Hihi Cost Estimate Review, Aug 2020

Purpose

Hoskin Civil have undertaken a Cost Estimate review of Budget Cost Estimates provided by WSP as Appendix J of their Hihi Options Review dated March 2020.

Our Cost Estimate review may be considered as reasonable, based on the provided engineers costing reports and in the absence of the Design, Structural and Services drawings, the Contract Documents and other Conditions. Please note this is a review of the Budget Cost Estimates previously provided to FNDC. Minor adjustments are proposed to P&G items only.

Brief Development Description

Hihi is a small coastal community located in the Far North District of New Zealand. As a popular tourist destination, the area experiences a significant increase in population during holiday periods, particularly during the Christmas and New Year's Holidays, when the Holiday Park experiences their peak occupancy.

The Hihi community currently has an existing Continuous Stirred-tank Reactor (CSTR) wastewater treatment plant located on Marchant Rd. Due to asset condition and process capacity for current loads, the plant has been identified by the Operational Team (Far North Waters) and WSP in 2018 to be underperforming and the exceedance of consented parameters can occur.

The overall capacity of the treatment plant is insufficient for both peak flow and peak load. This causes intermittently very poor effluent passing to the tertiary wetland and into the stream.

Furthermore, the Resource Consent for the current discharge is due for renewal by 2022 and new consent standards are expected for the discharge. Hoskin Civil has reviewed the options proposed previously in various reports and outlined below:

1. Option 1 - Do minimum:

   The scope of this option is to replace an aeration tank with a new tank, constructing safe working platforms, refurbishment and installation of the inlet screen. Note; the original Do minimum solution involved refurbishment of the existing main reactor only, which was discounted as an acceptable option. Therefore, the do minimum solution reviewed is the minimum scope of work required to obtain an acceptable outcome.

2. Option 2 - Conventional Activated Sludge (ASP)

   The scope of this option is to construct a like for like replacement of the existing activated sludge treatment and upgrade of the tertiary filter capacity.

3. Option 3 – Membrane Bioreactor (MBR)

This solution considers the construction of a biological process based on using membranes for the solid's separation stage.

Estimated Budgets:

The estimated construction costs of the different options studied, reviewed by Hoskin Civil, are presented on the following table (Option 2 and 3 proposed by WSP).

	Estimated Costs
Option 1 – Do Minimum	$ 2,424,659
Option 2 - Conventional Activated Sludge Plant (ASP)	$ 5,376,245
Option 3 - Membrane Bioreactor (MBR)	$ 5,970,973

Table 1 - Option 1: Hihi WWTP - Do minimum

Description	Unit	Qty	Rate	Estimated Price
Preliminary and General	LS	1	$200,000	$ 200,000
Aeration Tank	LS	1	$120,000	$ 120,000
Access Stairs and Screen Platform incl. Handrails	LS	1	$40,000	$ 40,000
Inlet Screen Installation	LS	1	$40,000	$ 40,000
Electrical Installation Works	LS	1	$35,000	$ 35,000
Commissioning and Testing	LS	1	$5,100	$ 5,100
Aeration Tank Demolition and Site Reinstatement	LS	1	$70,000	$ 70,000
Min Work on Wetland's Ponds	LS	1	$250,000	$ 250,000
Repair Work to Network	LS	1	$491,244	$ 491,244
Sub-total				**$ 1,251,344**
P&G	%	15		$ 187,702
Contractor Risk	%	3		$ 37,540
Installation and Commissioning	%	5		$ 62,567
Contractor Overheads	%	5		$ 62,567
Contract Design	%	5		$ 62,567
Sub-total project cost				**$ 1,664,288**
Contractor Profit and off-site overhead	%	11		$ 183,072
Sub-Total Contract Cost (Excluding GST)				**$ 1,847,359**
FNDC Cost 10%				$ 184,736
Consultant 10%				$ 184,736
Engineer to Contract 5%				$ 92,368
Sub-Total Contract Cost (Excluding GST)				**$ 2,309,199**
Project Uncertainty (5% On Grand total)				$ 115,460
TOTAL Estimated Cost				**$ 2,424,659**

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Table 2 - Option 2: Hihi WWTP - ASP

Description	Unit	Qty.	Rate	Estimated Price
Connection to Pre-treatment	LS	1	$21,460.00	$ 21,460
Pre-treatment	LS	1	$91,700.00	$ 91,700
Biological reactor - Civil Works	LS	1	$162,400.00	$ 162,400
Biological reactor - Equipment	LS	1	$38,160.00	$ 38,160
Aeration	LS	1	$100,840.00	$ 100,840
Services Building	LS	1	$80,000.00	$ 80,000
Pipework to Clarifier	LS	1	$17,000.00	$ 17,000
Secondary Clarifier - Civil Works	LS	1	$35,000.00	$ 35,000
Secondary Clarifier - Equipment	LS	1	$153,000.00	$ 153,000
Pipework from Clarifier to Final tank	LS	1	$2,850.00	$ 2,850
Sludge RAS + WAS - Civil works	LS	1	$2,000.00	$ 2,000
Sludge RAS + WAS - Equipment	LS	1	$81,415.00	$ 81,415
Tertiary Treatment - Civil Works	LS	1	$219,000.00	$ 219,000
Tertiary Treatment - Equipment	LS	1	$115,316.00	$ 115,316
Electrical Installation Works	LS	1	$132,760.00	$ 132,760
Control	LS	1	$65,000.00	$ 65,000
Commissioning and Testing	LS	1	$94,800.00	$ 94,800
Temporary Connection	LS	1	$1,000.00	$ 1,000
Demolitions and Site Reinstatement	LS	1	$110,000.00	$ 110,000
Temporary Site Works	LS	1	$100,000.00	$ 100,000
Wetland Earthworks	LS	1	$700,000.00	$ 700,000
Sub-total				**$ 2,323,701**
P&G	%	15		$ 348,555
Contractor Risk	%	5		$ 116,185
Installation and Commissioning	%	10		$ 232,370
Contractor Overheads	%	10		$ 232,370
Contract Design	%	5		$ 116,185
Sub-total project cost				**$ 3,369,366**
Contractor Profit and off-site overhead	%	11		$ 370,630
Sub-Total Contract Cost (Excluding GST)				**$ 3,739,997**
FNDC Cost 10%				$ 374,000
Consultant 10%				$ 374,000
Engineer to Contract 5%				$ 187,000
Sub-Total Contract Cost (Excluding GST)				**$ 4,674,996**
Project Uncertainty (15% On Grand total)				$ 701,249
TOTAL Estimated Cost				**$ 5,376,245**

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Table 3 - Option 3: Hihi WWTP - MBR

Description	Unit	Qty.	Rate	Estimated Price
Connection to Pre-treatment	LS	1	$21,460.00	$ 21,460
Pre-treatment	LS	1	$91,700.00	$ 91,700
Biological reactor - Civil Works	LS	1	$150,400.00	$ 150,400
Biological reactor - Equipment	LS	1	$483,660.00	$ 483,660
Aeration	LS	1	$97,940.00	$ 97,940
Services Building	LS	1	$138,000.00	$ 138,000
Sludge RAS + WAS - Civil works	LS	1	$2,000.00	$ 2,000
Sludge RAS + WAS - Equipment	LS	1	$49,165.00	$ 49,165
Tertiary Treatment	LS	1	$19,000.00	$ 19,000
Electrical Installation Work	LS	1	$170,600.00	$ 170,600
Control	LS	1	$70,000.00	$ 70,000
Commissioning and Testing	LS	1	$94,800.00	$ 94,800
Temporary Connections	LS	1	$1,000.00	$ 1,000
Demolitions and Site Reinstatements	LS	1	$130,000.00	$ 130,000
Temporary Site Works	LS	1	$140,000.00	$ 140,000
Emergency generator	LS	1	$200,000.00	$ 200,000
Sub-total				**$ 1,859,725**
P&G	%	15		$ 278,959
Contractor Risk	%	8		$ 148,778
Installation and Commissioning	%	30		$ 557,918
Contractor Overheads	%	20		$ 371,945
Contract Design	%	5		$ 92,986
Sub-total project cost				**$ 3,310,311**
Contractor Profit and off-site overhead	%	11		$ 364,134
Sub-Total Contract Cost (Excluding GST)				**$ 3,674,445**
FNDC Cost 10%				$ 367,444
Consultant 10%				$ 367,444
Engineer to Contract 5%				$ 183,722
Sub-Total Contract Cost (Excluding GST)				**$ 4,593,056**
Project Uncertainty (30% On Grand total)				$ 1,377,917
TOTAL Estimated Cost				**$ 5,970,973**

Options overview:

Option 1: Do minimum

WSP was commissioned by Far North District Council (FNDC) to carry out a condition assessment of the plant to confirm the previously observed issues around flow capacity. Their Structural Report, dated 22 November 2019, concluded that the internal dividing wall of the aeration tank has already experienced partial failure. It will fail completely as further deterioration occurs over time, or during a significant seismic event. All the other elements of the tank are in poor condition; if not repaired all cracking and spalling of concrete will propagate to the point where egress of stored water becomes unacceptable.

Option 1 proposes replacement of the aeration tank including repair and modifications to the plant to accommodate a working Inlet screen (refurbished from the Whatuwhiwhi WWPT). Power supply will be required for the inlet screen, the electrically actuated sludge discharge valve and the new sludge return pump. Additionally, thorough investigation will be required for replacing or repairing other components.

The wetland requires maintenance; land slips are known at the wetland site and there is evidence of further recent movement in the bank. Hoskin Civil propose to include earthworks to reshape wetland ponds, repair faulty drainage and minor works to support an eroded bank.

Furthermore, the CCTV network report dated 2011 produced by Project Max identified the AC networks as “Leaky”; the overall condition of the network is deteriorated, attracting 46.5% Structural Grades scoring 4.1 or greater (max score is 5.6). CCTV inspections also identified several defects in the manholes, such as; leaking benching, root intrusions through the lid and around the pipe connections. Hoskin Civil propose to include the repair cost to the network to Option 1.

Option 2: Conventional Activated Sludge.

The conventional activated sludge system is a treatment process that is familiar to the site operations team.

Hoskin Civil propose to include the nominal figure of $700K for wetland remediation and bank stabilization (WSP Report 11 March 2020).

Option 3: MBR.

Multiple reports previously provided by WSP to FNDC recommended MBR system, due to several advantages over activated sludge system.

Hoskin Civil conducted an investigation to support our business case; MBR systems are not familiar to FNDC and due to Hihi's remoteness and population size, we have outlined important aspects to consider.

It is not easy to make a general economical comparison between MBR and Activated Sludge systems. First of all, MBR is a modular system, that is easily expandable, which is often mentioned as an advantage of the system. However, this makes the system less economically competitive with conventional systems. It should be noted that the equipment and energy costs of an MBR are higher than systems used in conventional treatment. Furthermore, the efficiency of the filtration process in an MBR is governed by the activated sludge filterability, which is still not well understood and is determined by the interactions between the biomass, the wastewater and the applied process conditions.

MBR plants are operating all around the world and gaining in popularity, due to high-quality product water. It is important to note that MBR is still under development, and that the costs for MBR differ significantly depending upon the adopted technology and the site conditions.

There are two main different membrane systems; the hollow fibre membranes and plate membranes (also called "flat sheet" membranes) currently used in New Zealand.

Membrane fouling and energy consumption are important challenges that need to be managed through employing best operational practices, which could be a significant challenge for a remote WWTP plant like Hihi.

In New Zealand, a 2004 study by New Plymouth District Council found that wastewater related assets were the major consumer of energy for assets owned by the Council (Macdonald, French, & Caroline, 2008).

The aeration energy is used to both provide oxygen for biological nutrient removal, and scouring of membranes to control fouling. The total annual power costs could be substantial, adding to the operational cost and the need for an emergency generator. MBR systems often require cycling modulating valves or additional equipment to reduce the amount of bubbly flow supplied to the membrane modules, while still maintaining a certain scouring efficiency. This equipment can require increased maintenance and care over and above the accumulation device, which has no moving parts. Those systems rely on cycling air and require complex control systems to monitor plant operation to determine periods when air flow can be adjusted.

It was challenging to find accurate and relevant literature of actual operational experiences with MBR plants. Membrane fouling is the most serious problem which occurs in MBR. As an example, the first

three flat sheet membrane MBRs were installed in New Zealand at Tirau, Turangi and Te Aroha. All three of the subject MBR plants experienced varying degrees of sludge caking between the individual membrane panels and lint build-up around the membrane module housings and associated accessories. Because of the diverse range of operating conditions and the limited information reported on the suspended biomass composition, it is difficult to establish any generic behavior affecting membrane fouling. Once membrane fouling occurs, it will reduce permeate flux, increase feed pressure, reduce productivity, increase system downtime, increase membrane maintenance and operation costs due to membrane cleaning, and decrease the lifespan of the membrane modules. Thus, the MBR process requires the plant operators (who are permanently stationed at the facility, or conduct patrols on a regular basis) to have a high level of skill to ensure optimal operation and early detection of degradation in membrane performance.

Fouling affects both capital (CAPEX) and operational (OPEX) expenditures. The CAPEX is influenced by installation of required equipment for fouling prevention or mitigation. The OPEX are influenced by energy cost due to power required for aeration, pumping and mixing, chemical cleanings of the membrane and waste sludge treatment. The energy requirements account for the majority of the operational and maintenance costs (O&M). The periodical physical cleanings are not an energy intensive processes, but they still increase the total O&M costs. The chemical cleanings carried out to recover membrane performance and utilized cleaning agents also add to the total costs and environmental impact. Also, the addition of any sort of filtration enhancing additives increases the operational costs. Finally, during membrane cleanings, filtration is not performed. Subsequently, permeate production is reduced. Thus, specific costs increase, leading to a less cost-efficient process.

The full clean and inspection for the MBR plant was estimated to take up to 6-10 weeks with cost of up to $150K. New sheets would cost between NZ180K – NZ230K each. The proposed life span of the membranes is between 5-10 years, but no real data was provided to support those claims.

As part of the business case study Hoskin Civil also obtained three different quotations for implementing different MBR membrane systems that are suitable for Hihi WWTP and have not been mentioned before.

These are as follows:

1. Guaranteed Flow Systems (GFS) propose 2 options (Formerly Canadian Pacific Ltd).

GFS Option A

Treat the 70 m^3/day of waste from the regular community using an Effbuster 70 membrane bioreactor [MBR], with the expectation that the Beach Resort will manage the treatment of the peak flows generated from that area over the 10-day holiday period.

GFS Option B

Utilize the existing tank infrastructure, in conjunction with two new trains of membranes and controls, to treat a peak flow of 280 m3/day. Use one membrane train in low flow periods (using duty-standby to keep both trains fully functioning) and two trains during peak flow periods. During construction work the existing plant will need to be out of service. Allowance has been made in the estimate for rental of an Effbuster 70 MBR to treat the community waste for the duration of the construction period. A provisional sum has been included in the estimate for inspection and assessment of the existing tanks.

	Estimated Costs
GFS Option A – 70m³ / day	$750,000
Effbuster 70 MBR Unit Containerised MBR 12mL x 2.4mW – installed and commissioned	
GFS Option B – 280 m³ / day	$1,210,000
Existing tanks re-purposed as Anoxic, Aerobic and Anaerobic tanks Containerised MBR tank and control unit 6mL x 2.4mW Temporary treatment plant (Effbuster 70) in place for 5 months during construction	
Note	
Preliminary site investigation and design would be required to advance either option to confirm final price. If GFS is engaged to undertake this preliminary work, these costs would be taken from the sums allowed in the budget estimates.	

2. FILTEC proposed propose 2 options:

SUEZ's E-Series Membrane Bioreactor (MBR) ZeeWeed 500 hollow fiber membranes, 2 options:	**Estimated Costs**
2 x E-30K	$2,000,000
1 x E-75K	$1,350,000
Note	
Budget price for equipment only for the two options, including tanks and membranes, containerised process skid but excluding design/PM/civils/electrical supply. No other data was provided.	

3. Apex Environmental Ltd proposed:

SINAP flat sheet membranes. A budget price to design and construct an MBR designed to handle peak wastewater volumes of 275m^3 /day would be approximately $1.27M plus GST, ±20%. This budget includes an allowance for removal of existing equipment, turnkey supply of the process described above, design, project management, commissioning and training.

Conclusions:

This report includes a QS review of the WSP condition assessments, feasibility and options reports, Far North Waters operational and maintenance records and the assessment of whole of life and rate impacts.

The underlying issues at Hihi around population and treatment plant capacity were provided in the WSP report dated 9 March 2020. These findings summarised the following:

- The resident population given in the 2013 census is 170 people, data from flow and incoming wastewater shows that peak population is over 500 people.
- Off season, 2 persons will occupy a property but at peak holiday periods, population will increase to 4-8 people per property. This gives an estimated doubling of population from residential dwellings.
- Additionally, the campground operates seasonally and is connected to the wastewater system, population data from the campground confirms a dramatic rise in numbers over the peak period.

Based on this information, and current budgets and rate impacts, we propose installing an independent septic system for Hihi Holiday Park, designed to deal with seasonal fluctuations. FNDC can gift this asset to Holiday Park owner(s), eliminating the need to care for an additional asset. The repair or replacement works to aeration tank (Option 1) could be conducted, as recommended by the engineers and construction of a new plant (Activated Sludge system or MBR) may not be required. The pipe network connecting the holiday park to the plant could be decommissioned and abandoned with no need to further repairs or maintenance. The quotes for this option have not been obtained, but are estimated to be as high as $350k-$400K (for independent holiday park septic system only).