MOTT MACDONALD

Pōrangahau & Te Paerahi WWTP

Wastewater Treatment Strategy and Technology Selection - Review

Project:	Pōrangahau & Te Paerahi WWTP		
Our reference:	343853BA17	**Your reference:**	Pōrangahau & Te Paerahi WWTP
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Subject:	Pōrangahau & Te Paerahi Wastewater Treatment Strategy and Technology Selection & Wastewater Consent Conditions		

1 Introduction

Central Hawke's Bay District Council (CHBDC) operates the wastewater treatment plants (WWTP) for the Pōrangahau and Te Paerahi communities. The Pōrangahau WWTP currently provides treatment (pond treatment system) and then discharges wastewater directly to the Pōrangahau River. The Te Paerahi WWTP provides treatment (pond treatment system) and then discharges wastewater to adjacent sand dunes via soakage. The resource consents for these discharges expired on 31 May 2021 and the applicant is exercising S124 (RMA) rights to continue the current discharges while they transition to a new year-round irrigation system and consent to operate a new combined scheme for both townships. The consent period being sought is 35 years, and the specific consents include:

- Discharge of contaminants into air: discharge of aerosols and odour to air associated with the receipt, treatment, storage and discharge of wastewater from the new combined scheme WWTP and wastewater storage pond and existing Pōrangahau and Te Paerahi Wastewater Treatment Plants.
- Discharge of contaminants onto or into land: discharge of treated wastewater from the Te Paerahi WWTP to the existing land disposal area, discharge of treated wastewater from the Pōrangahau and Te Paerahi WWTPs at the proposed irrigation site and discharge of treated wastewater from the proposed new combined scheme WWTP which includes UV disinfection, but the exact wastewater treatment process has yet to be selected.
- Discharge of contaminants into water: discharge of treated wastewater from the Pōrangahau WWTP into the Pōrangahau River.

Mott MacDonald have previously reviewed (refer to the 1 October 2021 & 7 March 2022 memos) the wastewater treatment and best practicable option (BPO) matters contained within the consent application and assessment of environmental (AEE) and Section 92 (RMA) responses. This memo is a review of the *Pōrangahau and Te Paerahi WWTPs Redevelopment Options* (Beca, 24 August 2022) report with regard to the RMA definition of the BPO:

best practicable option, in relation to a discharge of a contaminant or an emission of noise, means the best method for preventing or minimising the adverse effects on the environment having regard, among other things, to -

(a) the nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects; and

(b) the financial implications, and the effects on the environment, of that option when compared with other options; and

(c) the current state of technical knowledge and the likelihood that the option can be successfully applied.

This review also considers the proposed WWTP treatment process (refer to high level diagram below) and potential to meet the applicant's proposed consent conditions (V5, 26 August 2022) for Stage 3 for the ultimate combined discharge to land (Table 4 consent conditions) and provides recommendations on WWTP effluent concentration consent conditions.

2 Review Comments

2.1 Beca Options Report (24 August 2022) & WWTP Schematic (11 July 2022)

The Beca Options Report (24 August 2022) outlined the WWTP options considered as part of the multi criteria analysis (MCA), to inform the BPO selection. The report recommends a 2-stage biological trickling filter (BTF) over pond-based treatment, rotating biological contactor, and fixed growth package plant. It is worth noting that aside from ponds, which were never expected to be acceptable, only fixed growth solutions were considered.

The BTF was noted by Beca to have the following benefits for this scheme:

- The BTF system is compact, it uses simple technology at a level appropriate for the treatment task at hand and is a low energy, low input technology.
- Easily augmented with additional BTF process units should additional capacity be required at some time in the future
- Easily augmented with additional unit processes should increase Levels of Service be required in the future. For example, it is quite common for a small, activated sludge (AS) plant to be added to the end (known as Trickling Filter / Solids Contact – TFSC) to improve nitrogen and or phosphorus removal performance or add BOD removal capacity.

It is arguable whether a BTF is compact when compared to the other fixed film options (RBCs and fixed growth package plant). However, it is certainly simple technology. It is also worth noting that any of the options considered can be augmented for additional capacity or level of service.

The report makes one other concluding remark relating to Pond based treatment systems, as follows:

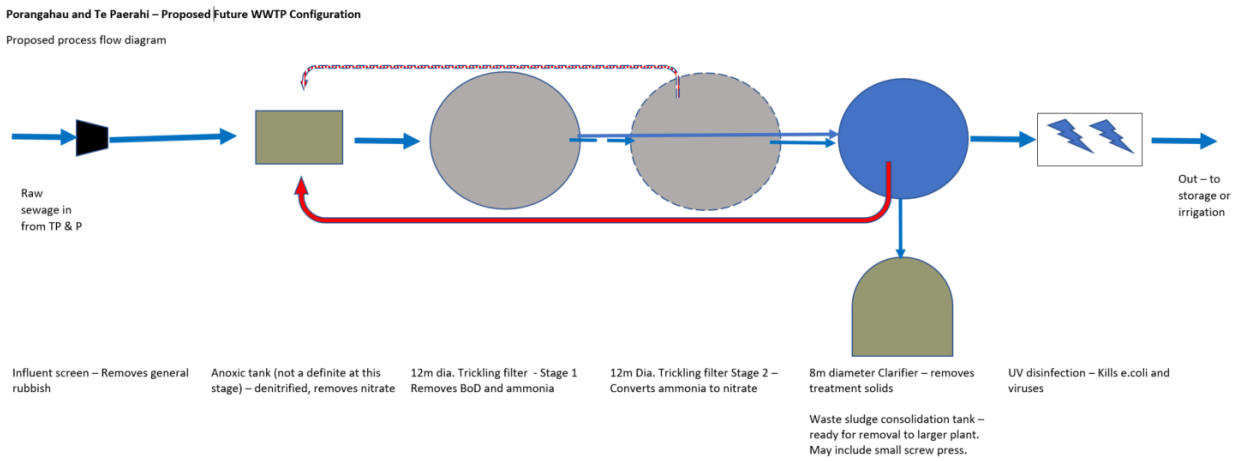
- Pond technology is second ranked, and should BTF technology be found to be cost prohibitive, Pond technology can be reconsidered. It would be less future proofed and flexible than BTF but could conceivably be augmented in future by technologically more complex and energy intensive systems such as moving bed biofilm reactor (MBBR) or membrane aerated biofilm reactor (MABR).

This statement is concerning, as it is not at all clear that Ponds are ranked second, Ponds are clearly shown to not be suitable for the Treatment Quality required, and any move to build another pond would move against the views of the community as outlined in the Options Report.

A move away from BTF to pond-based treatment would not be in line with the AEE or community goals outlined. In fact, it would require significant capital outlay for no treatment improvement.

A high level WWTP schematic was provided by CHBDC which was to be used for consultation purposes with local mana whenua (Ngāti Kere MACA Working Party):

Figure 2.1: High Level WWTP Schematic



The process described above is a two-stage BTF, with an optional anoxic tank up front. Also included are up front screening, secondary sedimentation, and UV disinfection. We note that it is conventional to include a primary settlement tank (PST) upstream of BTF systems. There are some examples in NZ that do not include PSTs, but these typically require increased screening upstream to ensure that the BTF media is not compromised.

BOD and TSS

Trickling filters alone can typically be expected to achieve 30 – 40 mg/L BOD and TSS, but can be operated to achieve as low as 10 mg/L.

Ammonia and TN

With a 2-stage BTF as proposed, ammonia reduction can also be designed to be very effective, typically achieving as low as 1 – 4 mg/L ammonia. The lower end in good (warm) weather, and the upper in cold weather.

With a 12-24 hr HRT anoxic stage up front of the tricking filters, total nitrogen removal could approach 50-60% TN removal, and will be limited by the availability of alkalinity in the wastewater (and possibly available carbon source at times). Assuming a 50% TN removal rate is not unreasonable, and would provide effluent in the range of 12 – 35 mg/L.

With no anoxic stage, there will be very little reduction in TN. Possibly 5-10% which is taken up in the biomass and removed from site in the dewatered sludge. This will be made worse if the sludge is stored in anaerobic conditions with liquors returning to the treatment plant.

Typical influent TN for municipal wastewater ranges from 23-35-69 mg/L (Low-Med-High strength[1]). The influent and effluent TN from the existing Pōrangahau and Te Paerahi ponds was:

Table 2.1: Existing Ponds Influent and Effluent Total Nitrogen

Parameter	Pōrangahau	Te Paerahi
Influent 2009 to 2021 (Beca,P:C.10)		
Average as TKN (mg/L)	25	36.2

[1] Metcalfe & Eddy Wastewater Engineering Treatment and Resource Recovery 5th Edition Table 3-18, and referenced in PC.10a.

Parameter	Pōrangahau	Te Paerahi
Effluent 2014 to 2019 (LEI,2021:P:D:10)		
5%ile (mg/L)	7.53	Not available
Median (mg/L)	13.68	Not available
95%ile (mg/L)	20.62	Not available

As can be seen above, if the consent limit for median discharge of TN is 40 mg/L and 90%ile is 50 mg/L, and later 35 mg/L and 40 mg/L respectively, no treatment will be required, and the discharge will be permitted to be considerably worse than what is currently discharged by the existing pond at Pōrangahau.

The above notes on typical performance assume typical design loading rates. In theory, it would also be possible to "under-design" the BTF to be smaller and perform a lot worse.

2.2 Proposed Consent Conditions

The CHBDC proposed conditions set out in Table 2.2 are taken from the Version 9 set of conditions as referenced in the LEI (6 December 2022) Overseer memo (*"Pōrangahau/Te Paerahi Land Discharge Consent – Version 9 Conditions – OverseerFM Modelling Review Summary*"):

Table 2.2: Proposed Consent Conditions (Table 4) for Discharge Property Treatment and Land Discharge

Condition #	CHBDC Proposed Condition	Comment
48	The Consent Holder must ensure that the treated wastewater meets the following standards prior to discharge to the irrigation and non-deficit (wet soils) irrigation system:	None
48 (a)	(a) The concentration of Carbonaceous five-day Biochemical Oxygen Demand (BOD_5) must not exceed 50 g/m^3 in more than 6 out of 12 consecutive monthly samples, or 100 g/m^3 in more than 2 out of 20 consecutive monthly samples;	These limits are higher than typical BTF performance, and much higher than the existing pond performance.
48 (b)	(b) The concentration of Total Suspended Solids (TSS) must not exceed 60 g/m^3 for more than 6 out of 12 consecutive monthly samples, or 140 g/m^3 in more than 2 out of 20 consecutive monthly samples;	These limits are considerably higher than typical 2-stage BTFs and the existing pond performance.
48 (c)	(c) In accordance with Conditions 3 and 5, the concentration of Total (TN) must not exceed the following: a. Stage 1: 40 g/m^3 for more than 6 out of 12 consecutive monthly samples, or 50 g/m^3 in more than 2 out of 12 consecutive monthly samples. b. Stage 2 onwards: 35 g/m^3 for more than 6 out of 12 consecutive monthly samples, or 40 g/m^3 in more than 2 out of 12 consecutive monthly samples.	These limits are higher than the existing influent wastewater concentrations, and higher than the effluent discharged from the existing Pōrangahau pond WWTP. As noted by PDP (memo, 22/12/2022), these may permit greater nitrogen loads to the Pōrangahau River via rapid leaching to groundwater from the raw sand soils in LMU3 which have very high nitrogen leaching vulnerability.
48 (d)	(d) The concentration of Dissolved Reactive Phosphorus (DRP) must not exceed 6 g/m^3 for more than 6 out of 12 consecutive monthly samples, or 10 g/m^3 in more than 2 out of 20 consecutive monthly samples; and	Unlikely to provide much removal in the proposed treatment system. Average total phosphorus concentrations of *influent* at P & TP WWTPs are historically 4 and 5.7 mg/L respectively.
48 (e)	(e) The concentration of Escherichia coli (E. coli) must not exceed 1,000 cfu /100 mL for more than 6 out of 12 consecutive monthly samples, or 10,000 cfu/100 mL in more than 2 out of 20 consecutive monthly samples.	Covered by others (ESR and PDP).

48 (f)	(f) The pH range shall be within the range of 6.5 – 9.	Alkalinity dosing may be required if no anoxic stage is added.

Comparing the proposed conditions with typical performance of a BTF, existing Pōrangahau WWTP consent conditions, and historical performance at the Pōrangahau WWTP (existing pond), we see in Table 2.3 that there is a significant relaxation proposed for many parameters, in particular BOD, TSS, TN, and DRP.

Table 2.3: Comparison between typical and historical performance, and proposed limits

Parameter	**Typical BTF Effluent**	**Existing Pōrangahau Performance (2014-2019)**	**Existing Pōrangahau Consent Limits**		**CHBDC Proposed Limits (v9)**	
		Median	**Median**	**90th %ile**	**Median**	**90th %ile**
Biochemical oxygen demand, BOD_5 (mg/L)	30 - 40 As low as 10	18	30 *(as $cBOD_5$)*	50 *(as $cBOD_5$)*	50	100
Total suspended solids, TSS (mg/L)	30 - 40	29	50	90	60	140
Ammonia, Amm-N (mg/L)	1 - 4	7.3	N/A	N/A	N/A	N/A
Total nitrogen, TN (mg/L)		12.7	N/A	N/A	Stage1: 40 Stage2: 35	Stage1: 50 Stage2: 40
• With anoxic stage • Without anoxic stage	12 - 35 21 - 64					
Dissolved reactive phosphorus, DRP (mg/L)	-	1.3	N/A	N/A	6	10
Escherichia coli, *E. coli* (cfu/100mL)	-	2,150	N/A	N/A	1,000	10,000

Notes: Pōrangahau performance data from Application Ref: Beca, 2021:P:D.25.
Typical BTF *E.coli* performance not included, as this varies widely with systems. It can be 1.5 log through a high rate plant, and the majority of removal will be taken up by the downstream UV system.
Typical DRP removal not included, as this is typically only taken up by biological uptake in the sludge. This will be low without chemical dosing.

By way of further comparison, the Water New Zealand Good Practice Guide: Waste Stabilisation Ponds: Design and Operation (November 2017), suggests the following typical effluent quality from one and two cell wastewater stabilisation ponds:

Table 2.4: Typical effluent results for one & two cell facultative WSP systems

Contaminant	**Typical NZ Pond Performance (1)**			**Median Performance of Existing WWTPs 2009-2021 (2)**	
	Minimum	**Median**	**95%ile**	**Pōrangahau**	**Te Paerahi**
BOD_5 (mg/L)	7	27	70	17	13
Suspended solids (mg/L)	10	56	150	29	40.5
Faecal coliform bacteria (#/100mL)	$9x10^1$	$4.3x10^3$	$2.3x10^5$	-	$2.7x10^4$
E.coli (#/100mL)	-	-	-	$2.7x10^3$	-
Total phosphorus (mg/L)	1.3	8.2	11.3	1.97	-
Dissolved reactive phosphorus (mg/L)	9.5	5	0.8	1.31	-
Ammoniacal nitrogen (mg/L-N)	0.001	7	29	7.3	6.3
Total nitrogen (mg/L-N)	-	-	-	13	-

Source: (1) Water New Zealand Good Practice Guide: Waste Stabilisation Ponds: Design and Operation, November 2017, Table 1-1.
(2) Appendix_H-PD.10-RE-10684-CHBDC-LandAEE-mrg.pdf. Tables 4.5 and 4.6.

It can be seen above that the existing Pōrangahau pond WWTP performs better than typical median results for New Zealand pond systems, and these typical performance parameters are well aligned with the existing consent conditions.

For Stage 1 of the proposed upgrade, it is also noted that the flows that are currently treated and discharged at Te Paerahi will be treated at Te Paerahi, and then discharged at the new site. It can therefore be expected that the current Te Paerahi WWTP treatment performance will continue for this stage. This could be used for guidance on discharge consent conditions for Stage 1. In particular, it can be seen in Table 2.4, that suspended solids are considerably higher than at Pōrangahau, and total nitrogen performance at Te Paerahi is not known.

3 Conclusions

The proposed limits for BOD are shown above to be higher than typical BTF performance, and much higher than the existing pond performance. In fact, the CHBDC proposed 90%ile limit (100 mg/L) is almost the same as the average raw wastewater at Pōrangahau (103 mg/L).

The proposed limits for TSS are shown above to be considerably higher than typical 2-stage BTFs and the existing pond performance.

Two stages are proposed for the TN consent limits, with a median starting at 40 and reducing to 35 mg/L, and a 90th%ile limit starting and 50 and reducing to 40 mg/L. All of these proposed limits are higher than the existing pond performance, and even the average *influent* TKN (25 mg/L).

Limits for TP, *E.coli*, and pH are not discussed extensively above, as they are covered by other experts, or treatment technology (e.g. chemical dosing or UV treatment).

4 Recommendations

It is strongly recommended that pond-based solution not be permitted as suggested in the Options Report, given the cost of constructing an asset that would show little or no improvement, and because the community has been clear about not supporting this option.

It is conventional to include a primary settlement tank (PST) upstream of BTF systems. There are some examples in NZ that do not include PSTs, but these typically require increased screening upstream to ensure that the BTF media is not compromised. It will be important to ensure that more intensive pre-screening is included if the final solution does not include a PST.

It is recommended that the anoxic tank which is shown as “not a definite” in the system diagram is installed. This will help to ensure that the BTF is at least equivalent at TN removal as the existing pond system (which is likely benefiting from ammonia volatilisation to remove TN). Including this step will also assist with pH management, potentially avoiding the need for pH correction through chemical dosing.

Lower consent limits are recommended for $cBOD_5$, TSS, and TN and are achievable based on proven WWTP technology available in NZ. Given the free draining nature of the soils (refer to PDP memo 22/12/2022) and potential for phytoplankton blooms (refer to Coast and Catchment memo 09/01/2022), WWTP TN effluent concentrations should be at least aligned with existing pond performance. As noted by PDP (memo, 22/12/2022) and as per the HBRC team recommended consent conditions (11/11/2022) as developed with PDP and Coast and Catchment, it is recommended that the WWTP effluent concentrations for the Stage 2 land discharge are:

The Consent Holder must ensure that the treated wastewater meets the following standards prior to discharge to the irrigation and non-deficit (wet soils) irrigation system:

(a) The concentration of Carbonaceous five-day Biochemical Oxygen Demand ($cBOD_5$) must not exceed 20 g/m^3 in more than 6 out of 12 consecutive monthly samples, or 40 g/m^3 in more than 2 out of 12 consecutive monthly samples;

(b) The concentration of Total Suspended Solids (TSS) must not exceed 30 g/m^3 for more than 6 out of 12 consecutive monthly samples, or 50 g/m^3 in more than 2 out of 12 consecutive monthly samples;

(c) In accordance with Conditions 3 and 5, the concentration of Total (TN) must not exceed the following:

> *a. Stage 1: 20 g/m^3 for more than 6 out of 12 consecutive monthly samples, or 40 g/m^3 in more than 2 out of 12 consecutive monthly samples.*
>
> *b. Stage 2 onwards: 20 g/m^3 for more than 6 out of 12 consecutive monthly samples, or 40 g/m^3 in more than 2 out of 12 consecutive monthly samples.*

(d) The concentration of Dissolved Reactive Phosphorus (DRP) must not exceed 5 g/m^3 for more than 6 out of 12 consecutive monthly samples, or 9 g/m^3 in more than 2 out of 12 consecutive monthly samples.

However, we do note that for Stage 1 (when the flows from Te Paerahi continue to be treated in the existing plant and discharged at the new site) the new discharge site will receive treated wastewater at the quality typically seen from Te Paerahi WWTP. There could therefore be justification for applying slightly more lenient discharge conditions for this stage, in particular TSS, which is known to have a higher median discharge value at Te Paerahi than at Pōrangahau, and also for TN, which does not have historical data to demonstrate discharge TN, provided that the environmental effects meet RMA requirements.