Raglan Optioneering

Prepared for Waikato District Council
Prepared by Beca Limited

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Contents

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1 Introduction

The Raglan Wastewater Treatment Plant (WWTP), under jurisdiction of the Waikato District Council (WDC) discharges treated wastewater to the Whaingaroa harbour. The discharge consent expires in February 2020 and a new application is currently being prepared. The purpose of this report is to identify a long list of options that are potentially available for improved wastewater treatment or alternative discharge locations/environments. Any treatment or disposal option selected would be required to service expected population growth for the long term.

The treatment and disposal options are outlined. A combination of treatment and disposal may be required to minimise environmental effects and satisfy cultural and community aspirations. The generally accepted treatment required for each disposal environment is also indicated.

2 Background

2.1 Description of Raglan WWTP

Raglan is a small community west of Hamilton, home to a usually resident population of 4,000 that increases for short periods in the summer. The Raglan wastewater reticulation system is a conventional gravity system with 17 pump stations as shown in Figure 1. The small Whaanga Coast community has a low pressure wastewater system, using E1 pumps manufactured by Ecoflow, which connects to the Raglan wastewater system at the WWTP.

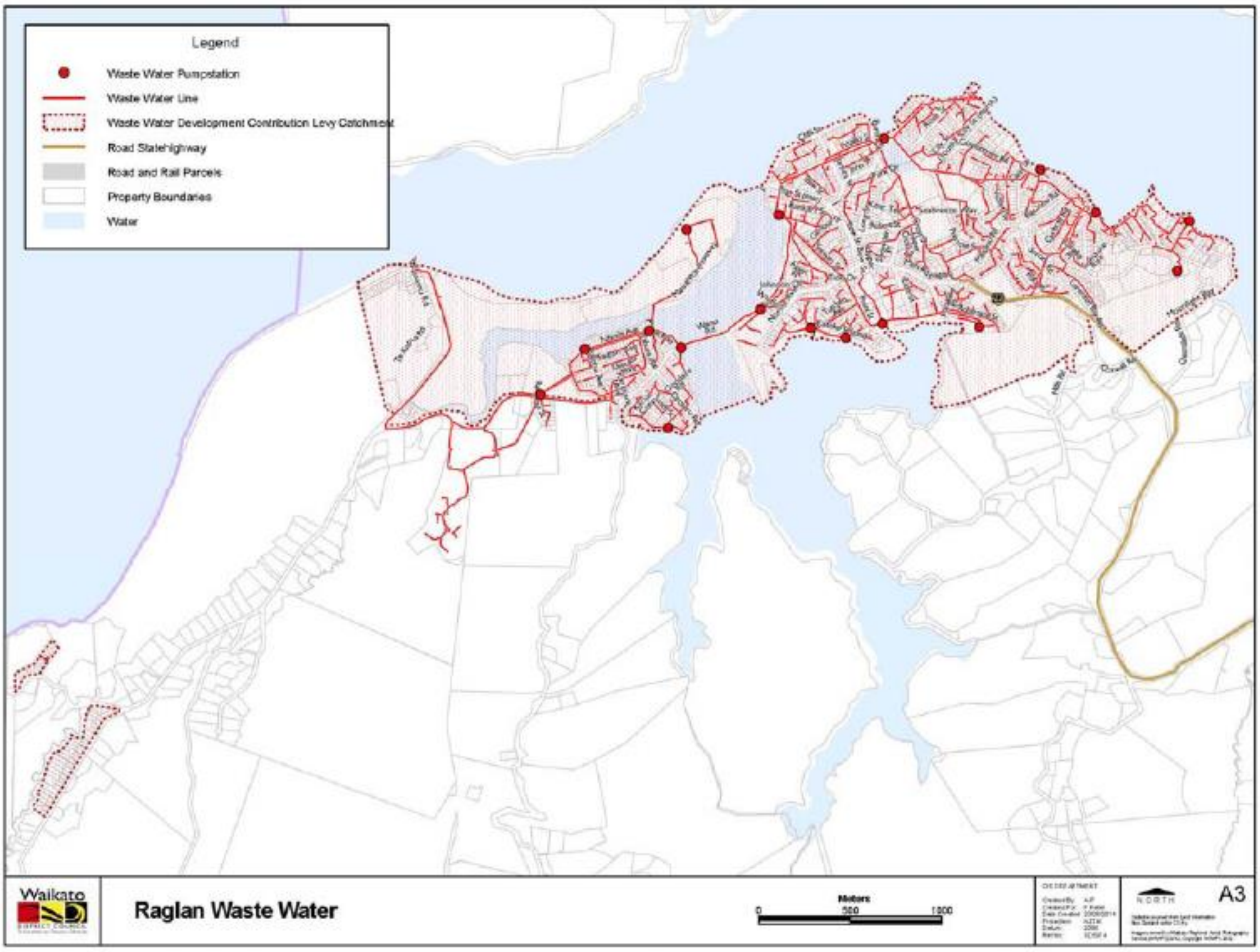

Figure 1: Raglan Wastewater System Schematic

Wastewater is treated at the WWTP, located to the south-west of the Raglan community on Wainui Road. Wastewater is received at the inlet works, from where wastewater is piped to aerated ponds A and D, and then to ponds B and C. Ponds A, B, C and D have aquamats, which are vertical curtains to provide extra surface area for biofilm. Diffused air is introduced through small diameter air lines at the base of the curtains. The pond wastewater currently discharges into a day pond for storage prior to discharge on the outgoing tide. If the holding capacity of the day pond is exceeded, flow is transferred to the storage pond. From the day pond treated wastewater is pumped via an inline UV disinfection system to a discharge point near the mouth of the Whaingaroa (Raglan) Harbour. Two anaerobic ponds currently exist on site prior to the aerated ponds, however, these are currently unused due to odour concerns. The existing process at Raglan WWTP is shown in **Error! Reference source not found.**.

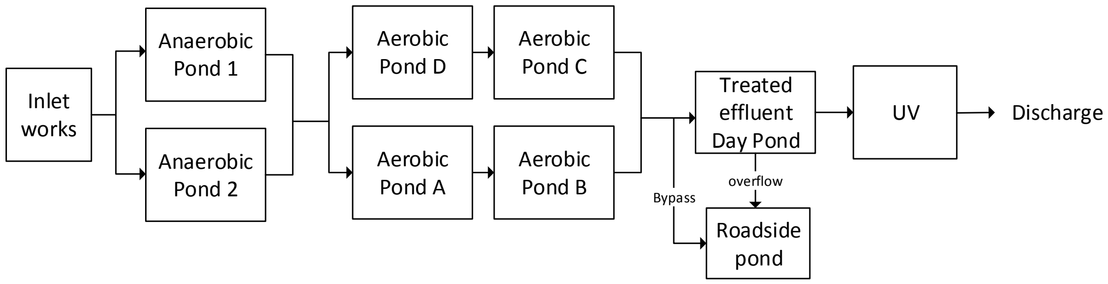

Figure 2: Raglan WWTP Existing Process Schematic

2.2 Resource Consent

The current discharge consent allows discharge of up to 2,600m³ of treated wastewater per day to Whaingaroa Harbour. This consent expires on 14 February 2020. Discharge is only permitted for a maximum of 5.5 hours per outgoing tide, commencing no earlier than 0.5 hours before high tide and ceasing no later than 1 hour before low tide. Discharge duration may exceed this after extreme weather but not for more than 20 days per year.

Compliance with treated wastewater quality consent conditions has not been achieved over recent years, generally due to total suspended solids (TSS) concentrations in the treated wastewater. To minimise excessive algal growth in the storage pond prior to the harbour discharge, WDC installed the 'day pond' in 2015. The day pond has generally improved the levels of TSS in the treated wastewater, however, the discharge is not consistently compliant with the median annual level of TSS required by the current consent conditions.

2.3 Wastewater Disposal In New Zealand

Treated wastewater may be disposed of through direct point discharge to a water body such as a river, lake or wetland (surface water), or to an estuary, harbour or the sea (ocean discharge). A high treated wastewater quality is generally required. Alternatively, the treated wastewater may be returned to land by various methods, where the treated wastewater quality requirements are generally not as high as for water-based disposal pathways.

The other waste produced from a treatment plant is the processed sludge (biosolids). This may be disposed to landfill, spread onto land, composted, pelletised or treated for use a soil conditioner.

Options for returning the treated wastewater to the ecosystem within the site boundaries (often referred to as on-site disposal) depend very much on the site's characteristics such as soil types, area and slope of land available, location of groundwater, and the local climate. Options include seepage into the soil subsurface, irrigation (surface or sub-surface) and evapo-transpiration.

Land application of treated wastewater effluent (either all flows or during dry weather), including to wetlands, has been implemented at several WWTP's in New Zealand (e.g. Taupo, Mangawhai, Paihia, Whangamata, Te Paerahi, Ashburton, Tekapo, Twizel and Queenstown). These disposal methods range from fully productive beneficial reuse irrigation, through to wetlands and rapid infiltration to sub-surface strata. Whilst land application is often preferred, geotechnical, soil, hydrogeological, land ownership and economic considerations are all key factors which inform the assessment of disposal pathways.

3 Treatment Options

3.1 Pond Enhancements

TSS is a typical issue for pond-based systems given the algal growth encouraged by the surface area (exposure to light) and nutrient availability of ponds. The existing ponds could be enhanced by either upgrading the current AquaMats® treatment or considering a similar process targeting a higher treatment level, particularly for TSS, BOD and ammonia.

AquaMats® are a high surface area media designed to maximize colonization by beneficial bacterial and algal communities that inhabit the wastewater environment. In contrast to floating or fixed plastic growth media, AquaMats® are designed to promote an optimal environment for bacteria and higher organisms. Ammonia removal performance of this system has been variable at North Island pond sites, which illustrates the inherent difficulty in predicting the performance of such systems – refer to Ratsey (2016). TSS removal at the Raglan WWTP does not consistently meet the current consent requirements.

Bio-Shells, as produced by Wastewater Compliance Systems Inc., Utah, USA, which are a series of nested shells placed in a pond to provide additional biofilm surface area. Compressed diffused air is introduced at the base to allow nitrification to proceed. This process has been proven to operate at very low winter temperatures in the mid-west USA, but is not proven in New Zealand.

Hanging curtains, as supplied by Waterclean as part of their Floating Treatment Media (FTM) systems. The vertical curtains provide biofilm attachment and are spaced 300mm apart with flow between the curtains generated by surface aerators which also provide extra oxygen.

3.2 Activated Sludge

Converting one or more of the current ponds to an activated sludge process will target the TSS, BOD and ammoniacal nitrogen parameters. A new clarifier would need to be installed. Activated sludge will be a more complex solution in terms of operation, with the operating expenditure increasing significantly.

A membrane bioreactor is an activated sludge process which uses membranes instead of a clarifier to separate solids from the treatment wastewater.

3.3 SBR as Replacement

Sequencing Batch Reactors (SBR), as opposed to a conventional activated sludge system has aeration and sedimentation of the biomass occurring in the same tank in a timed sequence. This allows SBR systems to be designed with a high degree of flexibility in terms of treating varying flows and concentrations (typically experienced in Industrial applications).

An SBR is a cost-effective solution for secondary treatment of wastewater as it allows for the treatment of variable flows, requires minimum operator intervention, allows anoxic or anaerobic conditions to occur in the same tank, has a reasonably small footprint and very good solids removal efficiency.

SBR's are very few in New Zealand's wastewater networks, with most instances occurring industrially. Disadvantages of SBR's include being electrically complicated, with short circuiting known to occur in wet weather.

3.4 Fixed Film Processes

Utilising the same bacteria as activated sludge, a fixed film process (e.g. submerged aerated filter, trickling filter) uses biological material (biofilm) attached to media in a tank to treat the wastewater. A clarification step is also required to separate the solids that slough off the media. Fixed film processes could be used in place of the existing plant, in parallel or as tertiary treatment, and will target BOD and ammoniacal nitrogen parameters.

3.5 Tertiary Treatment

Membrane systems – the wastewater flows through membrane modules (micro filtration) which allow only the smaller particles to pass through. Membranes have the added benefit of also removing some pathogens.

Lamella clarifier – acts as a high rate settlement process i.e. small footprint compared to a conventional settlement tank. Inclined media is submerged in a tank, with flows passing upwards through the media. The media attracts the solids particles by providing a large surface area, and this is either washed off during maintenance, or the sludge slides down the plates to a hopper where it is removed during a desludge cycle.

DAF – polymer is added to the treated effluent, and fine bubble diffusion is used to collect flocculated solids while travelling upwards through the tank. The floating sludge blanket consolidates the sludge and it is skimmed off.

Actiflo – the Actiflo process uses sand ballasted flocculation to remove TSS from the wastewater, generally after pond systems and results in a clear looking treated wastewater which is simple to disinfect via UV disinfection. Chemicals are required including alum and poly. WDC's experience with the Actiflo system at Ngaruawahia WWTP is that the operational labour and chemical/sand replacement costs are extensive.

3.6 Tertiary Wetlands

Constructed habitat wetlands attempt to mimic natural wetlands by directing water to flow through flooded beds of emergent aquatic plants. Like natural wetlands they can store, assimilate, and transform contaminants before they reach waterways. They are usually shallow to prevent drowning the aquatic plants, with a typical water depth of 0.3m. In some applications, the inlet of a constructed wetland also contains a deeper section or forebay where there is an absence of aquatic plants before the water flows on to shallower sections. The forebay buffers the flows and protects the wetlands should upstream treatment processes not perform as expected. Wetlands are typically constructed with a high-density polyethylene (HDPE) or compacted clay lining to prevent excessive leakage to groundwater.

Primarily, tertiary wetlands are used to regulate flow as the target parameter. They are typically considered aesthetically pleasing, can be considered culturally acceptable and provide habitat for wildlife. Disadvantages to this option is that new contaminants can be introduced by birds and decomposition of plants. Retention times for tertiary wetlands are typically 1-3 days.

3.7 Chemical Phosphorous Precipitation

Phosphorus can be removed from wastewater by incorporation into solid chemical precipitates which can be subsequently removed by a solids separation process (e.g. clarification).

The three major chemicals used for phosphorus removal are: Aluminium salts (primarily alum), Iron salts (primarily ferric chloride) and hydrated lime (calcium hydroxide).

All three chemicals have the potential to meet the final effluent phosphorus requirements. Capital costs for an alum or ferric tertiary removal system are expected to be similar. However, a bulk lime silo and make-up system is likely to be more expensive than bulk alum/ferric PE tanks. Alum is significantly cheaper than Ferric Chloride in terms of operating costs in NZ. Lime reacts with the alkalinity in the water which means the dose rate is independent of the amount of phosphorus to be removed.

The dose rate of lime is therefore uncertain (and hence cost is uncertain) without jar testing, there is potential to be cost competitive with alum. Alum has no significant material handling issues; however ferric chloride is highly corrosive and lime slurry can be difficult to handle. If lime is used, re-acidification may be required post-phosphorus removal to lower the pH in the effluent to <9.

3.8 Split catchment and build new WWTP

The wastewater network could be divided in two, with the networks being split at the Wainui Road bridge. A new WWTP could be built on the eastern side of the bridge to take the flows from that side of Raglan, and the western network would be treated at the existing treatment plant. Disposal options would still need to be considered for both WWTPs.

4 Disposal Options

4.1 Existing Discharge into the Harbour

Presently, the Raglan WWTP discharges its treated wastewater into the harbour on outgoing tides. This discharge is consented for up to 2,600m³ of treated wastewater per day to Whaingaroa Harbour at a location close to the harbour mouth.

This disposal pathway is the easiest to proceed with, as nothing will need further development due to the use of existing infrastructure. With the projected future flows to 2048, it will likely not have its current 2600m³/day discharge consent breached either. However, a direct harbour discharge (from the WWTP) has cultural implications as it does not align with Maori or community values, for instance it may have an adverse impact on the local shellfish beds and fish which are culturally significant.

The current discharge has levels of TSS which do not comply with the current discharge limit. Additional treatment targeting TSS removal would be required if this limit was to continue.

4.2 Optimise Existing Outfall into the Harbour

Optimising the existing harbour outfall includes options such as lengthening the outfall such that it is further away from the harbour edge, burying the outfall or using a diffuser. Optimising the outfall would lead to improved mixing.

4.3 New Ocean Outfall

A coastal discharge is one of the disposal options. This would require the construction of an overland pipeline and ocean outfall structure. The distance is approximately 1.3km (as the crow flies). It would be slightly longer by the time geographical obstacles (barbour and hill ranges) are considered. The Raglan coast is a very high energy environment and is likely to be very costly to engineer an outfall that has an adequate lifespan. Coastal discharge may not be supported by iwi / TMOTW. The nearest appropriate and accessible location is likely to be off the shore approximately 1km to the west of Ngarunui beach, with an outfall length of approximately 1km. The pumping distance is approximately 2.5km. This is technically challenging and expensive.

The Raglan coast is a very popular surfing area, so this option would likely not be favoured by the community – it would however remove the flow from the harbour and is not likely to require any additional treatment.

4.4 Land Based Slow Rate Irrigation

Slow-rate irrigation is a land-treatment and disposal system that involves total effluent absorption via soakage and evapo-transpiration through planted crop or vegetation ground cover. Large land areas are required due to application rates being only a few centimetres per week. The higher the level of pre-treatment (secondary treatment being a minimum), the more effective the long-term performance of the irrigated area in coping with the treated wastewater load (Ministry for the Environment, 2019).

Land based disposal would significantly remove treated wastewater flows out into the harbour. Two possible slow-rate irrigation options include year-round irrigation or part-year irrigation with discharge to the harbour when conditions are not suitable for irrigation.

Slow-rate irrigation year-round requires a deficit irrigation scheme with additional storage within 10km of the treatment plant. This disposal method is generally culturally and community acceptable (due to discharge to land as opposed to water) and has potential for beneficial reuse. Disadvantages include large storage required, a lack of suitable soil and terrain, potential harbour runoff and the establishment timescales.

Slow-rate irrigation part-year assumes treated wastewater is only irrigated when soil conditions are suitable (i.e. when there is a soil moisture deficit) and at other times the treated wastewater discharges to the harbour at the current discharge location. Less land area and storage volume is required compared to the year-round option. It may not be as culturally acceptable. Disadvantages include its continuation of flow to harbour in the off-period, and the establishment timescales.

The key issue for land based disposal will the availability of land for a scheme and whether WDC can secure the land in the long-term.

4.5 Rapid Infiltration

Rapid infiltration as a disposal option includes the use of shallow beds to allow the wastewater to soak into the ground. Most of these systems are adjacent to waterways and the treated wastewater eventually discharges to these waterways via shallow groundwater. It is generally considered a culturally and community accepted disposal option. Potential location options for this include the nearby airfield – however any location choice would need to consider the environmental effects. A negative aspect of this option is that the wastewater may need additional nutrient and pathogen removal prior to discharge due to a lack of flushing in the harbour.

4.6 Reuse

Reuse of treated wastewater for activities such as a plant nursery or golf course irrigation could be considered as a sub-option but are unlikely to take significant volumes or provide year round takes. Improved treatment such as the addition of a tertiary membrane plant would be required to avoid public health impacts. Reuse treats effluent as a resource, reducing the volume to be discharged elsewhere. Generally wastewater would not be suitable for stock or human potable uses.

4.7 Deep Bore Reinjection

Deep bore reinjection is a method not commonly understood in NZ. It is advantageous in its year-round disposal capacity and minimal footprint, however it requires an ultrafiltration type pre-treatment prior to discharge and the drilling of very deep wells to find a suitable aquifer to discharge to.

4.8 Stream Discharge

Treated wastewater would be discharged to a local stream where it would mix and then flow to the harbour. Habitat-enhancing planting and restoration techniques such as bank rehabilitation, riparian planting for shade and temperature buffering, and re-introduction of key aquatic species could be employed to rejuvenate the stream.

The project would provide community participation and educational opportunities.

5 Summary

5.1 Treatment Options

Description	Target parameter	Advantages	Disadvantages	Example sites
Aquamats or alternative	TSS, BOD, Amm	Potential re-utilisation of ponds	Limited technologies available for pond-based upgrades TSS/Algae still an issue	Te Kauwhata
Convert pond to activated sludge (AS) with new clarifier or install new MBR type AS system	TSS, BOD, Amm	Treats all parameters except pathogens Reliable performance	High CAPEX and OPEX More complex to operate Sludge to dispose of	Rotoma
SBR (as replacement for pond system)	TSS, BOD, Amm	Can be fully automated Treats all parameters except pathogens	Complex control High CAPEX costs	Russell Kerikeri
Fixed film process (parallel or tertiary)	TSS, BOD, Amm	Treats all parameters except pathogens Reliable performance	High CAPEX and OPEX More complex to operate Sludge to dispose of	Gisborne Napier
Tertiary membrane	TSS, pathogens	Utilising existing WWTP Small footprint Pathogen removal Colour removal	Moderate CAPEX and OPEX Low nutrient removal Membrane cleaning required (chemicals)	Maungatoroto, Matamata, Dannevirke, Motueka, Taihape, Kaitangata, Heriot
Solids removal via Lamella clarifier, Actiflo or DAF	TSS	Utilising existing WWTP Small footprint	Low nitrogen removal Variable performance on pond algal solids in NZ	Ngaruawahia Waipawa, Waipukurau, Taihape, Waihi
Tertiary wetlands	soluble BOD (solids, nutrients and pathogens can increase)	Aesthetically pleasing. Potentially culturally acceptable Provides wildlife habitat	Where would the compliance point be? Can introduce other contaminants e.g. bird poo History of lack of maintenance in WDC	Huntly, Otorohanga
Chemical P precipitation	P	Can load-strip if used on raw sewage Simple chemical reaction	P removal only Have to find a disposal route for sludge Sludge accumulation in process	Dannevirke, Te Kauwhata Waipawa, Waipukurau

5.2 Disposal Options

Description	Detail	Advantages	Disadvantages	Indicative treated wastewater quality required
Existing discharge into the Harbour mouth		Existing infrastructure Consented structure Proximity to WWTP	Visual impact Impact on shellfish beds? Cultural aspect/value Amenity value Vulnerability to debris flow	Improved solids and pathogen removal
Optimise existing outfall into the Harbour	Lengthen, bury, provide diffuser	Proximity to WWTP Existing infrastructure Improved mixing	Impact on shellfish beds? Cultural aspect/value Amenity value Potential navigation hazard	May require Improved solids and pathogen removal depending on mixing improvements
Land based – slow rate irrigation year-round	Deficit irrigation scheme with storage Within 10km WWTP	Generally acceptable culturally/community	High CAPEX and OPEX Large storage required Need to secure suitable soil and terrain Potential runoff to harbour Establishment timescales	No additional treatment
Land based – slow rate irrigation part year – discharge other flows to harbour	Discharge to land only when soil conditions suitable, very limited storage.	Less land required vs year round	High CAPEX and OPEX Need to secure suitable soil and terrain Potential runoff to harbour Retains some flow to harbour Establishment timescales	No further treatment for land disposal, harbour discharge may require improved solids and pathogen removal

Description	Detail	Advantages	Disadvantages	Indicative treated wastewater quality required
Ocean outfall	Pump treated wastewater to new coastal discharge outfall – potential locations to be confirmed	Flows taken out of harbour reduce potential impacts on shellfish and recreational users	High CAPEX High surfer use in Raglan beaches Very difficult coastal conditions (engineering aspects) Difficult terrain on route	No additional treatment
Rapid infiltration beds	Potential sites to be investigated May need additional nutrient/pathogen removal (lack of flushing in harbour)	Generally acceptable culturally/community	Difficulty locating suitable strata Proximity to shellfish and recreation areas	Additional nutrient/pathogen removal
Re-use	E.g. plant nursery irrigation or golf course	Treated wastewater is a resource Reduces volumes to be discharged elsewhere	Not year-round or full flows Potential public health risks	Additional treatment for solids and pathogens
Deep bore reinjection		Year-round disposal Minimal footprint	High CAPEX and OPEX Assessing potential impact difficult Not commonly understood in NZ	Would require ultrafiltration-type treatment similar to that needed to produce potable water
Stream discharge	Discharge to harbour via local stream	Opportunity to restore stream	May have to pump to stream Proximity to shellfish and recreational areas	Additional solids, nutrient and pathogen removal