Technical Memo – ADDENDUM 2

MANGAWHAI WASTEWATER SCHEME

WWTP CAPACITY ASSESSMENT AND UPGRADE COSTS

KAIPARA DISTRICT COUNCIL

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HG PROJECT NO : 1012-135494-02
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1.0 SUMMARY OF FINDINGS

1. This report provides capital costs for wastewater treatment plant upgrade. It does not include options' evaluation or recommendations.
2. The existing plant offers sufficient capacity to cater for the current flows and loads. However, it is not designed for enhanced nutrient removal.
3. Estuary Discharge – a two-stage upgrade is proposed:

a) The hydraulic capacity of the plant is sufficient for flows and loads up to 2030 (assuming a linear demographic growth rate). However, the secondary treatment system will need to be upgraded to deliver effluent suitable for estuary discharge. The upgrade will include anoxic zone and chemical addition system to assist with enhanced nutrient removal and a sludge dewatering unit to increase total capacity. The estimated capital cost of these works is $4.4M.

b) To accommodate future flows and loads and deliver enhanced effluent quality suitable for estuary discharge, the SBR will be converted to MBR. The upgrade will broadly include installation of a package MBR plant and a new inlet screen and grit removal system. The estimated capital cost of these works is $8.4M.

4. Disposal to Golf Course or through an Outfall:

a) If the current effluent quality is acceptable and the enhanced nutrient removal is not required, then the existing SBR system does suffice albeit with minor upgrades. In future, the third SBR tank will be required to cater for the increased flows and loads. The estimated capital cost of these works is $9M.

5. It is recommended that the plant capacity assessment under current and future scenarios is conducted through BioWin. It will serve the following objectives:

a) Provide a more accurate estimate of the plant capacity,

b) Identify process pinch points,

c) Optimise plant performance, and

d) Identify operating costs.

2.0 INFLUENT FLOWS AND LOADS

Table 1 below provides a comparison of current flows and loads (Source: monthly monitoring data) with the corresponding design figures (Source: Earth Tech Design). The 2044 projections are based on the flows presented in the report "Review of Potential Effluent Disposal Options, HG" and the effluent concentration from monthly monitoring data.

TABLE 1: INFLUENT FLOWS AND LOADS

PARAMETER	UNIT	EARTH TECH DESIGN 2014(1)		CURRENT AVERAGE		2044 AVERAGE	
		OFF-PEAK	PEAK	OFF-PEAK	PEAK	OFF-PEAK	PEAK
Flow	m^3/day	600	1620	285	643	640	1450
Concentrations							
TSS	mg/L	300	-	377	574	377	574
BOD_5	mg/L	300	-	296	445	296	445

TABLE 1: INFLUENT FLOWS AND LOADS							
PARAMETER	**UNIT**	**EARTH TECH DESIGN 2014(1)**		**CURRENT AVERAGE**		**2044 AVERAGE**	
		OFF-PEAK	**PEAK**	**OFF-PEAK**	**PEAK**	**OFF-PEAK**	**PEAK**
Total P	mg/L	12	-	14	15	14	15
Total N	mg/L	50	-	81	91	81	91
NH_3-N	mg/L	-	-	71	68	71	68
NO_3-N	mg/L	-	-	1.2	0.3	1.2	0.3
COD	mg/L	-	-	749	1012	749	1012
C:N ratio		6.00		3.66	4.89	3.66	4.89
Loads							
TSS	kg/day	180	486	107	369	241	833
BOD_5	kg/day	180	486	85	286	190	645
Total P	kg/day	7	19.4	4	9	9	21
Total N	kg/day	30	81	23	58	52	132
NH_3-N	kg/day	-	-	20	43	45	98
NO_3-N	kg/day	-	-	0.3	0.2	0.7	0.4
COD	kg/day	-	-	213	650	479	1467

(1) Table 2.2 EcoCARE Mangawhai WWTP - Design Report

3.0 TARGET EFFLUENT QUALITY

The following effluent quality is targeted for the estuary discharge.

TABLE 2: REQUIRED EFFLUENT QUALITY				
PARAMETERS	**UNITS**	**EFFLUENT QUALITY FOR ESTUARY DISCHARGE**		**EARTH TECH DESIGN**
BOD_5 average	mg/L	10	Median	10
Amm-N average	mg/L	1	Median	
TN average	mg/L	7	Median	30
TP average	mg/L	2	Median	10
E-coli median	MPN/100ml	10	Median	10

4.0 CURRENT PLANT CAPACITY

Table 3 provides approximate WWTP capacity at the current flows and loads. The rated capacity of the plant is taken from Mangawhai WWTP Design Report prepared by Water Infrastructure Group.

TABLE 3: PLANT CAPACITY ASSESSMENT UNDER CURRENT FLOWS					
UNIT	**CRITERIA**	**RATED CAPACITY 2014**	**CURRENT UTILISATION**	**POTENTIAL UPSIDE**	**POTENTIAL DOWNSIDE**
Inlet works	>5x Peak season average flow	70 L/sec	53%	Ample capacity available	
SBR	Reactor HRT* including sludge layer - Off peak average	27.9 hours	56.24 hours	Typical HRT – 24 to 48 hours; ample hydraulic capacity	
	Reactor HRT* including sludge layer - Peak average	20.7 hours	52.10 hours		
	BOD_5 - Off peak average	180 kg/day	47%	Ample capacity	
	BOD_5 - Peak average	486 kg/day	59%		
	TKN - Off peak average	30 kg/day	77%		Plant would soon require an

TABLE 3: PLANT CAPACITY ASSESSMENT UNDER CURRENT FLOWS

UNIT	CRITERIA	RATED CAPACITY 2014	CURRENT UTILISATION	POTENTIAL UPSIDE	POTENTIAL DOWNSIDE
	TKN - Peak average	81 kg/day	72%		upgrade for TN removal
Pressure sand filter and UV	> 3x Peak season average flow	2x 13 L/sec	86%		Existing UV system broken down, needs replacing. Pressure filter would soon require an upgrade.
Sludge processing	Manufacture's rating	Sludge transfer pumps – 13 m³/hr	1 to 4 hour operation	Ample capacity	
		Sludge thickening (GDD) – 13 m³/hr	1 to 4 hour operation	Ample capacity	
		Belt filter press – 2.5 m³/hr	6 to 20 hour operation	Typical operation 5-8 hours	Another dewatering unit is required.

** This is not a conventional criteria for designing a SBR reactor; however it is a reasonable check for high level assessment.*

As seen above, the plant offers enough capacity for the current flows and loads. However, its biological capacity would be constrained when the flows and loads increase in future.

5.0 PLANT UPGRADE

The plant upgrade is required to serve the following scenarios:

a) Current flows and loads with enhanced effluent quality for estuary discharge

b) Future flows and loads with enhanced effluent quality for estuary discharge

c) Future flows and loads at current effluent quality (no nutrient removal) for golf course irrigation

d) Future flows and loads for disposal through an ocean outfall

5.1 DELIVER ENHANCED EFFLUENT QUALITY

This includes plant upgrade in two stages. The stage 1 upgrade will deliver improved effluent quality at the current flows and loads. In stage 2, the plant will be upgraded to accommodate future flows and loads. An MBR system has been proposed to cater for the long term growth as it provides a robust solution for delivering high quality effluent.

5.1.1 STAGE 1 UPGRADE - CURRENT FLOWS AND LOADS WITH ENHANCED EFFLUENT QUALITY

The existing plant will require following upgrades to deliver the effluent quality presented in Table 2:

1. Upgrade of anoxic zone to improve nitrogen removal.
2. Phosphorus removal through chemical precipitation.
3. Chemical addition to assist with nutrient removal. It will include tanks and dosing system for carbon, caustic and alum.
4. Additionally, by upgrading blowers, the plant can cater up to 2030. This is assuming a linear demographic growth rate. The corresponding influent flow rate is 480m³/day (off-peak average) and 1,100m³/day (peak average).
5. Replace broken UV system.

6. Sludge dewatering facility is already constrained in its capacity. Moreover, nutrient removal will add to the sludge volume. Hence, another dewatering unit is required.
7. Upgrade electrical, instrumentation, controls and other ancillary services.
8. The use of second SBR reactor, which is currently used during the peak period only, will increase with the increase in the flow.

The estimated cost for the above upgrade is presented in Table 4 below:

TABLE 4: ESTIMATED COST

ITEM	AMOUNT	REMARKS
Preliminary and general	$ 256 000	
Inlet works	-	Existing capacity sufficient
Secondary treatment	$ 447 000	Install mixers in SBR tank and upgrade blowers
Chemical addition	$ 143 000	Chemical dosing system for enhanced nutrient removal
Tertiary treatment	$ 70,000	Replace UV system
Sludge processing	$ 670 000	Add another dewatering unit
Electrical, instrumentation and control	$ 380 000	
Installation	$ 228 000	Installation cost of mechanical and electrical works
Miscellaneous	$ 15 000	Includes extension of service and potable water pipelines only
Total works cost	$ 2 212 000	
Non-works cost @18%	$ 398 000	Includes engineering, project management, site observation and contract administration costs
Total works cost including non-works cost	$ 2 610 000	
Contingency @30%	$ 664 000	Includes items which are not detailed at this stage of concept plan
Total capital cost	$ 3 274 000	Accuracy -10% to +35%
Total capital cost - range	**$2.9 to $4.4M**	

For budgeting purpose, it is recommended that the cost accuracy at higher end is considered. This equates to a capital expenditure of $4.4M.

5.1.2 STAGE 2 UPGRADE - FUTURE FLOWS AND LOADS WITH ENHANCED EFFLUENT QUALITY

This will require hydraulic and biological upgrade to accommodate the future flows and deliver the effluent quality presented in Table 2. The proposed upgrade includes the following components:

1. Convert the SBR plant into a MBR plant.
2. Replace screen with a 3mm screen and grit removal system; and add another 1mm screen suitable for a membrane plant.
3. Utilise one reactor for biological treatment and convert the second into a flow balancing tank.
4. Create a larger anoxic zone in the biological tank and upgrade mixers.
5. Upgrade blowers to cater for the additional flows and loads.
6. Install a side stream MBR plant including membranes, tanks, blowers, pumps and chemical skid.
7. With MBR plant, the pressure filters will become redundant hence decommission and remove.
8. The requirement of UV system shall be evaluated during the detailed design stage.
9. Upgrade electrical, instrumentation, controls and other ancillary services

The estimated cost for the above upgrade is presented in Table 5 below:

TABLE 5: ESTIMATED COST

ITEM	AMOUNT	REMARKS
Preliminary and general	$ 486 000	
Inlet works	$ 376 000	Replace existing screen with a package screen (3mm) and grit removal system; and a fine screen (1mm)
Secondary treatment	$ 2 035 000	Convert SBR to MBR, install package MBR plant
Chemical cleaning	$ 85 000	CIP chemical tanks and piping
Tertiary treatment	$ 62 000	Decommission pressure filters and modify piping
Sludge processing	-	Sufficient capacity following the addition of a dewatering unit
Electrical, instrumentation and control	$ 629 000	
Installation	$ 467 000	Installation cost of mechanical and electrical works
Miscellaneous	$ 50 000	Includes extension of service and potable water pipelines, access road modifications, landscaping and storm water drainage
Total works cost	$ 4 190 000	
Non-works cost @18%	$ 754 000	Includes engineering, project management, site observation and contract administration costs
Total works cost including non-works cost	$ 4 944 000	
Contingency @30%	$ 1 257 000	Includes items which are not detailed at this stage of concept plan
Total capital cost	$ 6 201 000	Accuracy -10% to +35%
Total capital cost - range	**$5.6M to $8.4M**	

For budgeting purpose, it is recommended that the cost accuracy at higher end is considered. This equates to a capital expenditure of $8.4M.

The above costs do not allow for replacement of existing equipment which may be required based on their service life. A full condition assessment and life cycle analysis of existing equipment has not been undertaken under this study.

5.2 FUTURE FLOWS AND LOADS AT CURRENT EFFLUENT QUALITY

This option provides plant upgrade to accommodate future flows and loads while continuing to deliver current effluent quality i.e. no nutrient removal. This could be achieved by addressing the process pinch points identified in Table 3. The construction of third SBR tank would be required to accommodate the increased flows and loads. The proposed upgrade includes the following components:

1. Retain existing SBR plant.
2. Replace screens with a 3mm screen and a grit removal system.
3. Construct third SBR tank.
4. Upgrade blowers to cater for the additional flows and loads.
5. Replace pressure filters with a disc filter and replace broken UV system. New equipment sized to cater for future flows.
6. Sludge dewatering facility is already constrained in its capacity. Hence, another dewatering unit is proposed.
7. Upgrade electrical, instrumentation, controls and other ancillary services.

The estimated cost for the above upgrade is presented in Table 6 below:

TABLE 6: ESTIMATED COST

ITEM	AMOUNT	REMARKS
Preliminary and general	$ 589 000	
Inlet works	$ 256 000	Replace existing screen with a package screen (3mm) and grit removal system
Secondary treatment	$ 1 543 000	Construct 3rd SBR tank
Chemical addition	-	None required
Tertiary treatment	$ 439 000	Replace UV system, replace pressure filters with a disc filter and modify piping
Sludge processing	670 000	Add a new dewatering unit
Electrical, instrumentation and control	$ 605 000	
Installation	$ 393 000	Installation cost of mechanical and electrical works
Miscellaneous	$ 50 000	Includes extension of service and potable water pipelines, access road modifications, landscaping and storm water drainage
Total works cost	$ 4 515 000	
Non-works cost @18%	$ 813 000	Includes engineering, project management, site observation and contract administration costs
Total works cost including non-works cost	$ 5 328 000	
Contingency @30%	$ 1 355 000	Includes items which are not detailed at this stage of concept plan
Total capital cost	$ 6 683 000	Accuracy -10% to +35%
Total capital cost - range	**$6M to $9M**	

For budgeting purpose, it is recommended that the cost accuracy at higher end is considered. This equates to a capital expenditure of $9M.

5.3 FUTURE FLOWS AND LOADS FOR OCEAN OUTFALL

Ocean outfall provides another option for effluent disposal. Although, it does not require a high level of treatment as required in the case of estuary discharge, it does involve high capital cost for outfall construction. For this option, the existing level of treatment will suffice. However, the third SBR tank will be required to accommodate the increased flows in future. The overall upgrade works and their costs will be similar to those in the previous option in Section 5.2.

5.4 EXCLUSIONS IN COSTS

1. It is recommended that the cost accuracy at higher end is considered for budget planning.
2. Costs do not allow for transformer upgrade or electrical connection charges to the site.
3. Costs do not allow for piling or special type of foundations or any other geotechnical ground improvements.
4. Costs do not allow for expenses towards resource consents and ecological studies.
5. Costs do not include land purchase.
6. Costs are current as of date. Note that the validity of equipment costs is limited to 2-3 months only.
7. Costs are exclusive of GST. Inflation is not considered in costs.

5.5 CHEMICAL COST

At current flows and loads, the estimated cost of chemicals for nutrient removal will be $300/day during off-peak season and $600/day during peak season.