Report

Waipawa WwTP - Preliminary Stage 1 Review

Prepared for Central Hawkes Bay District Council

Prepared by Beca Limited

18 December 2017

Revision History

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Waipawa WwTP Monitoring Box Plots

Glossary

ADF	Average day flow	max	Maximum
BAS	Biofilm Attachment Surface	mg/l	Milligrams per litre. A measure of concentration.
$CaCO_3$	Calcium carbonate, A measure of the alkalinity of water.	mm	millimetre
$cBOD_5$	Carbonaceous 5 day biochemical oxygen demand. A measure of the demand of the waste for oxygen.	MoW	Ministry of Works and Development
cfu	Colony forming unit. A measure of the likely number of bacterial organisms present.	NH_4-N	Ammoniacal nitrogen
CHBDC	Central Hawkes Bay District Council	PE	Population equivalent
COD_T	Total chemical oxygen demand	pH	A measure of how acidic or alkaline a substance is. Neutral is 7.0.
CSV	.csv is a comma separated values file which allows data to be saved in a table structured format.	PWWF	Peak wet weather flow
DO	Dissolved oxygen	SCADA	Supervisory Control & Data Acquisition. Remote means of plant control and data collection.
DRP	Dissolved reactive phosphorus	SFBFP	Storm flow buffer facultative pond
DWF	Dry weather flow	SG	Specific gravity. A measure of the weight of a given volume of a substance compared to the same volume of water.
EC/e.coli	Escherichia coli. A bacterium used as an indicator of the presence of faecal matter.	SP	Sample point
ha	hectare	TKN	Total Kjeldahl nitrogen. A measure of ammonium – N plus organic N
HBRC	Hawkes Bay Regional Council	TN	Total nitrogen
hr	hour	TP	Total phosphorus

HRT	Hydraulic residence time. A measure of how long water stays in a system.	TSS	Total suspended solids
H_2S	Hydrogen sulphide	TWWS	Te Wastewater Specialists (Hugh Ratsey)
i&i	Infow and infiltration. Groundwater and stormwater entering the sewer system.	UV	Ultraviolet Light
kg	kilogram	UVT	Ultraviolet light transmissivity
kW	kilowatt.	WSP	Waste stabilisation pond. A form of WWTP.
m	metre	WWTP	Wastewater treatment plant
m^3	Cubic metre	%ile	Percentile

1 Introduction

1.1 Background

In December 2006 Central Hawkes Bay District Council (CHBDC) obtained resource consents from Hawkes Bay Regional Council (HBRC) to allow continued discharge of treated wastewater effluent from separate, oxidation pond based wastewater treatment plants (WWTPs) at Waipawa and Waipukurau, which ultimately drain into the Tukituki River system. The consents expire on 30 September 2030. It was envisaged that significant process changes and upgrades would be required within the Waipawa and Waipukurau WWTPs to meet the new standards. This was particularly with regard to Ammoniacal nitrogen reduction and disinfection. It appears that the consents have been reissued by HBRC in 2015. However, the requirements of Condition 8 appear unchanged.

In 2013-14, CHBDC procured upgrades of the Waipawa and Waipukurau WWTPs. These were designed and built by Waterclean Technologies Ltd. The upgrades consisted of dividing the pond system into 3 zones, adding fixed submerged, aerated media to establish conditions under which the effluent would nitrify (Convert ammonia to nitrate), and floating wetlands to further ‘polish’ the effluent and remove suspended solids.

HBRC commenced prosecution proceedings against CHBDC in the Environment Court (The Court), on 30 November 2016 for non-compliance with Resource Consent DP030232W & DP030860A, Condition 8(e), which relates to the allowable concentration of E.coli that can be discharged to the receiving water from the Waipawa wastewater treatment plant (W-WWTP).

The Court, has subsequently issued an enforcement order requiring CHBDC to undertake certain actions and provide the resulting reports to HBRC and to The Court.

In accordance with that enforcement order, this preliminary, Stage 1, report has been prepared by John Milton Crawford, of the company CH2MBeca Ltd. This is essentially a progress report and, by definition, a number of the work streams will not have been completed or final recommendations developed at the time that this report is submitted.

1.2 Court Enforcement Order

On 31 July 2017, the Environment Court made enforcement orders pursuant to section 314(1)(b)(i) and (ii) of the Resource Management Act 1991. Key paragraphs relating to the required scope of the associated review of the Waipawa WWTP are as follows:

"1. The Central Hawkes Bay District Council ("CHBDC") shall engage John Milton Crawford of CH2M Beca ("Mr Crawford") to review the operation of the Waipawa Wastewater Treatment Plant to determine whether any improvements or upgrades in treatment processes are reasonably necessary to ensure that the limits in Condition 8 of resource consents DP030232Wb and DP030860Ab are able to be complied with.

2. In the event that improvements or upgrades are reasonably necessary, Mr Crawford shall also make recommendations in a preliminary report and a final report on the best practicable option to implement the improvements or upgrades.

Stage 1

7. The Stage 1 review is to be commenced immediately, except for fixed dissolved oxygen and full inflow monitoring, which is to be commenced within 3 months of the date of these orders. It is to review the design and operation of the existing waste water treatment plant, consider the existing data and review existing reports. It is to include the commencement of a monitoring program within one month of the date of this order, such program to be in general accordance with that set out in Schedule A hereto and to be conducted for one year ("12 month monitoring program").

8. The Stage 1 review will also include:

a) The conducting of tracer studies and analyses of their results if it is confirmed by the relevant NIWA experts that the optimal timing for tracer study tests falls within the proposed Stage 1 time scale;

b) Consideration of lamella condition;

c) Consideration of the geometry of chemical dosing;

d) Manual analysis of dissolved oxygen dynamics in the ponds; and

e) Any other relevant tests and analyses thought to be appropriate by the engineer.

9. *A Stage 1 preliminary report will be provided to HBRC and filed in the Environment Court in this proceeding no later than 18 December 2017. It shall contain results from all tests completed including the results so far to hand from the 12 month monitoring program.*

10. *Where appropriate the Stage 1 preliminary report should include any required improvements or upgrades that are apparent from the Stage 1 review."*

1.3 Description of Treatment System

The original facultative pond is approximately 22,700 m^2 in area (2.3 ha)[(1)]. With an average depth of 1.5 m, the volume of the facultative pond is approximately 34,000 m^3. At a Ministry of Works (MoW, 1974) guideline loading rate of 84 kgBOD/ha.d, the original facultative pond had a treatment capacity of approximately 190 kgBOD/d.

The Waterclean upgrade partitioned the original facultative pond into the following three areas:

- Pond Section 1; Facultative pond (1.42 ha). A Reliant Lagoon Master aerator has recently been installed to replace the old 12kW vertical shaft aerator
- Pond Section 2; Nitrification zone (0.54 ha), using Biological attachment surface (BAS) media, with 1 x 2.2kW surface mounted Whitley brush-type aerator plus two Reliant blower aspirated surface aerators installed
- Pond Section 3; Floating wetland zone (0.31 ha)

In addition, a lamella clarifier and recirculating sand filters were installed after the modified pond to provide tertiary filtration, with UV disinfection after filtration. These tertiary processes were, nominally, to have a hydraulic capacity of approximately 1,600m^3/d. However, it is not clear that the intended levels of treatment are achieved at such flows.

1.4 Scope

The scope of this report is to address the requirements of enforcement order paragraphs 7 and 8 above. While the prosecution related to condition 8(e), the enforcement order requires that the Waipawa WWTP review considers the plant in the context of condition 8 as a whole.

[1] Based on measurements from GoogleMaps

2 Commencement of Monitoring Programme

CHBDC has, prior to this review, been undertaking its own monitoring program at the W-WWTP. A program of more intensive monitoring of key wastewater analytes was recommended to the Court and subsequently required in the enforcement order. The initial samples were taken on 29 August and 15 sets of sample results have been received since that time. The CHBDC monitoring officer has compiled the data in a logical format and provided very helpful statistical analysis and cells in the workbook, together with statistical box plots of the results. The box plots are appended to this report.

Reasonably consistent patterns of results are being seen at each monitoring station and we will be recommending that the sampling frequency is reduced henceforth. A summary of the recently obtained (Composite samples) wastewater influent characteristics is shown in Table1 below. Apart from the $cBOD_5$ (which is low) the characteristics look relatively typical of other New Zealand municipal wastewater systems. The $cBOD_5$ appears low compared to typical industry data and to the Total COD (COD_T) where the ratio would be expected to be of the order of 0.5. In his assessment of historical grab samples, Hugh Ratsey also noted this and recommended reviews of how the samples are obtained and analysed to ensure that this is not excluding or reducing BOD and solids which would have the effect of reducing the $cBOD_5$:COD ratio.

Table 1 – Summary of Recent Influent Characteristics

	COD_T	$cBOD_5$	TSS	NH_3-N	TN	TP	$CaCO_3$	e.coli
Average	498	116	303	36	50	6.6	269	2.8E6
90 %ile	918	218	751	49	66	9.8	338	4.2E6

The additional influent flow meters have not been installed as recommended. We have therefore estimated the treatment plant inflows using the following methodology:

- The existing flow meter serving pumps 1 and 2 provided the base flow data
- A CSV file was extracted from SCADA which provided run time for pump 3 for each hour since 1 January 2014. This was converted to 'hours run' for each day and multiplied by an estimated flow rate from the published pump curve to give flow totals for each day on which the pump ran
- A CSV file was extracted from SCADA which provided run time for the McGreevy St wet weather flow pump for each hour since 1 January 2014. This was converted to 'hours run' for each day and multiplied by an estimated flow rate from a 'drawdown' test that had been carried out on the pump wet well
- The three sets of daily flow rates were added together to obtain estimated total daily inflows since 1 January 2014

The influent flow analysis is provided in daily format in Figure 1. This has been reduced to annual flow statistics (July to June in line with consent conditions) in Figure 2, showing influent dry weather flow (DWF), average day flow (ADF) and annual 90th percentile flow (90 %ile).

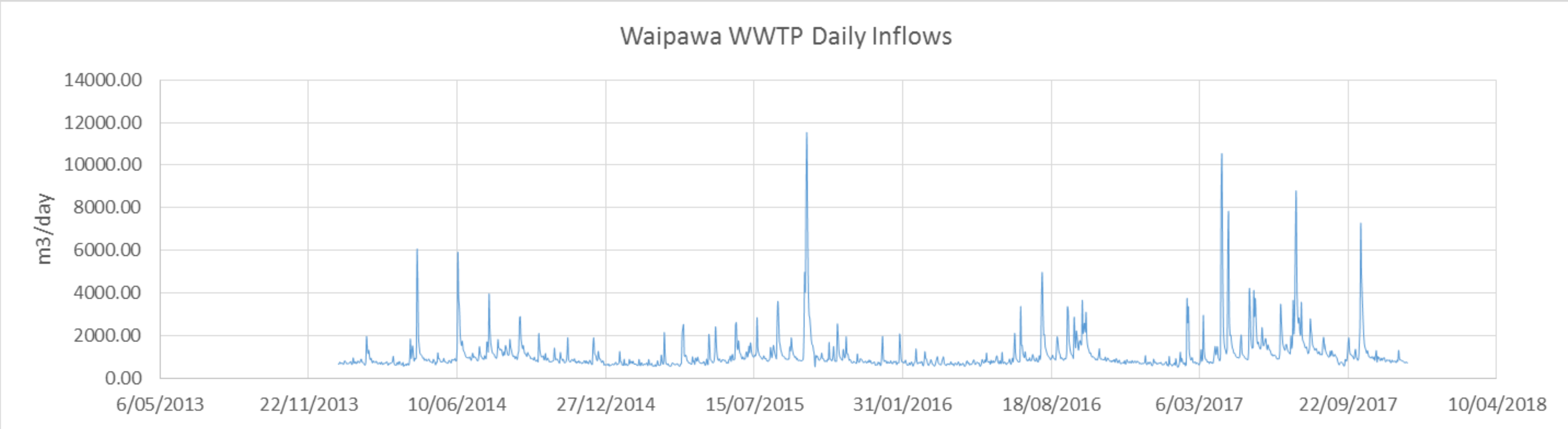

Figure 1 – Waipawa WwTP Daily Inflows

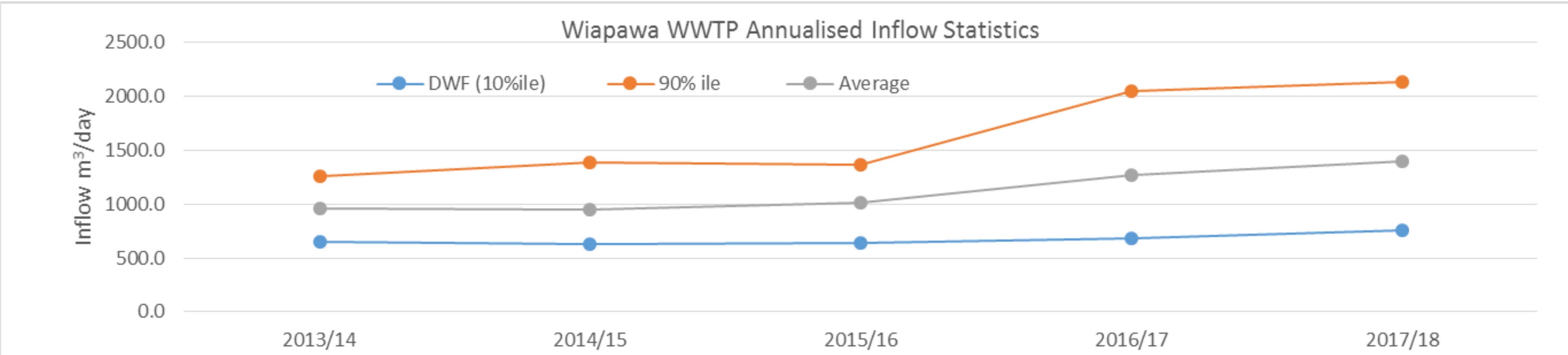

Figure 2 – Annualised Daily Inflow Statistics

The comparatively static nature of the DWF, indicates that the elevated numbers for 2016/17 and 2017/18 (to December 2017) are likely related to the very wet nature of 2017 rather than growth.

The permanent dissolved oxygen (DO) meters requested for two locations within the pond system had been purchased but not been installed at the time of undertaking this analysis. Thus, no sustained period of diurnal DO monitoring is available. I made manual DO readings at various locations and depths during my site visit on 14 November. I understand that the fixed DO meters were installed on 15/12/2017.

In addition to domestic and trade waste loading received and measured through the conveyance system, septage and landfill leachate is tankered to the Waipawa site on a daily basis and loaded in via the septage system. This has been happening since July 2017. From data to hand to date[2], the leachate volume has been up to 40 m^3/day, but the average has been 28 m^3/day. This could be exerting a significant additional loading onto the treatment plant, particularly of ammonia, however, it has not yet been possible to analyse current data at the time of writing.

[2] Data received 14 December 2017 so not yet fully analysed.

3 On Site Assessment

3.1 Tracer Study

During my visit of 26 May, the 12kW tripod style surface aerator was not functioning. This raised concern as to possible lack of aeration capacity in the plant and the potential for short circuiting. Subsequent to my previous visit to the site on 26 May, CHBDC have installed a new Reliant surface aerator in the facultative pond. The power rating is 3kW. The machine is tethered approximately 5m off the north western side of the pond and approximately 45 m from the northern corner. In order to determine whether a fully instrumented and accurately measured dye tracer study was required, I used two methodologies to first determine if there is a gross level of short circuiting occurring. These were carried out on Tuesday 14 November. The weather was fine and still. There was no rain and no wind.

i) The inlet pipe is toward the southern end of the north-western side of the facultative pond. Ten grapefruit were introduced into the raw influent stream at approximately 3 minute intervals. This is a common first step in identifying short circuits. Grapefruit have an ideal shape, colour and buoyancy profile for this work. They are only just positively buoyant, so float almost entirely below the water surface, avoiding the direct influence of wind. The vivid yellow colouring allows them to be photographed easily from the shore or aerially by a drone. In this case the grapefruit were photographed by both shore based camera and by a drone.

ii) Initially the fruit appeared to track across the centre of the pond in a north easterly direction toward the outlet point. However, about half way across they veered to a north westerly track, into a flow pattern which appeared to be established by the new Reliant aerator, and back toward the inlet. On the second circuit of the pond the fruit tracked around a sludge island on the short south western side of the pond, up the long southern side. After leaving the southern side, they once again appeared to track toward the outlet but again veered away before reaching that and again tracked back toward the Reliant aerator. This time, several of the fruit tracked in behind, then past the machine.

iii) The approximate circulation pattern of the fruit has been plotted and is included in Appendix 1.

iv) The second method was to release concentrated Rhodamine dye into the terminal pump station at the screening facility. The dye plume was tracked by drone photography until it was no longer visible. Sketches of the dispersal of the plume with time are appended. There was similarly no apparent gross short circuiting indicated by the dye release.

The combination of the grapefruit and dye tracking indicated to us that the facultative pond is not experiencing a gross short circuit and that there is likely to be a reasonably efficient use of the theoretically available hydraulic retention time in the facultative pond. While CHBDC has a quotation for it (from NIWA), it is not currently planned to proceed to a fully instrumented and sampled dye tracer study of the plant. Other investigations (refer section 4) suggest that the cost (approximately $25,000) of the full dye tracer study would be better spent elsewhere in the treatment plant implementing corrective measures.

3.2 Lamella Clarifier & Chemical Dosing Geometry

3.2.1 Description

The lamella clarifier is a second hand unit that was previously installed in a quarry application. In a quarry, the solids being settled would have a specific gravity (their weight compared to an equivalent unit volume of water) of approximately 2.65 (prior to coagulation). The solids being settled from the oxidation pond have a specific gravity of approximately 1.03 (prior to coagulation). Specific gravity is relevant to the settling rate of solids – see below.

The plan area of the lamella is 1.9m long x 1.99m wide. However, the 1.99m width dimension also includes a 250 mm wide central 'distribution chamber' and two side distribution chambers at approximately 150mm wide that feed the inflow sideways into the lamella sections. Without plans of the unit it is difficult to tell if the water is distributed under the bottom of the lamella plates or only through the sides. The clarifier plan area is therefore 2.7m^2.

The lamella plates are installed at an angle of 55^o up from the horizontal. Typical lamella clarifier plate angles range from 50 to 70^o. Having said that, most lamellas have traditionally been used in applications such as quarrying and potable water treatment where the majority of the solids to be settled are mineral in nature and which therefore have a much higher specific gravity (see above) than wastewater solids and which therefore settle more quickly. From the exterior, the lamella pack is approximately 1.9m high, although obviously it is not possible to see the base of the pack. The lamella plates have a separation gap of 50mm. Therefore the nominal maximum vertical settling distance is 87mm.

The flocculating chamber, prior to the lamella chamber is 1.4m x 1.99m in plan area. However, it is in the form of an inverted triangular prism. The flocculating chamber is fitted with a 0.55kW vertical shaft mixer. A sludge accumulation hopper sits below the lamella pack.

The discharge launders are two channels almost submerged in the water headspace above the top of the lamella plates. Water enters the launders through pairs of 15mm diameter holes in the base of the launder, spaced at 70mm. The base of the launders is only 60mm above the top of the lamella plates. Typically, this distance should be from 300 to 1,000mm above the top of the plates. The very close proximity will be creating uneven flow velocities off the top of the plates.

3.2.2 Performance

Please refer to section 4.2.3.3 below.

3.3 Dissolved Oxygen in The Ponds

The fixed in place dissolved oxygen sensors, intended for sampling points SP2 and SP3 had not yet been installed when the site work and reporting was undertaken. However, the operators and monitoring technician have been taking regular spot DO measurements at SP1, SP2, SP3, SP4, SP5 and SP6.

While not providing data on the temporal variation in DO through the day and night (which is what the fixed DO sensors would provide), these spot measurements provide a reasonably clear picture of what is happening across the treatment plant during the day time. That is:

- SP1: Influent DO is low (but aerobic) variable and typical of raw sewage. Average is 3.8mg/l. 10th percentile is 1.73mg/l
- SP2: DO of effluent leaving the facultative pond and entering the aeration zone averages 5.0 mg/l. This is slightly lower than would be ideal but is highly dependent on atmospheric conditions and the time of day the sample is taken. Because the photosynthetic nature of the activity of the algae populating the facultative pond, the DO can be expected to naturally swing between nearly zero (after a number of hours of darkness on a still night), and supersaturated (around mid-afternoon, and this is confirmed by the 5 September sample result)
- SP3: The DO of effluent leaving the aeration zone and entering the floating wetland zone averages 4.0. There is approximately 12 kW of aeration provided by two Reliant and one cage aerator in the zone. The cage aerator is stationed in an open water zone near SP3. Because there is a high degree of mechanical mixing in this zone, DO will be less influenced by photosynthetic activity of algae. Hence there is comparatively little variance in the DO readings at SP3. Dissolved oxygen is not uniform throughout the aeration zone. Please refer to the section below regarding the spot measurements taken on site on 14 November 2017
- BAS Media Curtains: On 14/11/2017 we took additional spot DO readings with a hand held DO meter. These included taking readings within the BAS Media curtains to determine if the aerators are actually aerating the media which is supposed to support the nitrifying bacteria. Dissolved oxygen along the outer extremities of the curtains appeared healthy, typically ranging from 4 mg/l to 9 mg/l, but most commonly between 4 and 5mg/l. However, when we put the DO meter into that area more than 2 or 3 curtains in from the outer edge, the DO was typically in the range 1.0 to 2.0 mg/l and significantly lower toward the bottom than the top of the curtains. This indicated that there was a little oxygen transfer at the surface, probably due to wind action, but virtually none through the bulk of the curtains. For safety reasons, we could not get the D.O meter more than about 3 or 4 rows in from the outside (Refer figure 3). In that environment, it is very unlikely the nitrifying bacteria would colonize or proliferate.

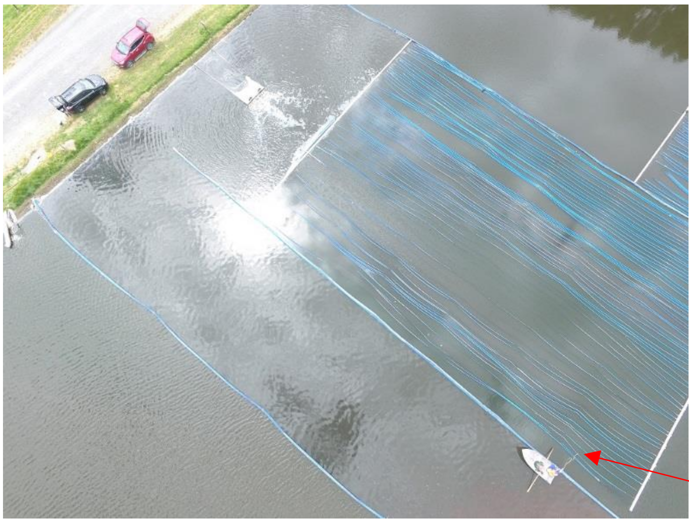

Figure 3 – Dissolved Oxygen Monitoring in the BAS Nitrification Zone

- SP4: The DO of the effluent leaving the floating wetland zone is very low, averaging 1.6mg/l. This is definitely not typical of effluent leaving a pond system and is symptomatic of a system that is receiving too little or no oxygen. The areas between the floating strips of planted wetland are completely covered over so that there is no transfer of oxygen possible between the atmosphere and the water. The spot measurement taken on 14/11/2017 was 0.2 mg/l and that taken on 26 May 2017 was 0.35mg/l. These indicate that the wetland area is borderline anaerobic. Indeed, the effluent is black in colour (Refer figure 4) and there is a distinct odour of hydrogen sulphide in the air. This is a strong indicator of septicity in wastewater. This effluent is then pumped up to the top of the lamella tower and there is again a strong odour as this is released to atmosphere and as the effluent flow enters the discharge launders

Figure 4 – Floating Wetland Discharge Area. Note Black Colouration of Effluent

- SP5: DO leaving the tertiary filter is healthy at an average of 4.2mg/l. The effluent will be receiving oxygen transfer in the floc mixing tank, as it goes through the lamella discharge launders, as it cascades down from the lamella tower and as it passes over discharge launders on the tertiary filters
- SP6: Likewise, effluent dissolved oxygen leaving the UV disinfection system appears healthy at an average of 7.7 mg/l

4 Design and Operation of the Wastewater Treatment Plant

4.1 General

The scope of the review of the Waipawa WWTP requires the reviewer "*to review the design and operation of the existing waste water treatment plant, consider the existing data and review existing reports".*

In addition to the prosecution 'e.coli disinfection' issue at Waipawa, CHBDC has had problems achieving sufficient nitrification at the Waipawa WWTP in order to achieve the 6mg/l mean discharge consent limit for Ammoniacal nitrogen (NH_4-N) and the 90th%ile limit of 10mg/l.

Both the Waipukurau and Waipawa WWTPs were upgraded by Waterclean Technologies Ltd (Waterclean) between 2013 and 2015, dividing each of the existing waste stabilisation ponds (WSPs) into three zones; a smaller facultative pond, a nitrification zone, and an area of floating wetlands. This did not provide reliable, year round ammonia removal through either WWTP[3].

In September 2017, in parallel to the Environment Court action, Central Hawkes Bay District Council passed the following resolution:

THAT a report on the appropriateness of the Waipukurau and Waipawa wastewater treatment systems and their ability to meet current resource consent requirements is presented to the Finance and Planning Committee by the end of November.

The scope of the report should include:

- ALL resource consent requirements for both systems,
- Capacity to deal with current residential and trade-waste demands,
- Capacity to deal with projected growth requirements under the draft Urban Growth Strategy (with reference to the economic projections in the draft LTP),
- Outline of potential capital investment required to address issues identified.

Results of the report will be used to inform the current Long Term Plan design and for working with potential external funders of capital works.

[3] Ratsey 2017

The Wastewater Specialists (twws - Mr Hugh Ratsey) were subsequently engaged to undertake a review of the Waipukurau and Waipawa WwTPs to address the scope of work identified in the Council resolution. CH2MBeca Ltd (Mr John Crawford), as part of the scope of this response to the Environment Court and to HBRC, has been required to peer review the work of twws so that it may be used in partial fulfilment of the requirements of the enforcement order.

4.2 Discussion

The following is a summary of the findings of the twws report, peer reviewed by CH2MBeca, and site investigations undertaken by CH2MBeca. Full details of the plant loading, performance and suggested improvements can be found in Ratsey, 2017.

4.2.1 Loading

The dry weather effluent flow is approximately 501 m^3/day and the average day flow for July 2016 to Jun 2017 was 1,134 m^3/d. Peak wet weather effluent flow was approximately 5,450 m^3/d in2017 while the 90^{th}%ile was approximately 1,600m^3/d. The consent provides for a 90^{th}%ile effluent volume of 1,500m^3/d.

The volumes above are effluent flows and have been buffered due to the residence time in the WWTP. As discussed in section 2 above, influent flows have only been estimated (albeit with reasonably good first principles information) at this stage. This information will be critical to planning treatment plant improvements as the various unit processes and or storage facilities need to be able to deal with the maximum daily inflows. The statistics for the estimated inflows are provided in Table 2.

Table 2 – Waipawa WwTP Estimated Influent Statistics

Statistic (m^3/d)	2014/15	2015/16	2016/17	2017/18 (to date)
DWF	627	642	683	754
ADF	949	1017	1272	1403
90th %ile	1393	1371	2047	2140
Max	3944	11516	10509	8746

The influent waste concentrations are not high. However, this may also be reflective of significant inflow and infiltration into the system. The current domestic population contributing to the Waipawa WWTP is approximately 2,000 PE (population equivalent). Trade waste discharges from two trucking companies contribute approximately another 700 PE although these are permitted to contribute loads equating to 2,350 PE.

4.2.2 Performance

The Consent Condition 8 numerical requirements are summarised in Table 3 below.

Table 3 – Waipawa WwTP Consent Conditions

Parameter	Median	90-percentile
Flow, m^3/d	1,300	1,500
$cBOD_5$, mg/L	20	30
TSS, mg/L	30	50
Ammoniacal-N, mg/L	6	10
Dissolved Reactive Phosphorous (DRP), mg/L	0.25	0.5
E. coli, cfu/100mL	800	4,000
pH	6.5 – 8.5	

Recent performance of the Waipawa WWTP is summarised as follows:[4]

- Compliant with TSS resource consent requirements over the past three years. Refer TWWS 2017, figure 21
- Comfortably compliant with the $cBOD_5$ resource consent requirements over the past three years. Refer TWWS 2017, figure 22
- In the 2014/15 and 2015/16 summer periods, compliant with the Ammoniacal nitrogen resource consent requirements. However, as shown in Figure 5, the WWTP did not achieve sufficient ammonia removal during the corresponding winter periods. In addition, since June 2016, the ammonia resource consent conditions have not been met under either summer or winter conditions.

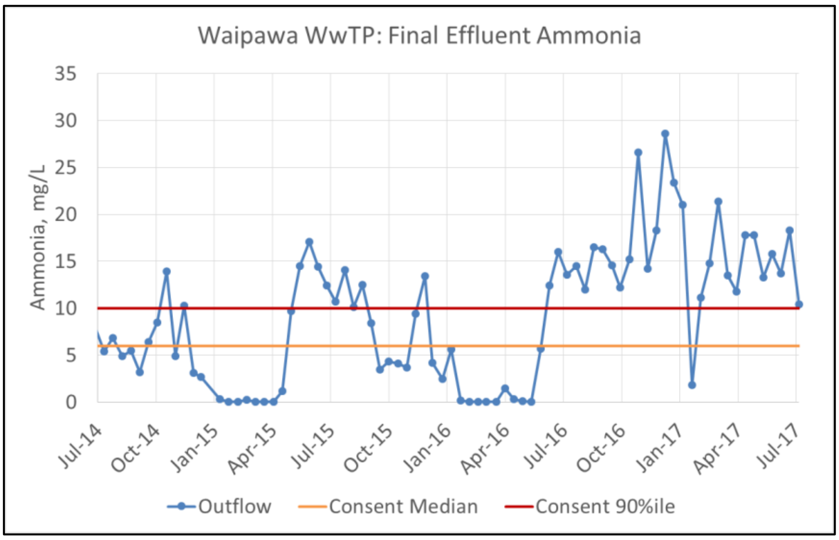

Figure 5 – Waipawa WwTP Final Effluent Ammonia

[4] TWWS 2017

Subsequent to the adoption of Tukituki Plan Change 6 ("PC6"), I understand that:

- CHBDC applied for a change of consent conditions to better reflect the new provisions of PC6 as regards Ammoniacal nitrogen.
- This would have provided for a more flexible discharge Ammoniacal nitrogen limit, as provided for by PC6.
- The application was declined by HBRC.

- Generally compliant with the consented DRP requirements. There are some excursions, potentially driven by wet weather flow management, sub-optimal dosing or clarification
- Figure 6 indicates the Waipawa WWTP has struggled to achieve the *E. coli* resource consent conditions over the past three years. This is considered likely to be due to a combination of the following factors:
  - Sub-optimal alum dosing / clarifier performance at times
  - Marginal sizing of the UV disinfection system
  - Partial bypass of the tertiary treatment processes during peak flows

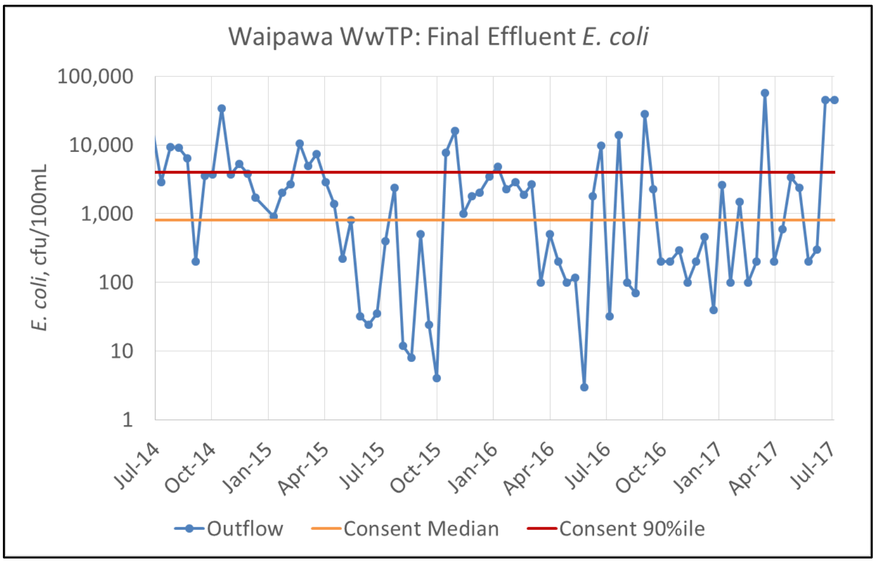

Figure 6 – Waipawa WwTP Final Effluent E.coli, 2014 - 2017

- The pH of the discharge has generally been within the resource consent range of 6.5 to 8.5, although it did drop below the minimum permitted pH in May and June 2016. It is our understanding this drop in pH was due to the change in coagulant from alum to ferric. When the adverse effects on pH were noted and understood, the coagulant was changed back to alum

4.2.3 Operational Issues

The following is a brief summary of operational issues noted at the Waipawa WWTP. These are covered in further detail in Ratsey 2017.

Stormwater and potentially groundwater **inflow and infiltration** (i&i) to the Waipawa WWTP is problematic. The high ratio between dry weather and wet weather flows is shown in Table 4.

Table 4 – Waipawa WWTP Comparison of Estimated Inflows and Measured Discharge Flows

2016/17	DWF	ADF	90%ile	PWWF
Inflow (m^3/d) (From pump hours run[5])	683	1272	2049	10,509
Discharge (m^3/d) (From effluent flow meter)	500	900	1,567	5,600

Thus influent PWWF = 15 x influent DWF and effluent PWWF = 11 x DWF. This is a very high ratio by contemporary standards. The high flows (particularly those experienced in 2017) cause the hydraulic retention time (HRT) in the plant to be significantly shortened (Ratsey, 2017, s7), reducing the possibility of sustained periods of nitrification occurring. Further, when the buffering capacity of the pond based processes is exhausted, flows in excess of 1,400m^3/d must be bypassed around the tertiary processes (clarifier, filter & disinfection).

Obviously the performance suffers under both scenarios. While the 90th %ile discharge volume (1,500m^3/d) has previously been within compliance, this does not appear to be the case for 2016/17 (1,567m^3/d July 2016 to June 2017). The dry weather of November and December may correct this trend for the 2017/18 monitoring year (commencing 1 July).

4.2.3.1 The plant as installed does not appear to be able to reliably nitrify (oxidise ammonia) to a level that would be necessary for compliance. The HRT can regularly be too low as discussed above. The aeration system does not appear to be able (from on-site D.O measurements) to penetrate the tightly packed curtains in order to provide dissolved oxygen to the nitrifying bacteria that are supposed to be populating the 'BAS' media.

The media itself appears[6] to have become clogged and is potentially only providing 10% of the area intended by Waterclean for attachment of nitrifying bacteria. Visually, there appears to be little or no

[5] Note that the near constant ratio between influent DWF and ADF indicates that the methodology using hours run to calculate the inflow volume may be over estimating the actual inflow and this should be addressed by installing flow meters.

[6] NIWA 2017, Waipukurau

flow velocity along and between the curtains to maintain clear pore spaces. Further, whilst monitoring DO concentrations between curtains, it was noted in several areas that there appeared to have also been a significant sludge build up between curtains.

We note that it would be extremely difficult to safely extract sludge build up from between the curtains. Similarly, removal of the curtains for cleaning would likely end in destruction of the curtains. A further problem noted during our 14/11/2017 visit was that the connections between the curtains and their end rails are badly corroded. The tension wires are braded stainless steel. The end rails are aluminium and the connectors between the two are simply galvanised agricultural fence tensioners. It is likely that 'batteries' (resulting from dissimilar metals (steel, aluminium, and galvanized steel) in contact with an electrolyte (water)) have effectively formed, to drive the corrosion, and that these joints will soon begin to fail if not replaced. At this stage, the problems with the curtains are likely greater than a potential lack of aeration. Council will need to take a decision as to whether to repair and retain the curtains or remove them to minimise further future operational difficulties.

Performance statistics for the floating wetlands are provided in Table 5. As can be seen, there are some improvements to BOD and TSS removal performance. However, the prime purpose of the zone, which is to achieve nitrification, is not happening at all.

Table 5 – Waipawa WwTP Summary of Nitrification Zone Performance

Analyte	DO	$CaCO_3$	$cBOD_5$	TSS	NH_4-N	TN	E.C	TP	pH
Upstream	4.9	251	26.2	53	28.6	36.0	53,000	4.6	7.5
Downstream	3.9	252	17.6	33	28.7	34.8	24,600	4.8	7.6
Change	Worse	Same	Better	Better	Same	Same	Better	Same	Same

4.2.3.2 The floating wetlands are achieving little to no additional treatment over that provided by the rest of the treatment plant. In fact, there is actually some degradation in quality through the wetlands as the effluent appears to become anaerobic as evidenced by very low dissolved oxygen readings, a black colouration to the effluent and the strong odour of hydrogen sulphide as the effluent is pumped up to the top of the Lamella clarifier tower. Performance statistics for the floating wetlands are provided in Table 6.

Table 6 – Waipawa WwTP Floating Wetland Average Performance

Analyte	DO	UVT	$cBOD_5$	TSS	NH_4-N	TN	E.C	TP	pH
Upstream	3.9	21.8	17.6	33	28.7	34.8	24,600	4.8	7.6
Downstream	1.5	21.0	14.3	19	28.0	33.1	34,561	4.5	7.5
Change	Worse	Same	Slightly better	Better	Same	Same	Worse	Same	Same

While the covering of the wetlands is likely intended to reduce TSS by stopping algal proliferation, it does appear to be to the detriment of the effluent quality in other regards. The wetlands appear to suffer from a lack of oxygen transfer and may function better if the covers between wetland rows were removed to permit wind action to maintain DO in the water column.

4.2.3.3 The Lamella clarifier

On both occasions that I have visited the site, the lamella clarifier performance has been poor. While good sized flocs are forming, the majority are/were carrying over into the discharge launders. As flocs appear to be forming well, it is not immediately obvious that it is the chemical dosing that is at fault. The required average hourly flow rate is 37.5m^3/hr. The upflow rate is therefore 13.7m/hr which is considered to be comparatively high for this type of clarifier and this type of solid.

The analytical results are showing, reasonably consistently, that the combination of the lamella Clarifier and sand filter is removing a significant amount of phosphorus but no suspended solids (TSS) and, in many cases, the final effluent TSS is worse than that leaving the wetlands. The alum dosing increases the amount of TSS in the effluent by precipitating substances out of solution and complexing with them to form solids. However, we would normally expect to see those solids removed in the clarifier / filter combination. Some clearly are removed (for the effluent TP and DRP to be less than the wetland discharge TP/DRP). However, on 14 November, there was no sludge deposition forming in the sludge hopper under the lamella plates and, visually, there was a very large amount of flocculated material rising through the lamella plates and into the discharge launders.

There are several possible issues causing this problem:

- The clarifier may be too small and the generalised up flow rate too high for the combination of solids type (low specific gravity organics) and relatively flat lamella geometry. Typical loading rates are 5 – 10m/hr. So at 13.7m/h and a very low specific gravity sediment, it is probable that the up flow rate is too high. There is not a lot that can be done to remedy this situation, short of duplicating the clarifier. However, it will be worth having Council’s chemicals supply company jar test a number of flocculating polymers which may help to group the coagulated particles into larger masses which settle more quickly than the dispersed flocs. These polymers can be added in immediately upstream of the flocculation tank at the top of the lamella tower
- Flocculated particles may be ‘hanging up’ on the top of the lamella plates and not sliding down to the hopper below. Eventually, this will constrict the flow passage to such an extent that the up-flow velocity prevents floc settlement. This could be remedied by instituting a regular cleaning cycle whereby the clarifier is drained down and a series of spargers is used to flush out the material from between the plates. Another possibility would be to find and experiment with a high frequency vibrating or ultrasonic device that is sufficient to cause the accumulated solids to loosen and slide off the plates
- The lamella plates can be cleaned in situ provided the solids have not been allowed to build up for too long. Cleaning of the plates should be undertaken regularly with a pressure washer (refer figure 4 below).

The exact frequency will need to be determined by operator familiarity with the degree to which cleaning improves performance and the length of time that improved performance is sustained

Figure 7 – Illustration of Lamella Plate Cleaning

- Feed distribution is not even, resulting in high localised flow velocities in parts of the lamellas. This can sometimes be remedied by inserting two or three baffle plates, of different lengths, into the feed channel to improve the evenness of distribution. This is normally done by the operator placing the baffles by trial and error and observing the changes in flow pattern at the top of the plates
- The close proximity (60mm) of the launder entry holes to the top of the lamella plates is causing high localised velocities through the plates. This can be remedied by swapping out the launders for new ones that have V-notch weirs in the top edges. This will increase the head space above the plates to approximately 300mm and provide much more uniform flow velocities above the plates

5 Summary and Recommendations

5.1 Short Term

The following changes are suggested to improve the short-term performance of the existing Waipawa WwTP:

- Work closely with the key contributing trade waste dischargers to ensure that they are optimizing the levels of pre-treatment at source and doing everything that is reasonably practicable to minimize the loads imposed upon the WWTP
- The landfill leachate tankered into the Waipawa WWTP is likely to be adding a significant ammonia load, and could also be impacting on the efficiency of the UV disinfection system due dissolved organic material reducing the UVT. It may be possible to discharge some, or all, of this leachate to an alternative WWTP to improve performance of the Waipawa WWTP. This waste needs to be quantified and characterized as soon as possible
- Install sufficient aeration in the facultative pond to maintain aerobic conditions. Providing good algal growth is achieved in the facultative pond, we estimate that approximately 6 kW of mechanical aeration would be required. Ongoing monitoring will determine whether the recently installed 3kW Reliant aerator provides sufficient DO
- Implement a regular pressure cleaning regime on the lamella clarifier
- Optimise the performance of the lamella clarifier and sand filters. We understand that the lamella discharge launders have now (since 14 November 2017) been replaced with launders that utilize a high level V-notch weir system. It was demonstrated through the addition of polymer dosing after coagulation at Waipukurau, that it may be possible to improve TSS removal through the tertiary treatment processes which, in turn, may improve UV disinfection performance
- It may be worth undertaking a more detailed sludge survey to determine the extent of sludge accumulation and, if necessary, desludging the pond
- Consider removing the lagoon covers between the strips of floating wetlands. The wetland strips will then probably need to be rotated 90º to prevent short circuiting to the outlet. Careful consideration of the associated risk will need to be undertaken first
- Determine the fate of the BAS media curtains. If these are to remain in place, the tensioning devices will all need to be replaced, in a suitable material in the near future
- The performance of the UV system at Waipawa has been inconsistent. While this may be partly due to changing effluent characteristics, it is also possible that UV system performance could be improved through more regular, scheduled maintenance. In addition to routine maintenance such as lamp, wiper and sleeve replacement, periodic manual cleaning of the quartz sleeves is required using dilute phosphoric acid to remove inorganic precipitates

5.2 Long Term – Interim Thinking

While in theory it should be possible to achieve reliable ammonia removal through an attached growth-type system, due to the following factors we consider it unlikely that such a system will provide the required level of treatment at Waipawa without significant additional investment[7]:

a) Stormwater I&I into the Waipawa reticulation is very significant. Following the heavy rains in 2017, the theoretical HRT reduced to approximately 10 days. Nitrification is very unlikely to be achieved through a modified waste stabilization pond (WSP) at such a low HRT

b) The BOD concentration entering the nitrification zone is considered likely to be too high[8] to allow nitrifying bacteria to remain established on the BAS media

c) Significant population growth is expected in Waipawa. This will further increase the wastewater flows and loads

d) The New Zealand experience of modifying WSP's to achieve low effluent ammonia concentrations is checkered, even in WWTP's with higher HRT's and more robust design and installation

In addition, the hydraulic capacity of the tertiary treatment processes (lamella clarifier, sand filters, UV system) is insufficient. Discharge flow rates greater than 1,400 m3/d bypass tertiary treatment which could result in breach of the TSS, BOD, DRP and/or E. coli resource consent conditions. Table 6 below presents a qualitative summary of what we consider, at this stage, Waipawa WWTP to be capable of with respect to Consent Condition 8. Table 6 summarises the likely ability of the Waipawa WWTP, remaining generally as now configured, to be able to be made consistently compliant with the 'Condition 8' consent criteria.

Table 7 – Likely Ability of Waipawa WWTP Achieve Resource Consent Compliance[9]

Parameter	Current Flow & Load[10]	Future Flow & Load[10]
Flow, m^3/d	Marginal	Marginal
$cBOD_5$, mg/L	Yes	Yes
TSS, mg/L	Yes	Yes
Ammonia, mg/L	No	No
DRP, mg/L	Yes	Yes

[7] Ratsey 2017

[8] Ratsey 2017

[9] Ratsey 2017

[10] Providing additional lamella, sand filter and UV capacity is installed to effectively treat the PWWF, or stormwater I&I is significantly reduced so peak flows are within the hydraulic capacity of these tertiary treatment processes

E. coli, cfu/100mL	Marginal	Marginal
pH	Yes	Yes

On that basis, it is likely that in the longer term a rebuild will be required in the form of one of the commonly available activated sludge variants. This thinking will be expanded upon in the final review.

6 References

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Craggs, R., Heubeck, S., Sukias, J, (2017 March) Review of Waipukurau WWTP Upgrade. NIWA.

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Waterclean Technologies (2012); *Proposal to CHBDC for the upgrade of Waipawa & Waipukurau WwTP using granular media filtration and floating treatment media*

Appendix 1

Facultative Pond Flow Patterns

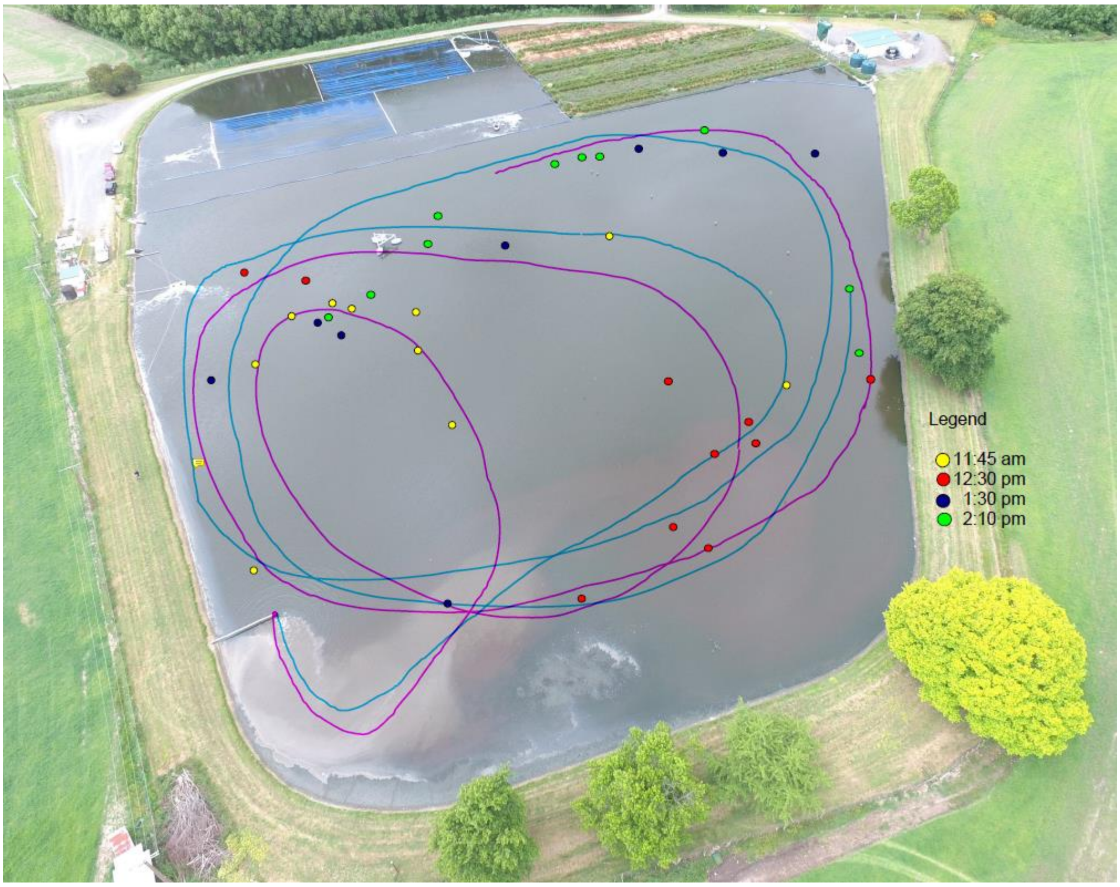

Figure 8 – Waipawa WwTP. 14/11/2017 Grapefruit Tacking Exercise. Note 2 basic tracks taken by fruit introduced over a 30 minute period

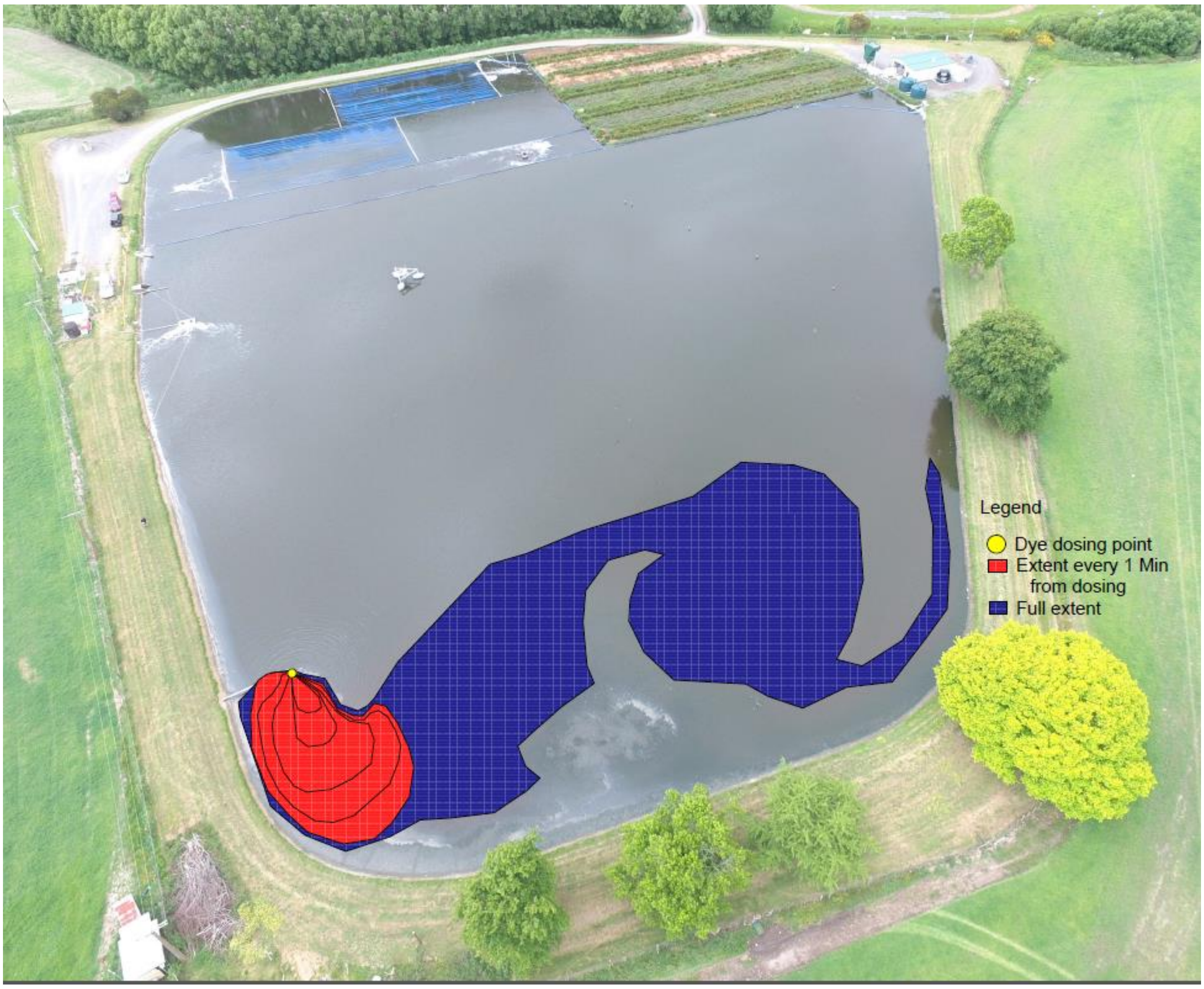

Figure 9 – Waipawa WwTP Dye Tracking on 14/11/2017. The further spread could not be detected by eye after approximately 1.5 hrs, indicating no concentrated stream progressing toward the outlet

Appendix 2

Waipawa WwTP Monitoring Box Plots

Legend:
1 = SP1 = Inlet
1 = SP2 = Entry to nitrification Zone
2 = SP3 = Entry to floating wetland zone
3 = SP4 = Discharge from floating wetland zone
4 = SP5 = Discharge from Tertiary Filter
5 = SP6 = Discharge from UV disinfection
C = Composite Samples
G = Grab samples

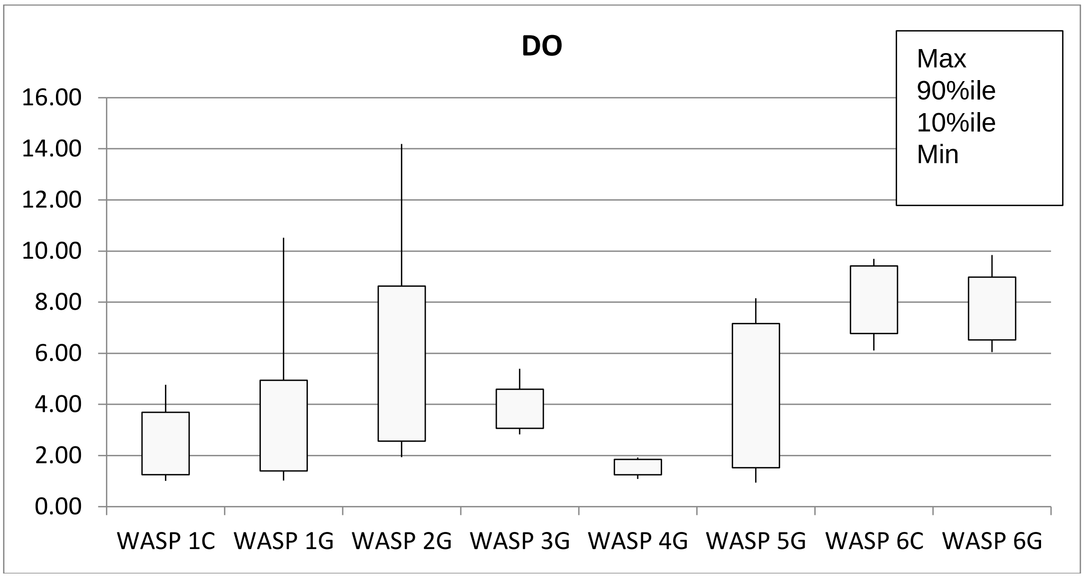

Figure 10 – Waipawa WwTP Dissolved Oxygen Profile

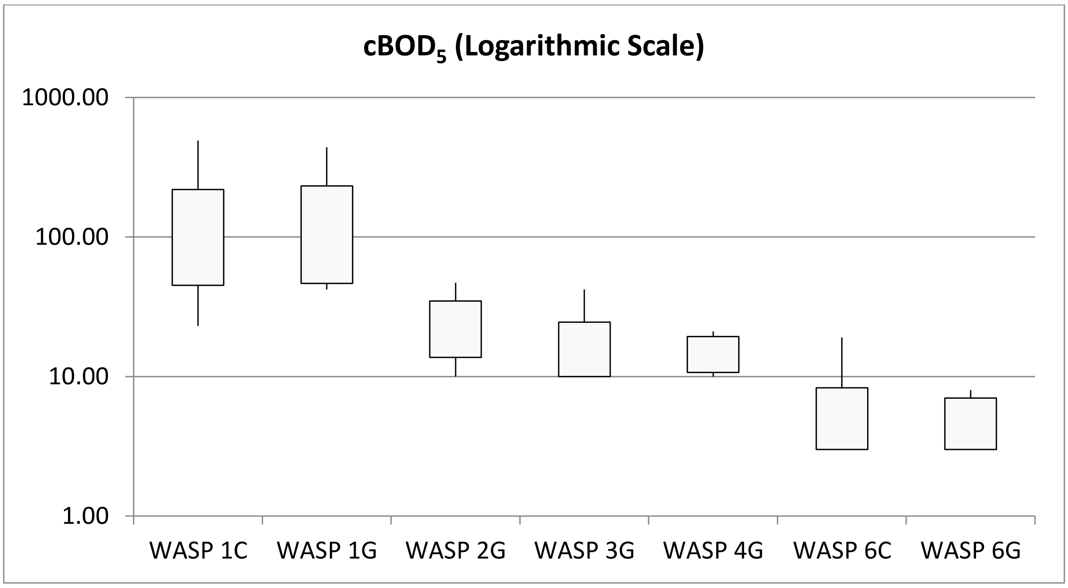

Figure 11 – Waipawa WwTP cBod$_5$ Profile

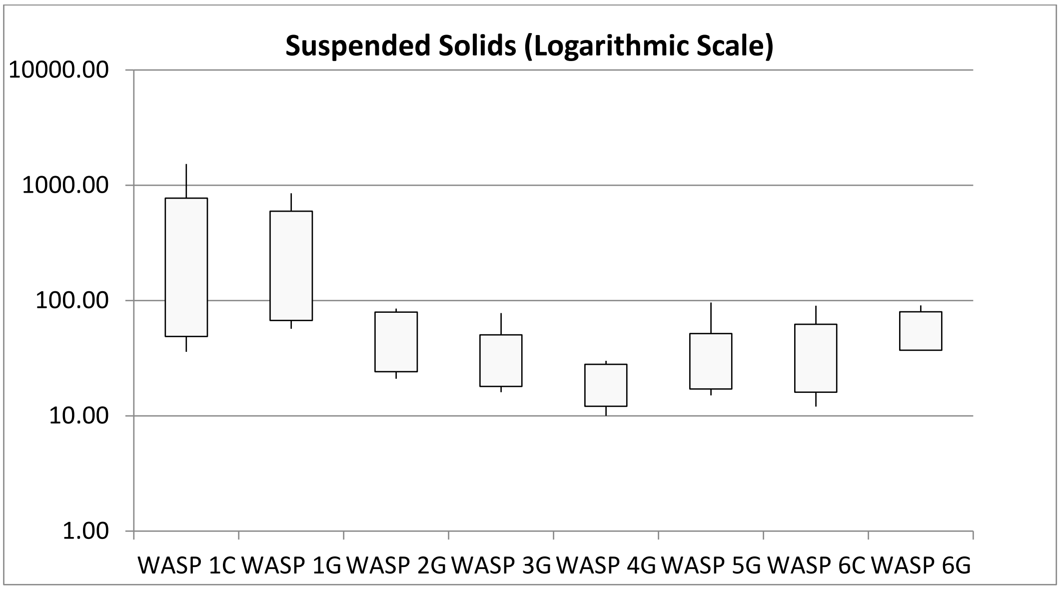

Figure 12 – Waipawa WwTP Total Suspended Solids Profile

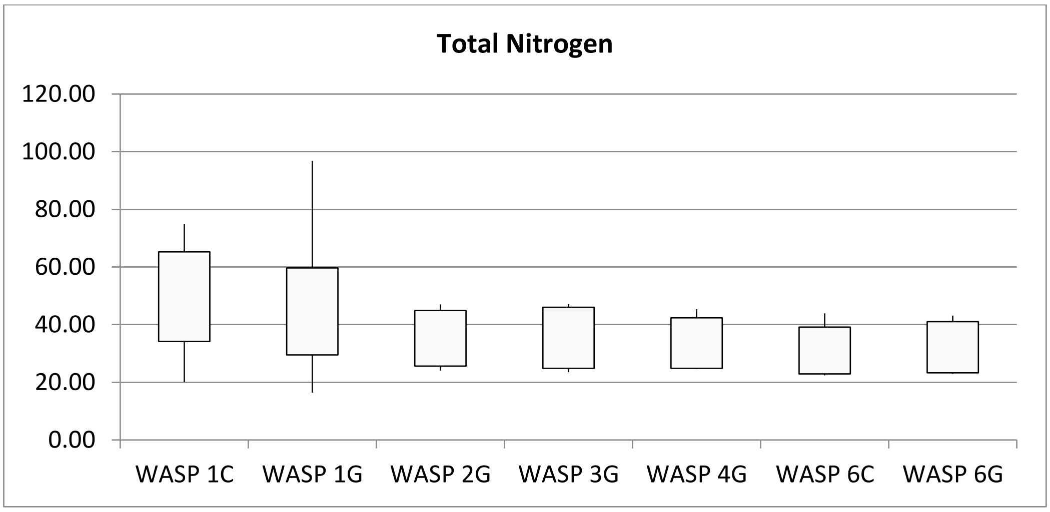

Figure 13 – Waipawa WwTP Total Nitrogen Profile

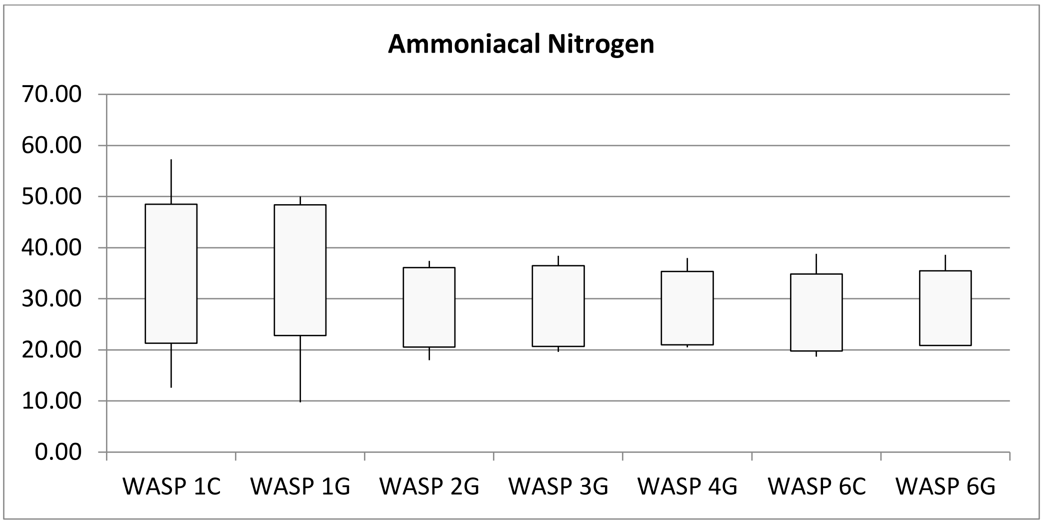

Figure 14 – Waipawa WwTP Ammoniacal Nitrogen Profile

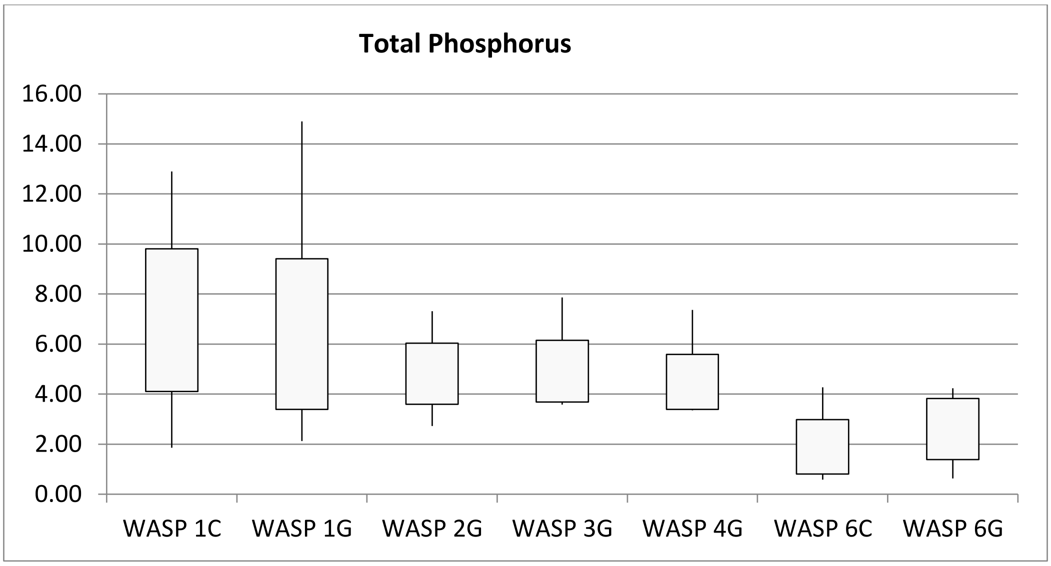

Figure 15 – Waipawa WwTP Total Phosphorus Profile

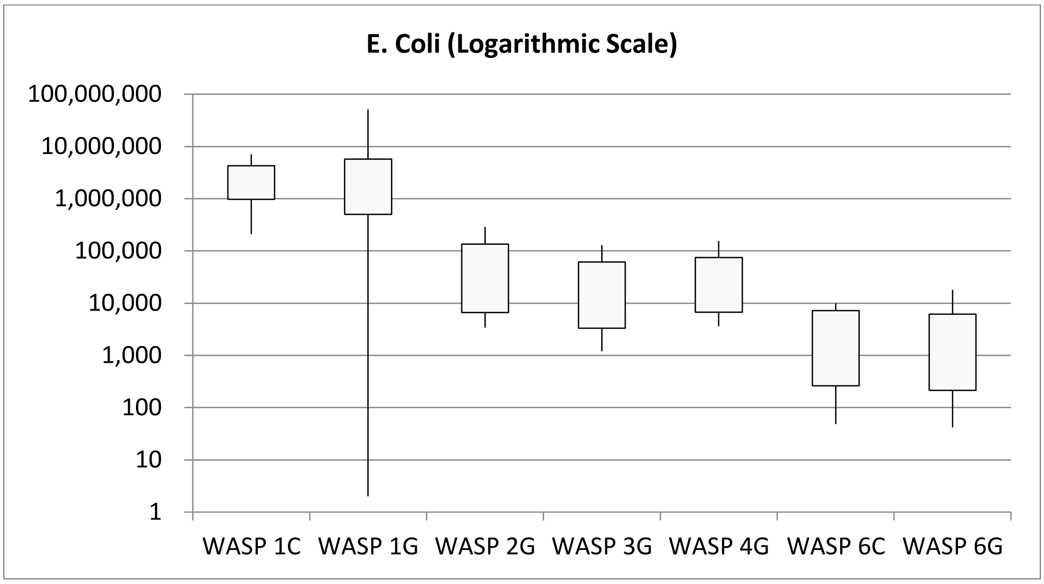

Figure 16 – Waipawa WwTP E,coli Profile