0	
				7		11		5		4	
				6		4		10		12	

APPENDIX 3
PRELIMINARY LONG LIST OF OPTIONS

TABLE 18: PRELIMINARY LONG LIST OF OPTIONS	
UPGRADE PURPOSE	**OPTIONS**

BOD / Nitrogen Removal	• Do nothing (status quo)
	• Additional aeration[1,3]
	• Mechanical mixers
	• Floating treatment wetlands partitioning into nitrification zone and anoxic zone[1]
	• Bioreef/Aquamats partitioning into anoxic zone with recycle[2]
	• Replacing existing ponds with:
	  o Intermittent Decanting Aerated Lagoon (IDAL) plant
	  o Sequencing Batch Reactor (SBR) plant[4]
	  o Biological Nutrient Removal (BNR) plant
	  o Membrane Aerated Biofilm Reactor (MABR) modules

Solids Removal	• Do nothing (status quo) • Sand filter[4] • Disc filter • Dissolved Air Flotation (DAF) • Actiflo (sand-ballasted Clarifier) • Clarifier • Rock filters
Phosphorus Removal	• Do nothing (status quo) • Chemical dosing & Rock Filter • Clarifier • Actiflo (sand-ballasted Clarifier) • Mechanical Plant
Algae Removal Algae Removal	• Do nothing (status quo) • Surface mixers • Inlet/outlet pipe reconfiguration
Disinfection	• Do nothing (status quo) • UV disinfection[2,3,4]
Sludge Handling	• Sludge lagoon[4]
Other Plant Modifications	• Upgrade constructed wetlands[4] • Abandon constructed wetlands[3] • Baffle curtains[3,4] • De-sludging of ponds • Inflow & infiltration (I&I) reduction[5] • Electrocoagulation and Clarifier after pond 2
Trade Waste	• Do nothing (status quo) • Discontinue trade waste.

[1] Kauri Park (2010) – Kaikohe Waste Water Treatment Plant Upgrade Options

[2] OPUS (2008) – Bioreef Investigation Prelim Design and Costing

[3] OPUS (2006) – Kaikohe WWTP Optimisation

[4] VK Consulting Engineers (2003) – Kaikohe WWTP Upgrade Options

[5] *It was assumed that I&I reduction options are being explored separately from the WWTP upgrade. This option will not be considered further.*

APPENDIX 4
MCA (SHORT LIST OF OPTIONS) AND SENSITIVITY ANALYSIS

KAIKOHE WWTP OPTIONS - Long List

Multi Criteria Analysis

N:\1014\147856_01-Kaikohe and Kaitaia WWTP\400 Tech\421 MCA\[Kaikohe Long List MCA-v3.0 - PDF printing version.xlsx]Print 1

DATE: 17/09/2020

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No	Category	Criteria	Description	1 Status Quo: Do Nothing – Score	Comment	2 Minor Upgrades: Mechanical mixers + Baffle curtains + Chemical dosing + Rock filter + UV – Score	Comment	3 Minor Upgrades: Additional aerators + Baffle curtains + Chemical dosing + Sand filter + UV – Score	Comment	4 Minor Upgrades: Mechanical mixers + Baffle curtains + Chemical dosing + Rock filter + UV + Remove constructed wetlands – Score	Comment	5 Major Upgrades: Floating wetland + Chemical dosing + Clarifier + Surface mixers + UV + Upgrade constructed wetlands – Score	Comment
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	R	Maintaining existing wetland aligns with cultural values. No improvements in the quality of the effluent being discharged to the waterbody. Location of WWTP was potentially contentious. Discharge to waterbody does not reflect cultural values.	R	Maintaining existing wetland, introducing rock filter to treatment process and making minor improvement in the quality of the effluent being discharged to the waterbody. Location of WWTP was potentially contentious. Discharge to waterbody does not reflect cultural values.	R	Maintaining existing wetland and some improvement in the quality of the effluent being discharged to the waterbody. Location of WWTP was potentially contentious. Discharge to waterbody does not reflect cultural values.	R	Introducing rock filter to treatment process and making minor improvement in the quality of the effluent being discharged to the waterbody. Removing existing constructed wetlands but natural wetlands still remain. Location of WWTP was potentially contentious. Reflects some cultural values. Discharge to waterbody does not reflect cultural values.	R	Additional floating wetlands, upgrade of constructed wetlands with some improvement in the quality of the effluent being discharged to the waterbody. Location of WWTP was potentially contentious. Discharge to waterbody does not reflect cultural values.
2	Environmental values	Land Use Effects	·Visual, Noise, Traffic impacts	G	No visual, noise and traffic impact.	G	Minimum visual, noise and traffic impact. The Kaikohe WWTP is in a remote rural area with few nearby farms.	G	Minimum visual, noise and traffic impact. The Kaikohe WWTP is in a remote rural area with few nearby farms.	G	Minimum visual, noise and traffic impact. The Kaikohe WWTP is in a remote rural area with few nearby farms.	O	Small visual, noise and traffic impact. Construction of new clarifier and UV may result in some disruption to the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.
		Odour	·The degree to which odour can be expected to be discharged beyond the property boundary.	O	Historical odour complaints from adjacent farm.	O	Historical odour complaints from adjacent farm.	O	Historical odour complaints from adjacent farm.	O	Historical odour complaints from adjacent farm.	O	Historical odour complaints from adjacent farm.
		Ecological Effects	·The degree to which the effluent quality exceeds the minimum environmental and consent requirements.	R	High risk of exceeding the nitrate, ammonia, DO and E. coli limits of the PRP. Additional may also exceed guidelines in NPS-FM for phosphorus limits.	R	Potential for insufficient nitrification. High risk of exceeding the nitrate, ammonia and DO limits of the PRP. Risk of exceeding NPS-FM guidelines for phosphorus.	O	Risk of exceeding the nitrate, ammonia and DO limits of the PRP.	R	Potential for insufficient nitrification. High risk of exceeding the nitrate, ammonia and DO limits of the PRP. Risk of exceeding NPS-FM guidelines for phosphorus.	R	Potential for insufficient nitrification. High risk of exceeding the nitrate, ammonia and DO limits of the PRP. Risk of exceeding NPS-FM guidelines for phosphorus.
		Carbon Footprint	·Level of energy consumption, secondary discharges and chemicals required.	G	No change from current system. Power requirements of pond based treatment system are relatively low.	O	Additional power requirements for mechanical mixers, UV unit and other equipment.	O	Additional power requirements for aerators, sand filter, UV units, and other equipment.	O	Additional power requirements for mechanical mixers, UV unit and other equipment.	O	Some power requirements for mechanical mixers, UV units, and other equipment.
		Public Health	·Impacts on mahinga kai ·Recreational use of the receiving environment ·Impact of spills and failure	R	Risk to public health due to pathogens and viruses in the treated effluent. High concentrations of nutrients in the effluent can impact on food gathering activities.	R	Risk to public health will be significantly reduced with UV disinfection treatment. Potential high concentrations of nutrients in the effluent can impact on food gathering activities.	O	Risk to public health will be significantly reduced with UV disinfection treatment. Improved effluent quality with minor control is unlikely to have major impacts on food gathering activities.	R	Risk to public health will be significantly reduced with UV disinfection treatment. Potential high concentrations of nutrients in the effluent can impact on food gathering activities.	R	Risk to public health will be significantly reduced with UV disinfection treatment. Potential high concentrations of nutrients in the effluent can impact on food gathering activities.
3	Practicability	Constructability	·Complexity of construction process ·Distance from networks and services ·Time taken to commission option	G	No construction/commissioning required.	O	Will require small scale construction works. Easy to commission.	O	Will require small scale construction works. Easy to commission.	O	Will require small scale construction works. Easy to commission.	O	Will require medium scale construction works. Moderate to high difficulty to commission.
		Regulations and Planning	·Complexity to obtain a consent or other authorisations	r	No additional consents required. Challenging consent process as does not achieve freshwater target standards.	R	Building consent required (chemical plant and tertiary treatment). Chemicals might require a compliance certificate. Challenging consent process as does not achieve freshwater target standards.	O	Building consent required (chemical plant and tertiary treatment). Chemicals might require a compliance certificate.	R	Building consent required (chemical plant and tertiary treatment). Chemicals might require a compliance certificate. Challenging consent process as does not achieve freshwater target standards.	R	Building consent required (chemical plant and tertiary treatment). Chemicals might require a compliance certificate. Challenging consent process as does not achieve freshwater target standards.
		Staging	Can the option be staged?	G	No construction required.	O	Only minor upgrades are required which could be staged. It is likely to be more cost-effective to build them in one stage.	O	Only minor upgrades are required which could be staged. It is likely to be more cost-effective to build them in one stage.	O	Only minor upgrades are required which could be staged. It is likely to be more cost-effective to build them in one stage.	R	Major upgrades are required. It is cost-effective to build them in one stage.
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	G	No change from current system. De-sludging ponds is a laborious task. Poor-quality sludge.	G	Simple operation. Additional equipment would have to be maintained. De-sludging ponds is a laborious task. Poor-quality sludge.	G	Simple operation. Additional equipment would have to be maintained. De-sludging ponds is a laborious task. Poor-quality sludge.	G	Simple operation. Additional equipment would have to be maintained. De-sludging ponds is a laborious task. Poor-quality sludge. Removing the wetland would eliminate the current heavy maintenance requirements.	G	Simple operation. De-sludging ponds is a laborious task. Poor-quality sludge. Excess of sludge would also be removed from clarifier.
		Process reliability and resilience	·Known performance of others with similar technologies ·Consistency of quality in the discharge ·Ability to maintain compliance with resource consents	R	No change from current system. Compliance issues related to nutrients and E.coli removal.	R	Very limited process control with pond-based treatment system. Consistency in effluent quality may have some improvements as a result of the treatment upgrade.	O	Limited process control with pond-based treatment system with aeration. Consistency in effluent quality will improve as a result of the treatment upgrade.	R	Very limited process control with pond-based treatment system. Consistency in effluent quality may have some improvements as a result of the treatment upgrade.	O	Limited process control with pond-based treatment system. Consistency in effluent quality will improve as a result of the treatment upgrade.
		Expandability/ future proofing	·The potential for the site to allow for extensions to the treatment process ·Proofing against changes in compliance requirements	R	Pond-based technology is land intensive. Low flexibility to deal with changes in compliance requirements or to expand the plant.	R	Pond-based technology is land intensive. Low flexibility to deal with changes in compliance requirements or to expand the plant.	R	Pond-based technology is land intensive. Aerators and chemical dosing add limited flexibility to deal with changes in compliance requirements.	R	Pond-based technology is land intensive. Low flexibility to deal with changes in compliance requirements or to expand the plant.	R	Pond-based technology is land intensive. Low flexibility to deal with changes in compliance requirements or to expand the plant.
		Hazards	·Proximity to known and potential hazards, e.g., flood plains, climate change hazards	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.
5	Financial	Capital Cost	·Cost of implementation ·Site investigations and procurement of land ·Ability to reuse existing FNDC assets	G	No additional costs associated with this option.	O	Medium comparative capital costs.	O	Medium comparative capital costs.	O	Medium comparative capital costs.	O	Medium comparative capital costs.
		Operating and Maintenance Costs	·Operations and maintenance requirements (e.g., chemical costs, sludge removal) ·Power cost	G	No additional costs associated with this option.	O	Medium comparative O&M costs.	R	Medium to high comparative O&M costs.	O	Medium comparative O&M costs.	G	Low comparative O&M costs.
		Rating impact	·Impact on targeted rate relative to other options	G	No additional costs associated with this option.	O	Medium comparative rate impact.	O	Medium comparative rate impact.	O	Medium comparative rate impact.	O	Medium comparative rate impact.

Total Score	Option 1	Option 2	Option 3	Option 4	Option 5
G	8	2	2	2	2
O	2	8	11	8	8
R	6	6	3	6	6

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				6		7		8		9		10	
				Major Upgrades		Major Upgrades		Mechanical Plant		Mechanical Plant		Mechanical Plant	
				Bioreef/Aquamats + Chemical dosing + Actiflo + UV + Remove all wetlands		Bioreef/Aquamats + Chemical dosing + DAF + UV + Remove all wetlands		SBR		MABR		IDAL	
No	**Category**	**Criteria**	**Description**	**Score**	**Comment**	**Score**	**Comment**	**Score**	**Comment**	**Score**	**Comment**	**Score**	**Comment**
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	R	Some improvement in the quality of the effluent being discharged to the waterbody. Removal of all wetlands. Minimal upgrade with cultural impact. Location of WWTP was potentially contentious. Discharge to waterbody does not reflect cultural values.	R	Some improvement in the quality of the effluent being discharged to the waterbody. Removal of all wetlands. Minimal upgrade with cultural impact. Location of WWTP was potentially contentious. Discharge to waterbody does not reflect cultural values.	R	Ponds (incl. wetland) are decommissioned. Significant improvement in the quality of the effluent being discharged to the waterbody. High quality effluent would be unlikely to effect potential food gathering activities and flora and fauna. Location of WWTP was potentially contentious therefore major land changes could be opposed. Discharge to waterbody does not reflect cultural values.	R	Ponds (incl. wetland) are decommissioned. Significant improvement in the quality of the effluent being discharged to the waterbody. High quality effluent would be unlikely to effect potential food gathering activities and flora and fauna. Location of WWTP was potentially contentious therefore major land changes could be opposed. Discharge to waterbody does not reflect cultural values.	R	Ponds (incl. wetland) are decommissioned. Significant improvement in the quality of the effluent being discharged to the waterbody. High quality effluent would be unlikely to effect potential food gathering activities and flora and fauna. Location of WWTP was potentially contentious. Discharge to waterbody does not reflect cultural values.
2	Environmental values	Land Use Effects	·Visual, Noise, Traffic impacts	O	Small visual, noise and traffic impact. Installation and construction of bioreef/aquamats, Actiflo and UV may result in some disruption to the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.	O	Small visual, noise and traffic impact. Installation and construction of bioreef/aquamats, DAF and UV may result in some disruption to the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.	O	Small visual, noise and traffic impact. Installation and construction of the mechanical plant may result in some disruption for the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.	O	Small visual, noise and traffic impact. Installation and construction of the mechanical plant may result in some disruption for the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.	O	Small visual, noise and traffic impact. Installation and construction of the mechanical plant may result in some disruption for the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.
		Odour	·The degree to which odour can be expected to be discharged beyond the property boundary.	O	Historical odour complaints from adjacent farm.	O	Historical odour complaints from adjacent farm.	O	Historical odour complaints from adjacent farm.	O	Historical odour complaints from adjacent farm.	O	Historical odour complaints from adjacent farm.
		Ecological Effects	·The degree to which the effluent quality exceeds the minimum environmental and consent requirements.	O	Risk of exceeding the nitrate, ammonia and DO limits of the PRP. Ability to denitrify through denitrification zone.	O	Risk of exceeding the nitrate, ammonia and DO limits of the PRP. Ability to denitrify through denitrification zone.	G	Low risk of exceeding the nitrate, ammonia and E. coli limits of the PRP and NPS-FM guidelines for phosphorus. Ability to denitrify.	G	Low risk of exceeding the nitrate, ammonia and E. coli limits of the PRP and NPS-FM guidelines for phosphorus. Ability to denitrify.	G	Low risk of exceeding the nitrate, ammonia and E. coli limits of the PRP and NPS-FM guidelines for phosphorus. Ability to denitrify.
		Carbon Footprint	·Level of energy consumption, secondary discharges and chemicals required.	R	Additional power requirements for bioreef/aquamats aerations, Actiflo, UV units, and other equipment.	R	Additional power requirements for bioreef/aquamats aerations, DAF, UV units, and other equipment. Power upgrade likely to be required.	R	Significant additional power requirements for mechanical plant. Significant power upgrade likely to be required.	R	Significant additional power requirements for mechanical plant. Significant power upgrade likely to be required.	R	Significant additional power requirements for mechanical plant. Significant power upgrade likely to be required.
		Public Health	·Impacts on mahinga kai ·Recreational use of the receiving environment ·Impact of spills and failure	O	Risk to public health will be significantly reduced with UV disinfection treatment. Improved effluent quality with minor control is unlikely to have major impacts on food gathering activities.	O	Risk to public health will be significantly reduced with UV disinfection treatment. Improved effluent quality with minor control is unlikely to have major impacts on food gathering activities.	G	Public health risks will be significantly reduced with tertiary treatment.	G	Public health risks will be significantly reduced with tertiary treatment.	G	Public health risks will be significantly reduced with tertiary treatment.
3	Practicability	Constructability	·Complexity of construction process ·Distance from networks and services ·Time taken to commission option	R	Will require medium scale construction works. Moderate to high difficulty to commission.	R	Will require medium scale construction works. Moderate to high difficulty to commission. Plant is in a valley. Challenging for construction works due to narrow, windy and steep access.	R	Will require large scale construction works. High difficulty to commission. Plant is in a valley. Challenging for construction works due to narrow, windy and steep access.	R	Will require large scale construction works. High difficulty to commission. Plant is in a valley. Challenging for construction works due to narrow, windy and steep access.	O	Will require medium scale construction works. Medium difficulty to commission. Plant is in a valley. Challenging for construction works due to narrow, windy and steep access.
		Regulations and Planning	·Complexity to obtain a consent or other authorisations	O	Building consent required (chemical plant and tertiary treatment). Chemicals might require a compliance certificate.	O	Building consent required (chemical plant and tertiary treatment). Chemicals might require a compliance certificate.	O	Building consent required (sludge de-watering system and tertiary treatment).	O	Building consent required (sludge de-watering system and tertiary treatment).	O	Building consent required (sludge de-watering system and tertiary treatment).
		Staging	Can the option be staged?	R	Major upgrades are required. It is cost-effective to build them in one stage.	R	Major upgrades are required. It is cost-effective to build them in one stage.	o	Additional SBR units can be staged as required.	R	MABR modules likely to be installed in one stage.	R	IDAL installation cannot be staged.
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	O	Additional equipment (e.g. Actiflo) would have to be maintained. De-sludging ponds is a laborious task. Poor-quality sludge. Excess of sludge would also be removed from Actiflo.	O	Additional equipment (e.g. DAF) would have to be maintained. De-sludging ponds is a laborious task. Poor-quality sludge. Excess of sludge would also be removed from DAF.	R	Operating and maintaining the mechanical plant adds complexity to the process. Mechanical plant is likely to require more intensive operator involvement. May cause resourcing issues. Removing the wetland would eliminate the current difficulties to maintain it. Medium level complexity sludge management.	R	Operating and maintaining the mechanical plant adds complexity to the process. Mechanical plant is likely to require more intensive operator involvement. May cause resourcing issues. Removing the wetland would eliminate the current difficulties to maintain it. Medium level complexity sludge management.	O	Operating and maintaining the mechanical plant adds complexity to the process. Mechanical plant is likely to require more intensive operator involvement. May cause resourcing issues. Removing the wetland would eliminate the current difficulties to maintain it. Medium level complexity sludge management.
		Process reliability and resilience	·Known performance of others with similar technologies ·Consistency of quality in the discharge ·Ability to maintain compliance with resource consents	O	Limited process control with pond-based treatment system. Consistency in effluent quality will improve as a result of the treatment upgrade.	O	Limited process control with pond-based treatment system. Consistency in effluent quality will improve as a result of the treatment upgrade.	G	Consistency in effluent quality will improve as a result of the treatment upgrade. Known technology with reliable performance.	G	Consistency in effluent quality will improve as a result of the treatment upgrade. Limited references of this technology.	G	Consistency in effluent quality will improve as a result of the treatment upgrade. Known technology with reliable performance.
		Expandability/ future proofing	·The potential for the site to allow for extensions to the treatment process ·Proofing against changes in compliance requirements	O	Pond-based technology is land intensive. Potential to add growth media as required. Low flexibility to deal with changes in compliance requirements or to expand the plant.	O	Pond-based technology is land intensive. Potential to add growth media as required. Low flexibility to deal with changes in compliance requirements or to expand the plant.	O	Smaller footprint of mechanical plant will increase options for future expansion of the treatment system compared to a pond-based system. Limited land availability required removal of trees. Geotechnical risks associated with plant site.	O	Modularity and smaller footprint of mechanical plant will increase options for future expansion of the treatment system compared to a pond-based system. Limited land availability required removal of trees. Geotechnical risks associated with plant site.	O	Pond-based technology is land intensive. Limited flexibility to expand system. Some flexibility to adjust treatment according to new compliance requirements.
		Hazards	·Proximity to known and potential hazards, e.g., flood plains, climate change hazards	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.
5	Financial	Capital Cost	·Cost of implementation ·Site investigations and procurement of land ·Ability to reuse existing FNDC assets	O	Medium comparative capital costs.	O	Medium comparative capital costs.	R	Medium to high comparative capital costs.	R	High comparative capital costs.	R	Medium to high comparative capital costs.
		Operating and Maintenance Costs	·Operations and maintenance requirements (e.g., chemical costs, sludge removal) ·Power cost	R	Medium to high comparative O&M costs.	R	Medium to high comparative O&M costs.	R	High comparative O&M costs.	R	High comparative O&M costs.	R	High comparative O&M costs.
		Rating impact	·Impact on targeted rate relative to other options	O	Medium comparative rate impact.	O	Medium comparative rate impact.	O	Medium comparative rate impact.	R	High comparative rate impact.	O	Medium comparative rate impact.
				Total Score		**Total Score**		**Total Score**		**Total Score**		**Total Score**	
				0		0		3		3		3	
				11		11		7		5		8	
				5		5		6		8		5	

KAIKOHE WWTP OPTIONS - Long List

Multi Criteria Analysis

N:\1014\147856_01-Kaikohe and Kaitaia WWTP\400 Tech\421 MCA\[Kaikohe Long List MCA-v3.0 - PDF printing version.xlsx]Print 1

DATE: 17/09/2020

HG PROJECT NUMBER: 1014-147856-01

				11		12		13		14	
				Mechanical Plant		Side Stream Treatment Plant		Industrial Re-use		Alternative Upgrades	
				BNR		Portion of effluent treated through a mechanical plant. Remaining effluent treated through existing pond system. Final effluents are blended for discharge.		Portion of effluent treated by mechanical plant and re-used by industry close by that is willing to take wastewater. Remaining wastewater treated through existing pond system.		Following oxidation pond, Electrocoagulation + Clarifier	
No	**Category**	**Criteria**	**Description**	**Score**	**Comment**	**Score**	**Comment**	**Score**	**Comment**	**Score**	**Comment**
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	R	Ponds (incl. wetland) are decommissioned. Significant improvement in the quality of the effluent being discharged to the waterbody. High quality effluent would be unlikely to effect potential food gathering activities and flora and fauna. Location of WWTP was potentially contentious therefore major land changes could be opposed. Discharge to waterbody does not reflect cultural values.	R	Maintaining existing wetland and some improvement in the quality of the effluent being discharged to the waterbody. Location of WWTP was potentially contentious therefore major land changes could be opposed. Discharge to waterbody does not reflect cultural values.	R	Ponds (incl. wetland) are decommissioned. Effluent would not be discharged to the water body. No effect on food gathering activities and flora and fauna of the Wairoro River. Location of WWTP was potentially contentious therefore major land changes could be opposed. Discharge to waterbody does not reflect cultural values.	R	Wetland is maintained, but in poor conditions. Minimal evidence of technology used for treatment of municipal wastewater therefore uncertain regarding the quality of the effluent being discharged to the waterbody. Location of WWTP was potentially contentious therefore major land changes could be opposed. Discharge to waterbody does not reflect cultural values.
2	Environmental values	Land Use Effects	·Visual, Noise, Traffic impacts	O	Small visual, noise and traffic impact. Installation and construction of the mechanical plant may result in some disruption for the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.	O	Small visual, noise and traffic impact. Installation and construction of the mechanical plant may result in some disruption for the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.	R	Medium visual, noise and traffic impact, mostly related to building a pipeline from the WWTP to the industry.	O	Small visual, noise and traffic impact. The Kaikohe WWTP is in a remote rural area with few nearby farms.
		Odour	·The degree to which odour can be expected to be discharged beyond the property boundary.	O	Historical odour complaints from adjacent farm.	O	Historical odour complaints from adjacent farm.	O	Part of wastewater still treated through existing pond system. Historical odour complaints from adjacent farm.	O	Part of wastewater still treated through open treatment system. Options doesn't resolve odour issue.
		Ecological Effects	·The degree to which the effluent quality exceeds the minimum environmental and consent requirements.	G	Low risk of exceeding the nitrate, ammonia and E. coli limits of the PRP and NPS-FM guidelines for phosphorus. Ability to denitrify.	O	Low risk of exceeding the nitrate, ammonia and E. coli limits of the PRP and NPS-FM guidelines for phosphorus. Part of treatment undertaken through pond system which may impact final effluent quality. Ability to denitrify in part.	O	A portion of discharge will still go to the river. Therefore, may lead to some ecological effects.	R	High risk of exceeding the nitrate, ammonia and E. Coli limits of the PRP. Plant is likely to do not have enough BOD removal capacity to deal with increasing loads in the future. Algae blooms in Summer.
		Carbon Footprint	·Level of energy consumption, secondary discharges and chemicals required.	R	Significant additional power requirements for mechanical plant. Significant power upgrade likely to be required.	R	Significant additional power requirements for mechanical plant. Significant power upgrade likely to be required.	R	Significant additional power requirements for mechanical plant and pump station. Significant power upgrade likely to be required.	R	Significant additional power requirements for mechanical plant. No chemical dosing required. Significant power upgrade likely to be required.
		Public Health	·Impacts on mahinga kai ·Recreational use of the receiving environment ·Impact of spills and failure	G	Public health risks will be significantly reduced with tertiary treatment.	O	Public health risks will be reduced with partial tertiary treatment.	O	Risk to public health will be significantly reduced with UV disinfection treatment. A portion of the effluent will still be discharged to the river. Therefore, some effect on food gathering activities.	R	Risk to public health due to pathogens and viruses in the treated effluent. High concentrations of nutrients in the effluent and algae blooms can impact on food gathering activities.
3	Practicability	Constructability	·Complexity of construction process ·Distance from networks and services ·Time taken to commission option	R	Will require large scale construction works. High difficulty to commission.	R	Will require medium to large scale construction works. High difficulty to commission. Plant is in a valley. Challenging for construction works due to narrow, windy and steep access.	R	Will require large scale construction works. High difficulty to commission. Plant is in a valley. Challenging for construction works due to narrow, windy and steep access.	R	Will require medium scale construction works. High difficulty to commission due to limited experience or exposure of technology in NZ
		Regulations and Planning	·Complexity to obtain a consent or other authorisations	O	Building consent required (sludge de-watering system and tertiary treatment).	O	Building consent required (sludge de-watering system and tertiary treatment).	R	Building consent required (sludge de-watering system). Consents will be required for the construction of pipeline and pump station. FNDC would need to obtain permission of owners to cross private land (if required).	O	No additional consents required. Potentially challenging consent process due to freshwater target standards and limited examples of technology adopted in NZ for municipal wastewater treatment.
		Staging	Can the option be staged?	O	BNR streams can be added to the system as required.	O	Modular mechanical plants can be added to the system as required.	R	Modular mechanical plants can be added to the system as required. Due to pipeline construction likely to be completed in one stage.	R	Electrocoagulation cannot be staged.
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	R	Operating and maintaining the mechanical plant adds complexity to the process. Mechanical plant is likely to require more intensive operator involvement. May cause resourcing issues. Removing the wetland would eliminate the current difficulties to maintain it. Medium level complexity sludge management.	R	Operating and maintaining the mechanical plant adds complexity to the process. Mechanical plant is likely to require more intensive operator involvement. May cause resourcing issues. O&M of two WWTPs. Removing the wetland would eliminate the current difficulties to maintain it. Medium level complexity sludge management.	R	Operating and maintaining the mechanical plant and long pipeline adds complexity to the process. Mechanical plant is likely to require more intensive operator involvement. May cause resourcing issues. Removing the wetland would eliminate the current difficulties to maintain it. Medium level complexity sludge management.	R	Operating and maintaining the electrocoagulation system adds complexity to the process. This system is likely to require more intensive operator involvement. May cause resourcing issues. Medium to high level complexity sludge management especially with chemical sludge.
		Process reliability and resilience	·Known performance of others with similar technologies ·Consistency of quality in the discharge ·Ability to maintain compliance with resource consents	G	Consistency in effluent quality will improve as a result of the treatment upgrade. Known technology with reliable performance.	G	Consistency in effluent quality will improve as a result of the treatment upgrade. Known technology with reliable performance.	G	Resource consent to discharge treated effluent to the Wairoro River could be surrendered. Known technology with reliable performance.	R	Limited knowledge on technology and performance for large scale municipal wastewater treatment in NZ.
		Expandability/ future proofing	·The potential for the site to allow for extensions to the treatment process ·Proofing against changes in compliance requirements	O	Modularity and smaller footprint of mechanical plant will increase options for future expansion of the treatment system compared to a pond-based system. Limited land availability required removal of trees. Geotechnical risks associated with plant site.	O	Modularity and smaller footprint of mechanical plant will increase options for future expansion of the treatment system compared to a pond-based system. Limited land availability required removal of trees. Geotechnical risks associated with plant site.	O	Modularity and smaller footprint of mechanical plant will increase options for future expansion of the treatment system compared to a pond-based system. Limited land availability required removal of trees. Geotechnical risks associated with plant site.	R	Smaller footprint of electrocoagulation plant. Uncertain on sizing due to proprietary design.
		Hazards	·Proximity to known and potential hazards, e.g., flood plains, climate change hazards	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	O	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.
5	Financial	Capital Cost	·Cost of implementation ·Site investigations and procurement of land ·Ability to reuse existing FNDC assets	R	Medium to high comparative capital costs.	O	Medium comparative capital costs.	R	High comparative capital costs.	R	High comparative capital costs. Would require high effluent quality requirements for re-use
		Operating and Maintenance Costs	·Operations and maintenance requirements (e.g., chemical costs, sludge removal) ·Power cost	R	High comparative O&M costs.	O	Medium comparative O&M costs.	R	High comparative O&M costs.	R	High comparative O&M costs.
		Rating impact	·Impact on targeted rate relative to other options	O	Medium comparative rate impact.	O	Medium comparative rate impact.	R	High comparative rate impact.	R	High comparative rate impact.

	Mechanical Plant (11)	Side Stream Treatment Plant (12)	Industrial Re-use (13)	Alternative Upgrades (14)
	Total Score	**Total Score**	**Total Score**	**Total Score**
G	3	1	1	0
O	7	11	5	4
R	6	4	10	12

APPENDIX 5
RISK ANALYSIS

KAIKOHE WWTP OPTIONS - Short List Assessment

Risk Matrix

N:\1014\147856_01-Kaikohe and Kaitaia WWTP\400 Tech\421 MCA\Risk Analysis\[Kaikohe WWTP Short List Risk Matrix-Rev0.4MSM.xlsx]General (2)

DATE: 06/10/20

HG PROJECT NUMBER: 1014-147856-01

			Option 1: Additional aerators + Baffle curtains + Chemical dosing + Sand filter + UV						Option 2: Bioreef/Aquamats + Chemical dosing + Actiflo + UV + Remove all wetlands						Option 3: IDAL					
	Risks	Descriptions	Likelihood		Consequence		Risk Grade	Risk Score	Likelihood		Consequence		Risk Grade	Risk Score	Likelihood		Consequence		Risk Grade	Risk Score
			Rating	Score	Rating	Score			Rating	Score	Rating	Score			Rating	Score	Rating	Score		
1	Non-performance of the overall treatment scheme	Treatment and disposal systems not operating to design objectives. Assumptions about the Wairoro Stream flow to calculate the required effluent quality are incorrect. Breach of Consent.	Possible	3	Major	4	Extreme	12	Possible	3	Major	4	Extreme	12	Unlikely	2	Major	4	High	8
2	Option not acceptable to iwi	Scheme may not have iwi endorsement; difficult to progress the scheme.	Likely	4	Major	4	Extreme	16	Likely	4	Major	4	Extreme	16	Likely	4	Major	4	Extreme	16
3	Option not acceptable to community (negative perception and social unacceptance)	Public opposition to preferred option.	Possible	3	Major	4	Extreme	12	Possible	3	Major	4	Extreme	12	Possible	3	Major	4	Extreme	12
4	Local expertise not available to operate the plant	Plant operations and performance affected if expertise are not available to operate it correctly.	Unlikely	2	Moderate	3	Medium	6	Unlikely	2	Moderate	3	Medium	6	Unlikely	2	Moderate	3	Medium	6
5	Disruptions to existing WWTPs during construction	Effluent quality affected; breach of consents.	Likely	4	Major	4	Extreme	16	Likely	4	Major	4	Extreme	16	Likely	4	Major	4	Extreme	16
6	Consenting difficulties	Required consent are not granted (land disposal options). Options selection process does not meet the requirements of the existing consent.	Possible	3	Major	4	Extreme	12	Possible	3	Major	4	Extreme	12	Unlikely	2	Major	4	High	8
7	Capacity/future proofing	Option is unable to meet the long term needs of the community. Insufficient capacity for future industry. Unable to deal with changes on the compliance requirements.	Likely	4	Major	4	Extreme	16	Possible	3	Major	4	Extreme	12	Unlikely	2	Major	4	High	8
8	Failure of equipment at the WWTPs	Failure of equipment at the WWTPs. Power loss.	Possible	3	Major	4	Extreme	12	Possible	3	Major	4	Extreme	12	Possible	3	Major	4	Extreme	12
9	Option unaffordable		Unlikely	2	Major	4	High	8	Likely	4	Major	4	Extreme	16	Possible	3	Major	4	Extreme	12
10	Availability of suitable land	Risk that suitable land is unavailable to build WWTP upgrades (i.e. land has to be purchased), or the ground conditions of existing land are not appropriate.	Unlikely	2	Moderate	3	Medium	6	Possible	3	Moderate	3	High	9	Possible	3	Moderate	3	High	9
11	Odour issues and wastewater sprays	WWTP odour issues affecting nearby residents. Wastewater spray from ponds to beyond property boundary.	Possible	3	Minor	2	Medium	6	Possible	3	Minor	2	Medium	6	Possible	3	Minor	2	Medium	6
12	Cyanobacteria	Risk of discharging cyanobacteria to the waterbody.	Unlikely	2	Major	4	High	8	Unlikely	2	Major	4	High	8	Rare	1	Major	4	High	4
13	Other risks	Avian botulism. Steep site access.	Possible	3	Moderate	3	High	9	Possible	3	Moderate	3	High	9	Possible	3	Moderate	3	High	9
							Total	**116**					**Total**	**123**					**Total**	**107**

Likelihood		**Consequence**			
		Severe	Major	Moderate	Minor
		5	4	3	2
Almost certain	5	Extreme	Extreme	Extreme	High
Likely	4	Extreme	Extreme	High	High
Possible	3	Extreme	Extreme	High	Medium
Unlikely	2	Extreme	High	Medium	Low
Rare	1	High	High	Medium	Low

KAIKOHE WWTP OPTIONS - Short List Assessment

Risk Matrix

N:\1014\147856_01-Kaikohe and Kaitaia WWTP\400 Tech\421 MCA\Risk Analysis\[Kaikohe WWTP Short List Risk Matrix-Rev0.4MSM.xlsx]General (3)

DATE: 06/10/20

HG PROJECT NUMBER: 1014-147856-01

	Risks	Descriptions	Option 4A: Side Stream Treatment Plant (BNR)						Option 4B: BNR Plant					
			Likelihood		Consequence		Risk Grade	Risk Score	Likelihood		Consequence		Risk Grade	Risk Score
			Rating	Score	Rating	Score			Rating	Score	Rating	Score		
1	Non-performance of the overall treatment scheme	Treatment and disposal systems not operating to design objectives. Assumptions about the Wairoro Stream flow to calculate the required effluent quality are incorrect. Breach of Consent.	Unlikely	2	Major	4	High	8	Unlikely	2	Major	4	High	8
2	Option not acceptable to iwi	Scheme may not have iwi endorsement; difficult to progress the scheme.	Likely	4	Major	4	Extreme	16	Likely	4	Major	4	Extreme	16
3	Option not acceptable to community (negative perception and social unacceptance)	Public opposition to preferred option.	Possible	3	Major	4	Extreme	12	Possible	3	Major	4	Extreme	12
4	Local expertise not available to operate the plant	Plant operations and performance affected if expertise are not available to operate it correctly.	Unlikely	2	Moderate	3	Medium	6	Unlikely	2	Moderate	3	Medium	6
5	Disruptions to existing WWTPs during construction	Effluent quality affected; breach of consents.	Unlikely	2	Major	4	High	8	Unlikely	2	Major	4	High	8
6	Consenting difficulties	Required consent are not granted (land disposal options). Options selection process does not meet the requirements of the existing consent.	Unlikely	2	Major	4	High	8	Unlikely	2	Major	4	High	8
7	Capacity/future proofing	Option is unable to meet the long term needs of the community. Insufficient capacity for future industry. Unable to deal with changes on the compliance requirements.	Unlikely	2	Major	4	High	8	Unlikely	2	Major	4	High	8
8	Failure of equipment at the WWTPs	Failure of equipment at the WWTPs. Power loss.	Possible	3	Major	4	Extreme	12	Possible	3	Major	4	Extreme	12
9	Option unaffordable		Likely	4	Major	4	Extreme	16	Likely	4	Major	4	Extreme	16
10	Availability of suitable land	Risk that suitable land is unavailable to build WWTP upgrades (i.e. land has to be purchased), or the ground conditions of existing land are not appropriate.	Likely	4	Moderate	3	High	12	Likely	4	Moderate	3	High	12
11	Odour issues and wastewater sprays	WWTP odour issues affecting nearby residents. Wastewater spray from ponds to beyond property boundary.	Unlikely	2	Minor	2	Low	4	Rare	1	Minor	2	Low	2
12	Cyanobacteria	Risk of discharging cyanobacteria to the waterbody.	Unlikely	2	Major	4	High	8	Rare	1	Major	4	High	4
13	Other risks	Avian botulism. Steep site access.	Possible	3	Moderate	3	High	9	Rare	1	Moderate	3	Medium	3
							Total	106					Total	106

Likelihood		Consequence			
		Severe	Major	Moderate	Minor
		5	4	3	2
Almost certain	5	Extreme	Extreme	Extreme	High
Likely	4	Extreme	Extreme	High	High
Possible	3	Extreme	Extreme	High	Medium
Unlikely	2	Extreme	High	Medium	Low
Rare	1	High	High	Medium	Low