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Rangitikei WWTP and WTP Consenting

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CONFIDENTIAL

Ratana WWTP Process Review

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Revision Details

Revision	Details
2b	Updated to reflect temporary treatment needed
A	Updated – removing temporary treatment needs, identifying potential effluent standard.
B	Updated with RDC comments
C	Updated resource consent conditions

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Abbreviations

BOD	Biochemical oxygen demand
$CBOD_5$	Carbonaceous Biochemical Oxygen Demand measured over 5 days
DAF	Dissolved Air Flotation
DO	Dissolved Oxygen
DRP	Dissolved Reactive Phosphorous
MBBR	Moving Bed Biofilm Reactor
NPS-FM	National Policy Statement for Freshwater Management
RDC	Rangitikei District Council
SAF	Submerged Aerated Filter
SIN	Soluble Inorganic Nitrogen
TKN	Total Kjeldahl Nitrogen
TON	Total Oxidised Nitrogen
TP	Total Phosphorous
TSS	Total Suspended Solids
UV	Ultraviolet
WWTP	Wastewater Treatment Plant

Executive Summary

Rangitikei District Council have been working to find an alternative location to discharge treated wastewater from the Ratana Wastewater Treatment Plant (WWTP). The intention is to discharge treated wastewater to land and so removing the associated nutrient loadings to Lake Waipu. In preparation for the pending resource consent application for Ratana WWTP, Rangitikei District Council (RDC) have requested that WSP undertake a review of the Ratana WWTP and the likely implications of future consent changes on the plant and its equipment.

This report reviews and presents

- Site process description
- Performance of the existing plant
- Flow data
- Prediction of future flow and load
- Future performance requirements
- Potential solutions for the plant

The intent of this review is to document the current assets and ability of the plant to deal with future flow and loads. This information will be used by RDC in the development of the discharge strategy, as part of background information used in community engagement and in the preparation of documentation in support of a resource consent application for the Ratana WWTP to authorise discharge to land.

The existing Ratana WWTP consists of an inlet screen, two treatment ponds and an outlet flow meter.

The plant is estimated to serve 370 resident population, with a forecast of an additional 160 people from expected developments. The Ratana Festival, held annually at the end of January, sees an influx of visitors to the community and flows increase substantially for a short period. Data available suggests that although the loading rates to the system are high at this time, the attenuation through the ponds and overall long retention time of > 40 days is sufficient to treat this load.

Quality data has been reviewed and presented for the plant and shows that the quality being currently achieved in the final effluent is probably sufficient to meet quality requirements for long term land disposal.

To ensure that the existing plant can continue to perform, it is necessary to undertake several maintenance activities. These are;

- Refurbish/ replace screen
- Sludge survey and if needed, desludge ponds
- Replace gravel at outlet of pond 2.
- Minor repairs to outlet chamber structure.
- Ensure both flow meters are calibrated regularly

Disclaimers and Limitations

This report ('**Report**') has been prepared by WSP exclusively for Rangitikei District Council ('**Client**') in relation to a review of the Ratana WWTP, its performance and high level consideration of future plant upgrades for the purpose of discussion with RDC and the local community. ('**Purpose**') and in accordance with Regional Water and Wastewater Treatment Plant Consenting Programme CCCS dated July 2021. The findings in this Report are based on and are subject to the assumptions specified in the Report, data provided by RDC for flow, effluent quality, and asset information. WSP accepts no liability whatsoever for any reliance on or use of this Report, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Report by any third party.

1 Introduction

Rangitikei District Council have been working to find an alternative location to discharge treated wastewater from the Ratana WWTP. The intention is to discharge treated wastewater to land and so removing the associated nutrient loadings to Lake Waipu. In preparation for the pending resource consent application for Ratana WWTP, Rangitikei District Council (RDC) have requested that WSP undertake a review of the Ratana WWTP and the likely implications of future consent changes on the plant and its equipment.

This report reviews and presents

- Site process description
- Performance of the existing plant
- Flow data
- Prediction of future flow and load
- Future performance requirements
- Potential solutions for the plant.

2 Site Description

Ratana is in Rangitikei District on the west coast of the North Island, approximately midway between Marton and Whanganui.

Figure 2-1 : Aerial View of Ratana (from Google Earth)

The Ratana community is served by a public sewerage network shown in Figure 2-2. The entire system of the wastewater network is a gravity flow system, discharging directly to the Ratana WWTP. The community have retained historic roof tanks but are provided with potable water network supply. The effect of water supply is discussed in section 3.1. A separate stormwater system is provided for the entire community.

The entire catchment is on gentle sloping land, with a fall towards the WWTP, with an altitude between 60 and 40 m above sea level.

Discharge from the WWTP is currently on the North side of the Pond System, with a discharge directly to a stream that feeds into the Eastern arm of Lake Waipu. It is the intent of this capital project and resource consent application to remove the discharge of treated wastewater from Lake Waipu and dispose of treated wastewater to land.

Figure 2-2 : Wastewater Network and WW Treatment Works.

3 Historic Performance of Existing Plant

The existing resource consent was granted in 1998 with conditions for the wastewater treatment plant at Ratana to continue discharging from the existing location into the tributary of Lake Waipu.

Conditions cover:

- Flow
- Ammonia- as N
- cBOD
- Total Suspended Solids
- Enterococci
- Dissolved Oxygen

Sample data has been made available for all compliance monitoring since 2018, and this is compared to the historic consent conditions below. The statistics summarised in Table 3-3 below show that not all parameters have been compliant.

3.1 Flow Data

3.1.1 Historic Flow Statistics

Flow is measured at the outlet of Ratana WWTP on a continuous basis and reported on a 24 hour basis. Flow data provided for this review covers the following periods.

- 25 October 2016 through 6 October 2018
- 6 January 2021 through 20 May 2021

Flow data is measured at the inlet to the Ratana WWTP, but due to issues with the meter the data is limited. This data has not been used in this review as historic data was known to be unreliable. This meter has now been calibrated for part of 2021 data. As there is insufficient reliable data to draw comparisons across the plant. Flow meters should be calibrated on inlet and outlet, and if necessary new meters installed.

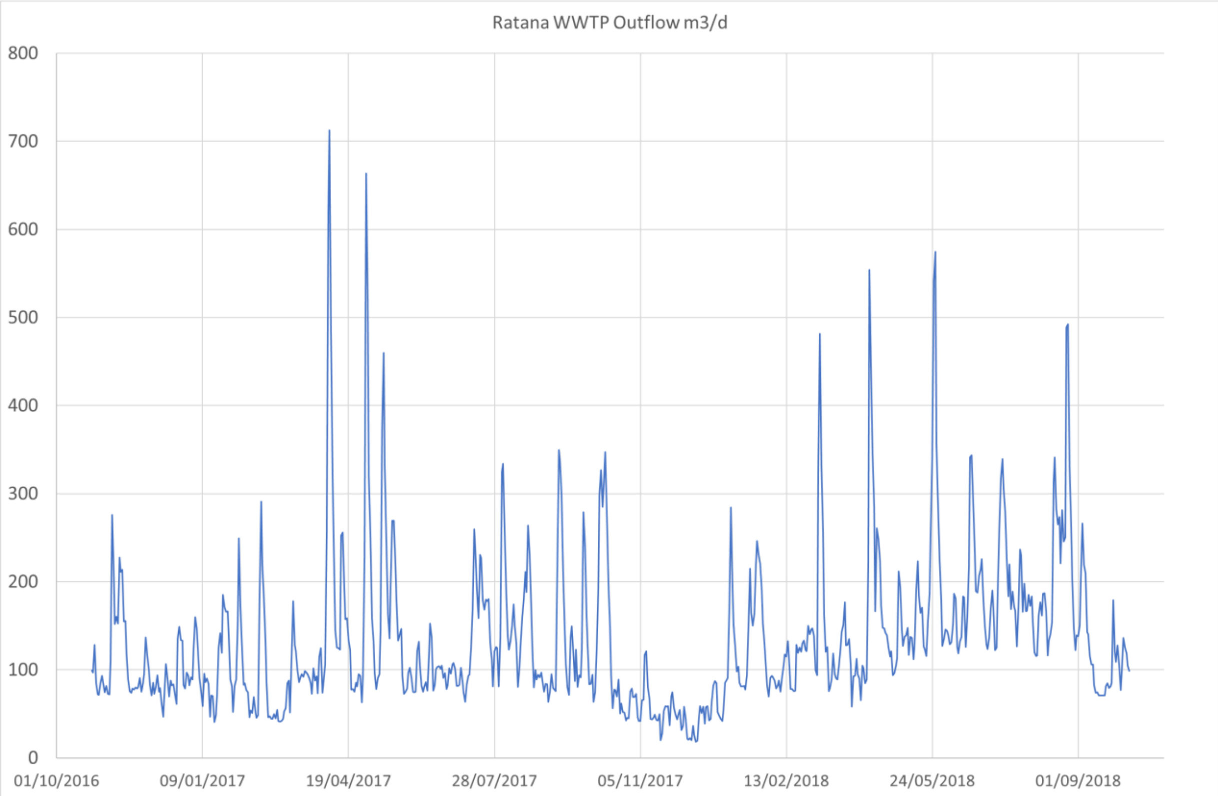

Figure 3-1 : WWTP Discharge flow 2016-2018

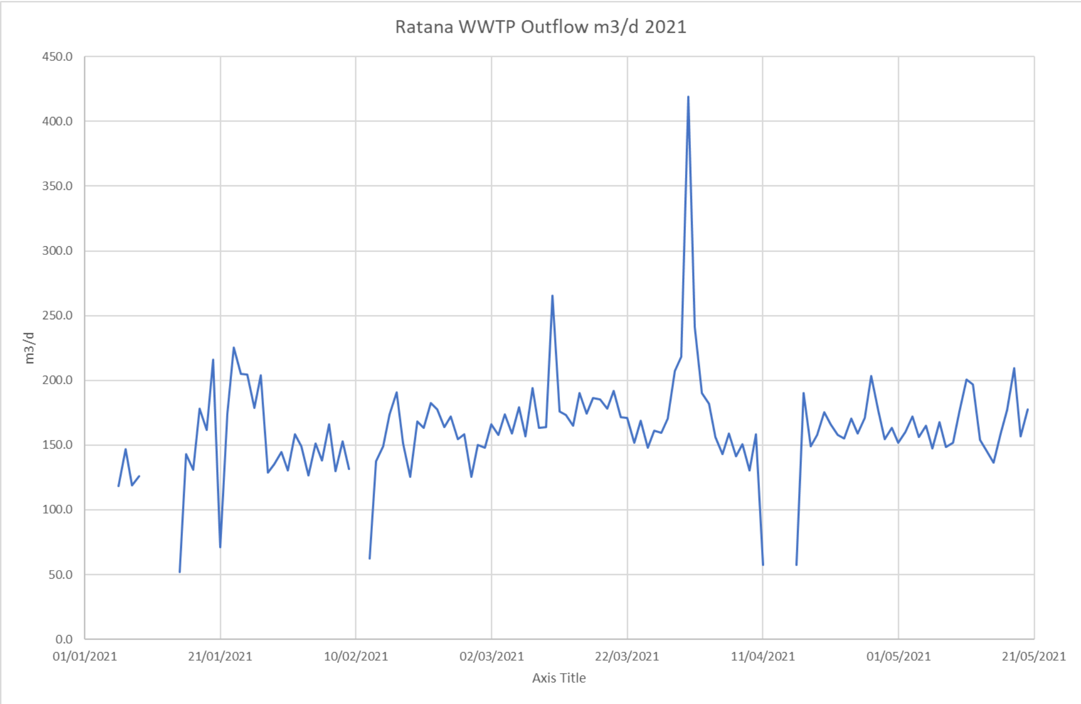

Figure 3-2 : WWTP Discharge flow 2021

Year	Outlet 2016	Outlet 2017	Outlet 2018	Outlet 2016-18	Outlet 2021	Inlet 2021
Number of records	68	365	279	712	105	105
Number usable records	68	365	279	712	105	94
Mean	103.8	134.5	163.3	135.6	121.5	166.2
Median	84.8	101.6	139.0	112.3	110.8	163.4
20%ile	75.2	77.6	97.1	75.6	88.4	149.9
95%ile	212.3	315.4	332.1	246	202.7	207.3
Max	275.8	712.2	574.8	712	373.8	419.3

Table 3-1 : Historic Flow Statistics for Ratana WWTP

The incomplete flow data provided makes comparison between years difficult. A part year does not enable comparison between dry summer and wetter winter conditions. For this reason, although 2021 data is available it is only for 6 January through 20 May 2021, so it cannot be considered representative as it does not fully cover a summer or a winter period.

The 20th Percentile data from the Historical Flow Statistics (Table 3-1 above) has demonstrated good correlation to traditional dry weather flow measurements. As the 2021 period data includes a period of summer dry weather, the values obtained for dry weather flow into the plant are considered acceptable. With a current population of 370, a dry weather flow of 149.9 m^3/d is equivalent to 405 litres per person. This may be due to infiltration or a behaviour of high water usage in the community as water is available and cheaper than many areas. As a cross check, theoretical average flow to the WWTP is predicted to be 74 m^3/d at 200 l/hd/d. It is uncertain whether this difference is due to high domestic usage caused by having roof tanks and potable supply, or high levels of infiltration. If the latter, exfiltration may also occur at times giving rise to lower summer flows.

On this information, the relatively high per capita water contribution, and a static population, means that all incoming sewage parameters are expected to be diluted except for the Ratana Festival period. No influent quality data is available for further analysis.

For design basis the statistics for flow across 2016-2018 are used as this is a continuous long period of data.

3.1.2 Effect of Ratana Festival on Flow

It is known that Ratana has an annual festival that takes place around 24 January each year. During this event it is reported that 3000-5000 people visit the Ratana church and community.

The effect of this period on flow is shown in the graph below

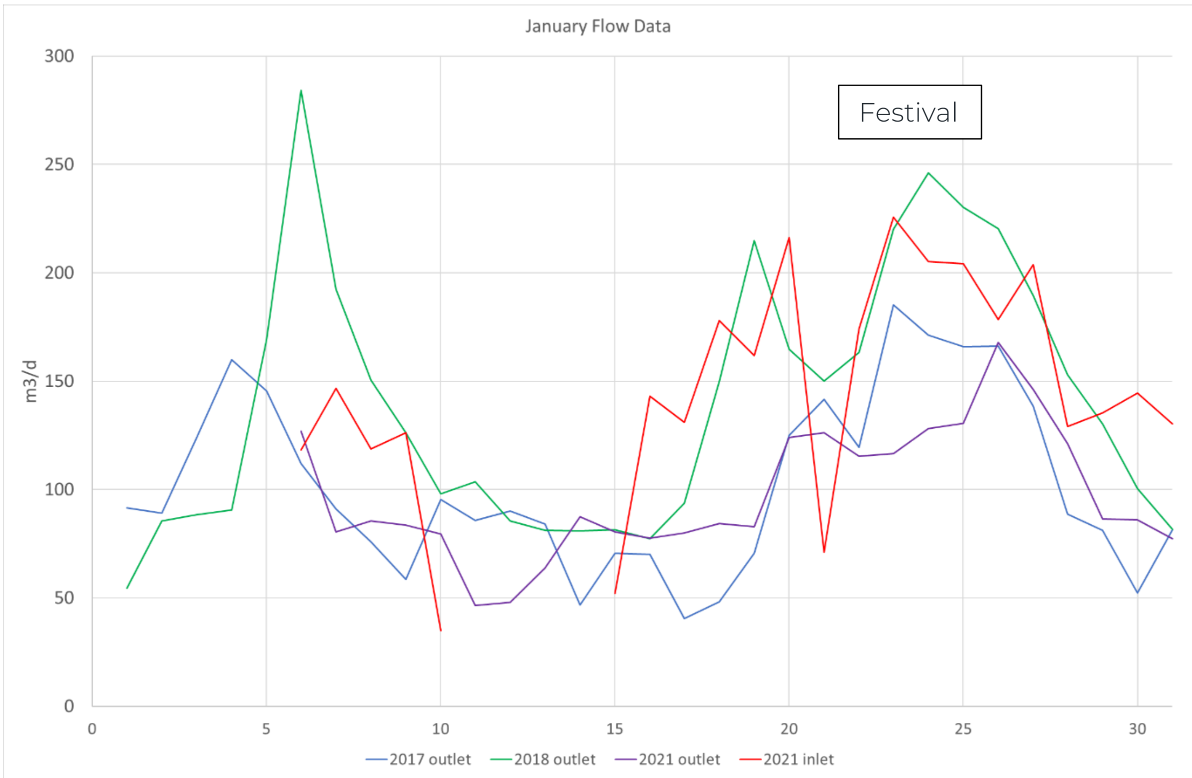

Figure 3-3 : Daily Flows in January 2017,2018, 2021, showing Festival Period.

This data shows that like many pond systems, flow is generally low in mid-January as evaporative losses are high. However, Ratana shows a consistent increase in daily flow over mid to late January as preparations and visitors arrive for the annual festival. This data shows that the daily flow arriving and discharged from the WWTP during Festival periods can reach 250 m^3/d, around 3 x dry weather flow (discharge) seen in the preceding weeks.

Although no data is available to confirm this assumption, it is assumed that the 3000-5000 visitors to the festival will largely be day visitors, so do not have a large water usage (or contribution) and will not contribute a significant organic and nutrient load. The table below gives expected plant loading for normal occupancy and during the festival.

Period	BOD Load kg/d	N Load kg/d	Pond 1 Load kgBOD/ha/d
Resident only	20.7	4.1	52kg/ha/d
Peak	120.7	16.6	302 kg/ha/d

Table 3-2: Current Influent Load Estimates at Ratana WWTP

A typical treatment pond will have an average organic loading of 84 kgBOD/ha/d, so the Ratana ponds perform a good level of treatment in winter for the resident only loading. For short periods, due to long retention time, higher loading can be applied in summer when flow is lower and bacterial activity is greater. This means that higher loading rates can be applied in summer with no change in performance.

3.1.3 Effect of rainfall

There are several high peaks in the flow data shown in Figure 3-1 and Figure 3-2 above that may be attributed to high rainfall impacts. In considering whether these peaks are due to influent flow from rain in the catchment, or just heavy rainfall on the pond area, it is necessary to consider the area and maximum rainfall seen in the vicinity. The total pond area at Ratana is 0.7 ha, so a 50mm rainfall event would contribute 350 m^3 of daily volume. If only 10 mm falls as a rainfall event, then this is reduced to 70 m^3/d.

The peak flow recorded is 5.2 x average flows, which is within the normal range of flows variations seen in wastewater networks. This flow is in part rainfall on the pond area and increased flow into the network.

3.2 Quality Parameters

Samples of effluent are collected at Ratana every 3 months and analysed. Statistics for effluent quality recorded for the Ratana WWTP since 2018 are presented in Table 3-3. Data has been provided only for 2018-2020 inclusive.

	cBOD mg/l	TSS mg/l	NH_3 mg/l	TKN mg/l	NO_3 mg/l	DRP mg/l	TP mg/l	Enterococci cfu/100ml	SIN mg/l	pH
Mean	19.5	86	9.0	16.7	0.6	1.57	2.64	24,332	9.6	8.4
Median	21.0	83.5	7.0	14.6	0.6	1.52	2.62	1,000.0	7.2	8.6
90%ile	24.0	134	18.4	21.4	1.1	2.54	4.0	31,190	18.6	8.9
Max	45.0	161	23.6	32.0	1.1	3.51	4.4	230,000	24.1	9.1
Mean Load kg/d	2.8	11.7	1.2	2.3	0.1	0.21	0.36		1.4	

Table 3-3 : Statistical summary of all Quality Parameters as mg/l.

Due to limited flow and quality data, mean load discharged is estimated using mean flow (2016-2018) multiplied by mean concentration.

3.2.1 pH

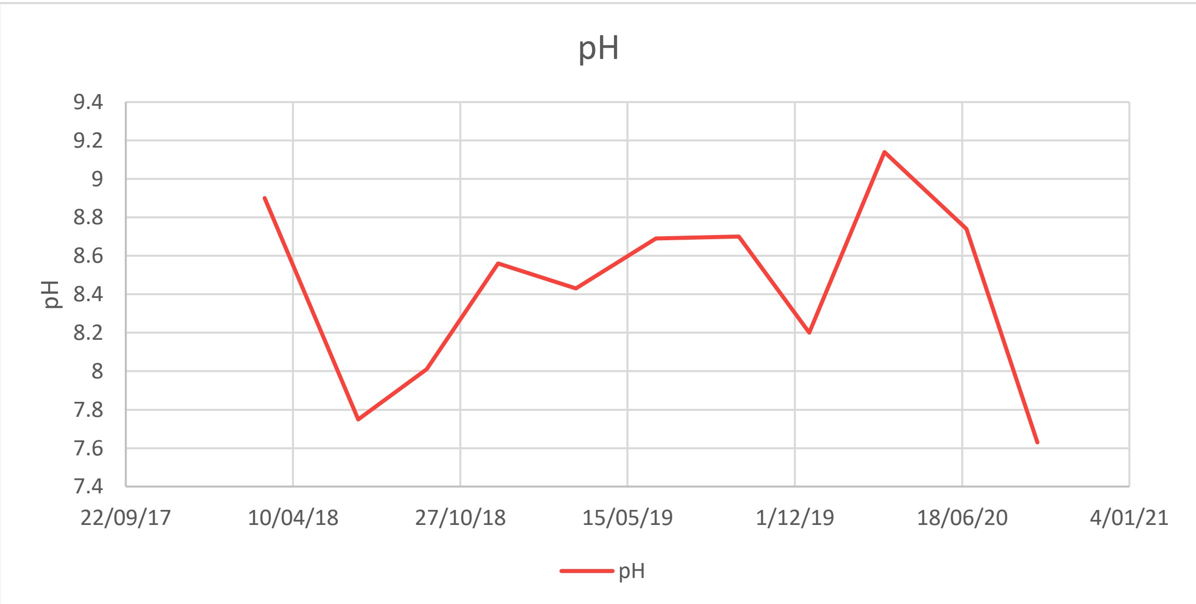

Figure 3-4 : Graph showing effluent pH pH in a pond system can vary through each day and seasonally due to the action of the algae within the pond. As algae tend to fix carbonate in the water, it is commonly seen that the effluent from a treatment pond system will be up to pH 9.0. These results reflect the algal behaviour in that peak pH is seen to match peak suspended solids, indicating high algae activity.

This range of pH is expected to continue with the current plant configuration and is unlikely to have any adverse effects on the environment.

3.2.2 Total Suspended Solids

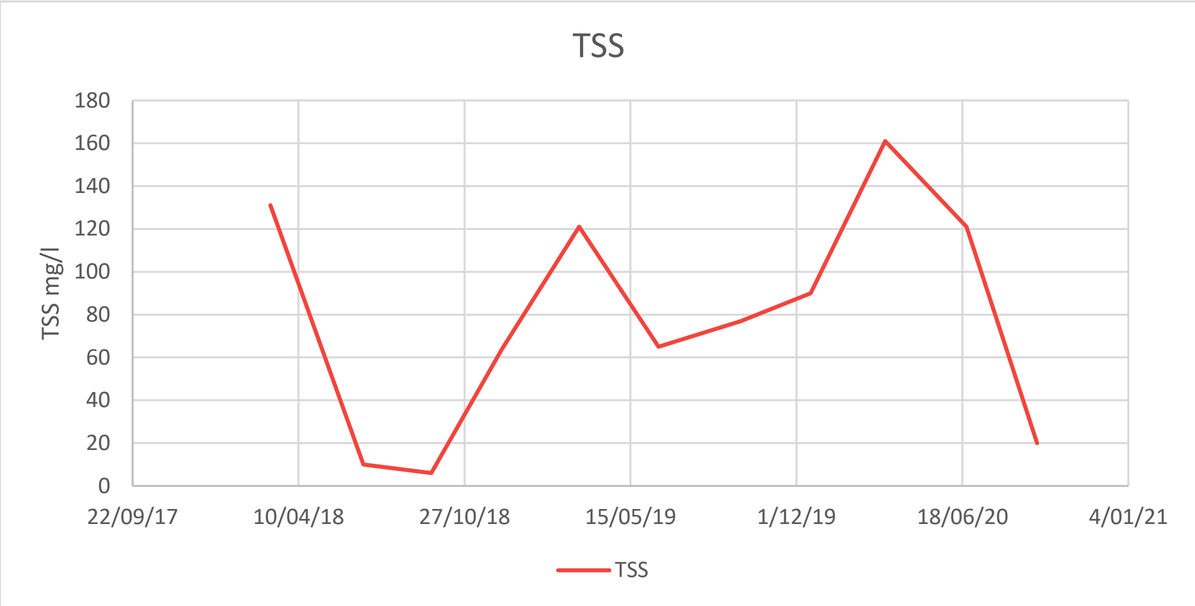

Figure 3-5 : Graph showing Effluent Total Suspended Solids

Suspended solids show significant variability, from < 10 mg/l to over 160 mg/l. This reflects the variability of suspended solids associated with algal growth within a pond system. These concentrations are normal for pond systems, but should an algal bloom occur, may increase beyond the levels reported.

The second pond has a rock gabion understood to provide a degree of filtration before leaving the pond. However, observations saw algal growth between the outlet and the gabion, so concluding that the filtration has limited benefit.

Other pond systems monitored in the region see total suspended solids peak at 250 mg/l in summer. It is considered that this is likely to occur at Ratana, but has not been captured due to low frequency of monitoring.

The current resource consent sets an average of 120 mg/l TSS and a maximum of 200 mg/l. No recorded data exceeds this maximum condition.

3.2.3 $CBOD_5$

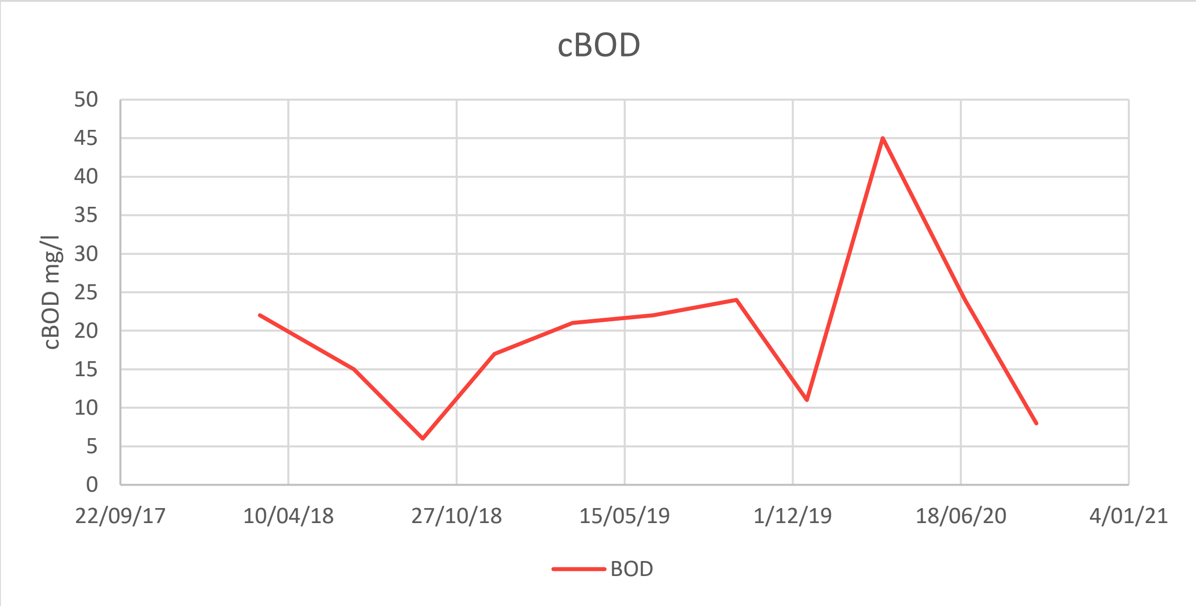

Figure 3-6 : Graph showing effluent BOD concentration

The cBOD trend largely tracks the suspended solids in the effluent. All organic solids in the effluent will contribute to this value as the organisms respire and degradation of dead organic matter occurs.

It is not possible from the limited data available to determine whether BOD removal is effective as the TSS masks the removal of soluble BOD. Soluble BOD is a better indicator of pond performance as it is not influenced by algal solids but reflects the pond's ability to remove organic material.

The current resource consent sets a standard of average 45 mg/l and not to exceed 80 mg/l. For all data available this has not been exceeded.

3.2.4 Nitrogen

There are several forms of nitrogen seen in the wastewater effluent stream. These are as follows:

- Total Kjeldalh Nitrogen, TKN, which is the total of ammonia and organic bound nitrogen, such as found in proteins.
- Ammonia, NH_3-N which is derived from the breakdown of urine and in-pond degradation of organic matter.
- Nitrate NO_3-N and Nitrite NO_2-N, which are byproducts of ammonia breakdown by nitrifying bacteria. These can be summed to give Total Oxidised Nitrogen (TON). Normally in a pond these are found at low concentrations as the nitrifying bacteria do not thrive in the pond environment. Nitrite has not been recorded at Ratana.
- Soluble Inorganic Nitrogen, SIN, is the sum of TON and ammonia, and is commonly used in river quality assessment.
- Total Nitrogen, TN, is the combination of all forms of nitrogen in the effluent and represents soluble and solid associated forms of nitrogen. This is not routinely monitored, but can be considered in a downstream assessment as the organic bound nitrogen can be degraded in the river, to increase the nitrogen load. As nitrate nitrogen is only at very low concentrations, total nitrogen is assumed to be the same as TKN and SIN as Ammonia for Ratana.

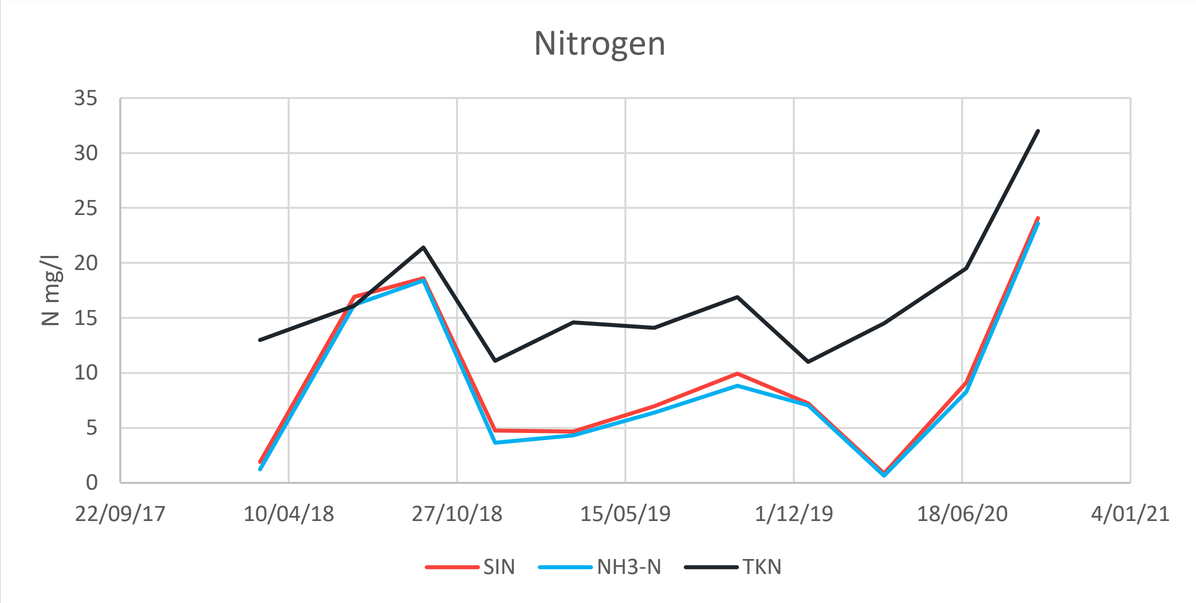

Figure 3-7 : Graph showing Nitrogen Species

Most facultative wastewater ponds will show a seasonal variation in nitrogen and the species present due to the biological processes. As such it is common in pond effluent to see ammonia high in late autumn to spring and very low mid-summer to early autumn due to the assimilation of algae of this nutrient. When algae are growing at their greatest rate, and abundant, there is the maximum uptake of nitrogen.

The nitrogen taken up by algae becomes part of their cellular structure and becomes bound to organic material. Typically, organic bound nitrogen is 5% of bacterial biomass, and 10-15 % of algal biomass.

Nitrate is a by-product of bacterial nitrification (ammonia breakdown). Nitrification requires specific bacteria to be present, but these are not at high numbers in an open pond. Where there are structures and a high area of wave band, these bacteria can grow. However, the low levels of nitrate (the difference between Ammonia (NH3-N) and SIN in the graph), indicate that conditions do not support these bacteria as almost no nitrate is present.

A key design parameter for land disposal is the application rate of nitrogen, expressed as kg N per hectare per year.

Owing to the limited quality and matching flow data there is insufficient to calculate individual daily load discharges for statistical analysis. Instead, an estimate is made by deriving total nitrogen from average measured flow and average TKN.

From available flow and quality data current discharge nitrogen load is 2.3 kg/d, which equates to 840 kg/yr. Typically land disposal to pasture ranges between 150-200 kg/ha/yr., indicating a minimum land area for disposal of 5.6 to 4.2 ha of land

Future growth will see an additional

The current population of Ratana is 370 people, as permanent residents, which would see an influent total nitrogen load of 4.4 kg/d. The nitrogen will be acted upon by the bacteria and algae in the pond. If no nitrogen removal occurred at Ratana WWTP, an annual incoming load of 1,606 kg/yr.

3.2.5 Phosphorous

There are two commonly reported forms of Phosphorous in wastewater as follows:

- Dissolved Reactive Phosphorous, DRP which is a measure of soluble phosphorous forms, largely phosphate.
- Total Phosphorous, TP is a measure of the organic bound, mineral bound and soluble phosphorous forms.

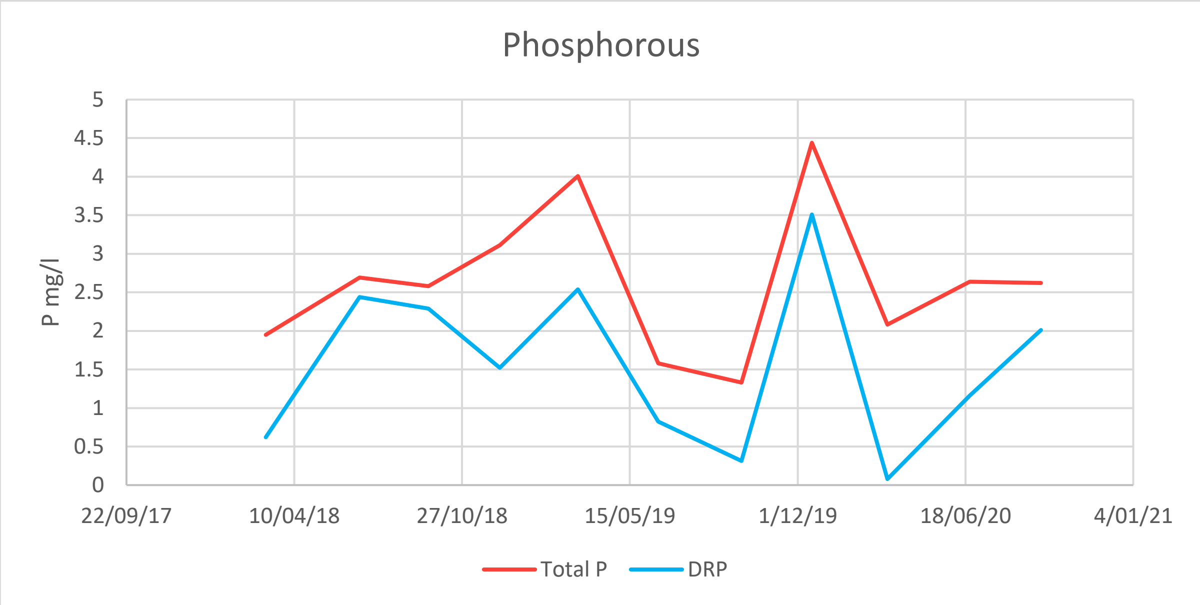

Figure 3-8: Graph of effluent phosphorous concentration

Concentrations of DRP and Total Phosphorous are lower than observed in many wastewater treatment plants. Typically incoming wastewater is 8-10 mg/l Total Phosphorous, with 6-8 mg/l DRP. The flow data that considers dry weather incoming flow from 2021 indicates that there is substantial dilution of the contaminants and the peaks of 4- 4.5 mg/l Total Phosphorous have probably had little removal through the plant. The variation seen is likely due to seasonal changes in algal uptake rates, decomposition and release of phosphorous from accumulated sludge and seasonal dilution. Further dilution will occur in winter and wet periods lowering the concentration recorded.

This low concentration should not be considered a sign of great efficiency, rather a function of influent and variations.

Phosphorous is not a consented parameter

3.2.6 Enterococci

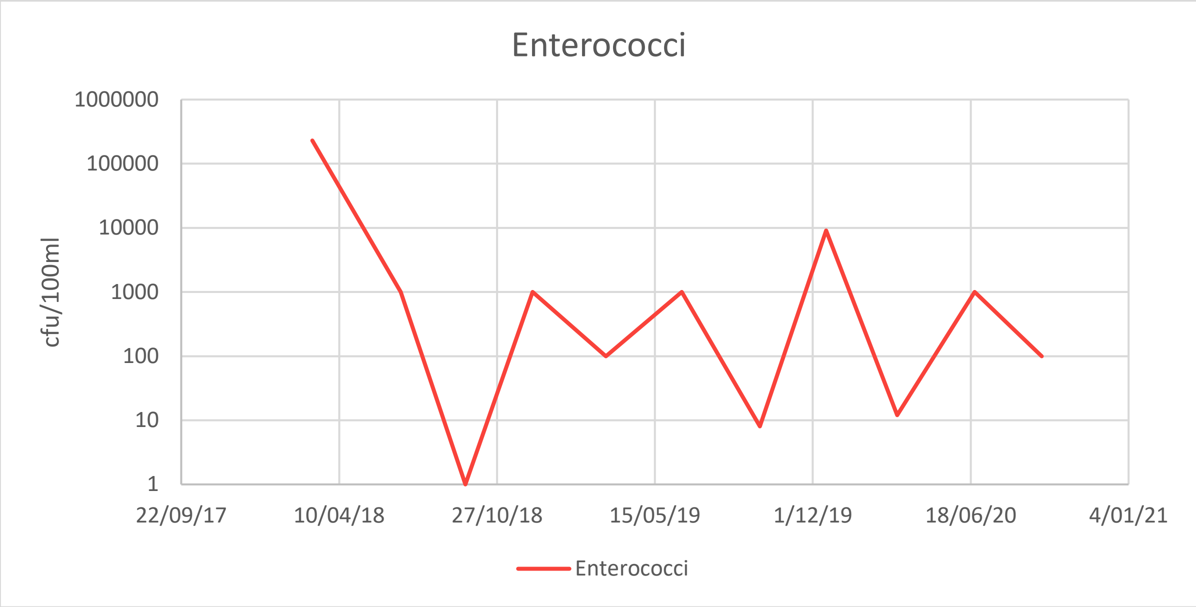

Figure 3-9: Graph of effluent enterococci.

E coli and Enterococci are widely found in mammal and bird faecal matter and are used as an indicator of historic faecal contamination. When low numbers are present, then the levels of more harmful pathogens are also low.

Results for Enterococci are at times elevated, with a peak value of 230,000 cfu/100ml. The median value of 1000 cfu/100ml is typical of a long retention time pond system, where bacteria die off and sunlight will reduce the bacterial levels.

Usually for land disposal the level of E.coli is measured, rather than Enterococci, but both are good indicators of quality. In freshwater or recreational marine waters, a level greater than 280 Enterococci/100ml is considered unsatisfactory whereas 1000 E. coli cfu/100ml is suitable for application used for stock grazing.

E coli is not currently a consented parameter.

4 Future Population and Flow and Load

4.1 Future Population

The 2018 population for Ratana was reported from the census to be 345. It is reported by RDC that the latest estimate, for 2021 is 370 population.

In 2019 central government made funding allowed for a subdivision for 34 plots to be developed at Ratana. It is uncertain how far this growth has progressed, but should all these 34 plots be developed, a population growth of approximately 85people can be expected in the short term to medium term.

It is necessary when considering a long term resource consent to forecast future demand on the system and assess the long term effects. For this reason, to allow future growth beyond the foreseeable period, these estimates will allow for a further 30 plots above the funded number. No specific date has been associated with these plots but represent full development within Ratana in current plans. This will allow an additional 75 people

This gives a future population for design and effect assessment of

2018	345	People
2021	370	People
Growth Assumption 64 Properties	160	People
Total Future Population	530	People

4.1.1 Estimate of average flow.

The following is the estimate of future average and peak flow rates into Ratana WWTP.

Future Average Flow = Current Average Flow (2016-18) + Future Population @ 200l/hd/d

= 136.5 m^3/d + 32 m^3/d

= 169 m^3/d.

Assuming that all new development is on a separate network and does not make significant wet weather contribution peak flow can be estimated as.

Future Peak Flow = Current Peak Flow (2018) + Future Population @ 3 x 200l/hd/d

= 712 m^3/d. + 96 m^3/d.

= 808 m^3/d

= 9.4 l/s.

Due to limited matching inflow and outflow data, there is some uncertainty on whether the peak flow estimate is representative of flows delivered to the site, and this will be further influenced by previous weather conditions in the discharge and the intensity of rainfall on the treatment ponds. It is therefore considered that the minimum capacity of the rising main system to irrigation storage be 1,036m^3/d (12 l/s). Flows above this value can be buffered in the pond capacity as high flow conditions are of short duration.

The pond area is 0.7 ha, so allowing 300 mm of storage across the ponds provides 2100 m^3 of storage for storm events and emergency storage. Based on future average daily flow of 169 m^3/.d, this is 12 days of emergency storage.

No discharge to the local stream and Lake Waipu should occur even in storm events or failure of the transfer pump station.

4.1.2 Future Loading

The following predict future treatment plant incoming load based on the population estimates presented above.

Parameter	Current kg/d	Future kg/d
BOD (60 g/hd/d)	20.7	31.8
TKN (12 g/hd/d)	4.4	6.4
NH3-N (7.5 g/hd/d)	2.78	4.0
Total Phosphorous (2.3 g/hd/d)	0.85	1.22

Table 4-1 : Summary of future loads to treatment

5 Treatment Process Review

This section of report provides a high level overview of the existing treatment plant capacity and the known issues with this system. Many of these issues can be rectified easily, and where this is likely, the benefits are explained.

The wastewater treatment process receives gravity flow sewage from the community of Ratana. The incoming flow passes through a screw type screen and then enters a pump station. This pump station was originally to feed the bio tower in the background of Figure 5-1 below, where organic load was to be removed. At the time of the site visit this equipment was reported to not be operational.

Normally flow enters pond 1 and then flows to pond 2. At the outlet of pond 2 there is a set of gabions and a weir chamber, before cascading from the plant to the stream. The point of discharge at the stream has not been observed due to excessive plant growth.

Each stage is described in more detail below.

It is understood that the plant upgrades were installed in 1999.

5.1 Inlet

Figure 5-1: Ratana WWTP inlet Screen

Wastewater from the Ratana community gravitates to the inlet screen. An internal inspection was not possible during the site visit. It is understood that this screen was installed in 1999, and external equipment such as control panels are showing near end of life. The internals of the screen are expected to consist of a screw auger with automated spray bars and a side hand raked bar screen. It is considered, that unless recently refurbished, this screen is in need to a major overhaul having been operational for over 20 years.

Screenings collected, washed, and compacted by the screen are bagged and captured in a skip for offsite disposal.

The photograph in Figure 5-2 Shows the discharge end of the screen.

Figure 5-2: Ratana WWTP inlet Screen handling system

The roughing process consists of a biotower (plastic media filters and a recirculation pump). The condition of the biotower is uncertain, but it is understood to be over 20 years old. It was evident in the site visit that the PVC pipework used was brittle and in places damaged, it is understood that the pump was no longer present. For this review no capacity assessment has been made of the biotower as it is reported to be unusable.

Figure 5-3: Ratana WWTP Biotower and Pond 1 inlet

5.2 Treatment Ponds

Figure 5-4: Ratana Pond 1 Inlet

Pond 1 is approximately 0.4 ha in area, and of unknown depth. The exact date of construction is unknown from available information, but the design is like others in the area, so probably constructed in the 1980s. Typically ponds built in the 1980s, will be 1.8 m deep in Pond 1 and 1.6 m deep in pond 2.

This gives a total pond 1 volume estimate of 7,200 m^3, which at an average flow of 136 m^3/d is a retention time of 52 days.

Under normal loading conditions with 370 people this primary pond will receive an estimated organic load of 20.7 kg BOD/d. That is a primary pond loading rate of 52 kg/ha/d, considerably under the recognised facultative pond rate of 84 kg/ha/d. Future Pond loading from residential population will increase on the primary pond, pond 1 to 80 kg/ha/d.

The Ratana Festival increases the flow rate up to 250 m^3/d, reducing retention time for that period, approximately 2 weeks, to as little as 29 days and a primary pond loading estimated at 250 kgBOD /ha/d. This short duration loading rate is excessive and understood to be the original reason for the bio tower to reduce some of the load to the pond system. However, from the effluent data this event does not appear to have significant deterioration of overall plant performance.

Pond 1 has a supplementary air mixer of unknown size. This is located to provide a cross pond current, so reducing the risk of short circuiting of high peak loads and providing some supplementary aeration.

Excessive loading to a pond, particularly in peak summer can result in very low oxygen concentrations, anaerobic sludge formation, rising clumps of sludge and large scale odour production and a deterioration in effluent quality. To minimise this risk and provide the maximum capacity for peak period treatment a pond sludge survey is planned to be undertaken of both ponds, and desludging undertaken if required. It is understood from operational discussions that these ponds may never have been desludged since construction.

Figure 5-5: Ratana WWTP Pond 2, Outlet Area

Pond 2 is linked to Pond 1 by a gravity pipe located at the western end of the ponds, opposite the outlet. This configuration gives maximum retention in the ponds.

No assessment of the ponds has been made for short circuiting due to the weather conditions at the time of the site visit creating many waves that obscure the visual indicators.

The gabions have been installed to provide a gross solids removal barrier prior to discharge and is considered effective against larger material such as leaves and feathers that could cause blockage.

It is understood from observation and shown in Figure 5-6 that flow passes through the gabions and then must percolate through the gravels before overflowing the weir in the chamber.

Results show that some filtration may be occurring, but peak suspended solids are comparable to the suspended solids commonly found in pond systems. It is considered that the gravel is either unable to trap small algae and organic particles, or there is at times sloughing of the solids from the gravel.

A gravel filter will over time become blocked with solids and biofilms and requires periodic maintenance to remain filtering and not contaminate the effluent.

Corrosion of walkways, gratings and supports is a concern for the safety of those on site, and it is recommended that a thorough asset inspection is made and where corroded replacement made.

Figure 5-6: Pond 2 Outlet showing gabions, gravel, and overflow chamber

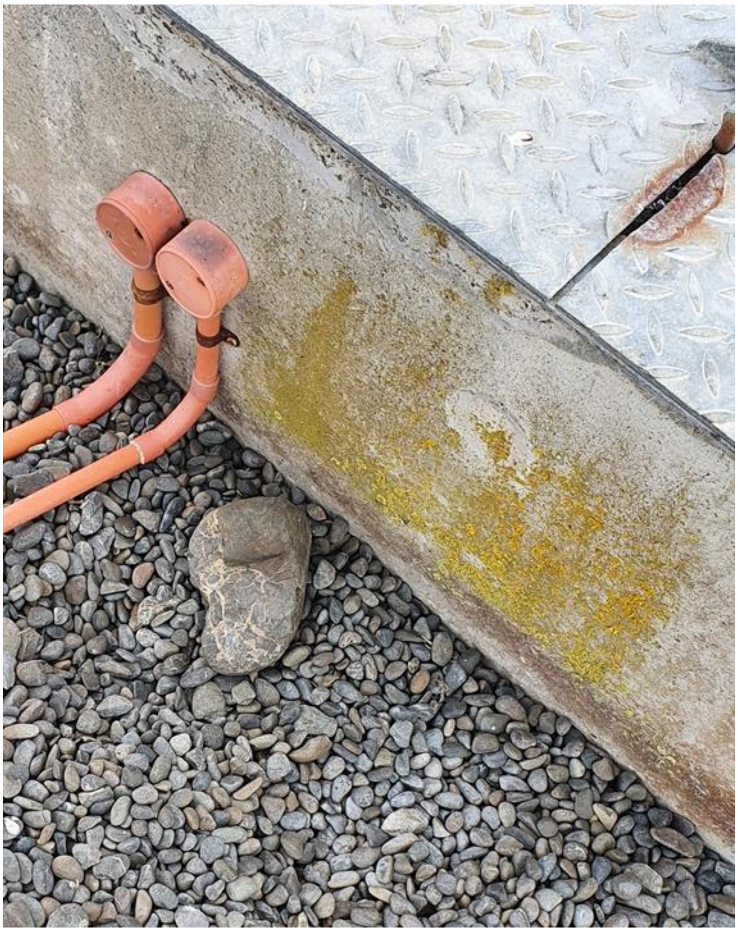

Figure 5-7: Pond Overflow chamber showing corrosion.

5.3 Discharge

The discharge from Pond 2 is by gravity through a series of manhole chambers which serve as flow meter and sample point, before discharge to stream.

Figure 5-8 below shows the V-notch flow meter. It is reported by RDC that this flow meter is regularly calibrated and provides a reliable reading. Samples can be taken easily with little risk of contamination from the discharge of the V-notch, although it is recommended to move the cable away from the sample point.

Figure 5-8: V Notch Flow meter and sample point

The current discharge is to stream, but due to excessive plant growth it was not possible to observe the discharge or any potential effects on the stream. It is recommended that the stream is kept clear of excessive plant growth to prevent flooding. Once the transfer of treated effluent to irrigation is complete, this maintenance will not be required.

5.3.1 Summer Algae problems

The site visit did not have the benefit of the site operator, so it was not possible to ascertain whether the site has experienced algal blooms. Blue green algal blooms can produce cyanotoxins that can paralyse or kill mammals and birds, so if these occur, discharge should be stopped from entering the receiving watercourse. This applies whether to stream or discharge to groundwater.

If these algal blooms are occurring, it is recommended that further upgrades are made to prevent recurrence and discharge.

5.3.2 Pond permeability

Details of the construction of the ponds are not available for this review. Observations show that these ponds, with concrete waveband are not likely to have a plastic or butyl liner and are probably clay lined. As part of investigations a bore was installed for the purpose of providing some ongoing monitoring. Bores in the bunded area between pond 1 and pond 2 (western end) show a layer of clay overlaying sands and gravels. Initial tests of the ground water in the bore in the western bore found very little water, indicative of low seepage from the pond towards the stream.

6 Future Performance Requirement

The final resource consent effluent quality standard will be determined based on the potential effects. Factors that influence potential effects include irrigation area, irrigation method, and sensitivity of local groundwaters, soil type and land use. The parameters given below are based on typical parameters and standards applied that can be expected at Ratana WWTP, further details are discussed in the irrigation report.

6.1 Parameters to be considered for land discharge

The discharge to land quality requirement will be dependent on the land use, planting and potential effects on ground water and type of irrigation system. The following is a high level summary of potential changes expected in wastewater quality, these would be further considered and assessed in both the irrigation report and groundwater assessment.

pH

It is considered that the pH longer term will reduce as the retention time reduces and the organic load increases, which will reduce algal activity. However, at times high algae activity will still occur, and the pH will typically be pH 7.0 to 9.0.

This is considered to not be an issue for land disposal and this range will be achieved with existing plant.

Nitrogen

Land application of wastewater is commonly limited to 150-200 kg N/ha/yr. Higher application rates can be used where cut and carry of animal fodder is practiced but further assessment would be required.

Based on the current nitrogen load (discharged), estimated as 2.3 kg/d, 839 kg/yr. would be discharged. The effect of 160 additional people will be to increase the influent Nitrogen load by 1.92 kg/d into the plant. If no additional nitrogen removal occurs in the treatment process, then the nitrogen load discharged is an average of 4.22 kgN/d, The annual discharge of total nitrogen is estimated in future to be 1,549 kg N/yr.

Should additional nitrogen removal be required, low cost in-pond treatment such as Bioshells may be applied to remove ammonia and allow some denitrification.

BOD

BOD is a measure of organic content that can be degraded by microorganisms. The effect of growth on pond 1 loading rate will be to increase the average pond load to 32 kg/d, equivalent to 79.7 kg/ha. This is below the typical pond design loading of 84 kg/ha/d so a reasonable level of treatment can be expected outside of the peak festival period.

A small increase in soluble BOD will occur in the system due to the lower retention time in the ponds, and this could lead to a low level of biofouling on pipes and irrigators. This is unlikely to cause issues provided the pipeline runs above a self-scouring velocity (0.7 m/s recommended) and the nozzle system can manage sloughed biofilm. Operational practices may be used for cleansing.

To achieve consistent low levels of BOD it is necessary to maximise pond retention time, so desludging of the ponds is required.

Should soluble BOD become an issue in the irrigation system, then in-pond treatment such as Bioshells can be used to reduce BOD. Similarly, the bio tower system could be refurbished for organic removal if required.

Microbial Quality.

In older resource consents monitoring was undertaken for Enterococci, as undertaken at Ratana. More recently E. coli is used a measurement requirement. The E coli standard will be influenced by land use and groundwater effects

Commonly, where stock animals are grazed a standard of median 1,000 E coli, cfu/100ml, is used, with drying off periods between cattle rotation. With no additional treatment, it is expected that E coli results will be like the Enterococci results reported, with a peak of 230,000 and median of 1,000 cfu/100ml. This relationship can be proven by taking samples of both parameters over a period to show the correlation and expected output as E coli.

A concern commonly raised is the health impact on workers in the disposal area. Like most modern disposal areas, it should be possible to isolate, all or parts of the system to enable maintenance. Operations wearing basic gloves and exercising basic hygiene practices will be at very low risk of illness.

Should a higher level of disinfection be required it will be necessary to make additional plant modifications to allow UV disinfection. Techniques that may be used include:

- Floating covers suppress algae in the back of Pond 2. This lowers solids enough for additional UV treatment to operate.
- Tertiary solids removal followed by UV. This approach is a mechanical system such as a DAF before the UV disinfection.

Phosphorous.

Land discharges may have a requirement for monitoring of total phosphorous. A typical standard of 50 kg/ha/yr. is commonly applied. Current phosphorous loading is 0.36kg/d, which over 7.9 ha is 16.6 kg/ha/yr.

Future growth may increase this load by 0.37 kg/d, giving a future application rate of 33.7 kg/ha/year.

If phosphorous removal is required for groundwater quality, it can be achieved by two mechanisms.

- Solid reduction. Approximately 15% of all phosphorous discharged is associated with organic solids as it forms part of plant and animal cell structures and proteins. A small reduction can be achieved by reducing suspended solids.
- If a larger reduction is required, it is necessary to removal soluble phosphorous (DRP), and this is commonly achieved by dosing with alum. A tertiary treatment system such as a DAF is ideal for this as it allows the chemical mixing and capture of the resulting solids. Gravity settlement of alum treated pond solids is not recommended as algae are commonly neutrally buoyant, so will not sink.

6.2 Effects of Irrigation Storage on Effluent Quality

A few issues are reported across New Zealand where the quality of stored treated wastewater deteriorates for several reasons. This may cause operational problems and influence disposal rates and frequency. This section summarises several of these issues and how these factors may be managed. It is recommended that these issues are considered in the design of the storage and included in the site management plan to mitigate if required.

Nitrogen

The transfer main will be coated in bacterial growth. Some nitrogen will be reduced by these bacteria during the transit to the storage pond. This has not been quantified and will vary with temperature and oxygen levels and BOD levels entering the pipe.

Storage lagoons will provide additional retention and conditions where bacteria and algae can assimilate nitrogen. This will be variable depending on temperate and season, particularly because of algae growth.

The lower levels of a storage pond will have anoxic conditions, which will allow bacteria to denitrify nitrate that has been produced in the treatment process.

It is recommended that monitoring of WWTP effluent and flow to irrigation are undertaken to determine whether additional treatment is required to further lower nitrogen levels in the future.

Suspended solids

An open pond with available nutrients is a suitable location for the growth of algae, which may result in a bright green storage pond due to algae. This increases the risk of irrigation (dripper and subsurface) blockage. Blue green algae may occur, which to protect the groundwater from toxins, mean that discharge should cease. If high solids levels occur preventing discharge, additional treatment such as membranes will be required at the disposal site for seasonal improvement.

Odours

A storage pond over time will accumulate solids from the treatment plant effluent and new biomass production in the pond. This accumulates in the pond as a sludge layer. In shallow ponds, < 1.5 m, this rarely creates problems, but in deeper ponds, the degradation of this sludge layer in summer can result in production of hydrogen sulphide. This creates nuisance to neighbours. During periods of odour production, there is increased risk of sludge clumps rising to the surfaces, which also increased risk of irrigation system (all types) blockage. Odours may be managed by chemical addition (iron salts) or by pond aeration.

E coli increase

In a pond E coli should decrease because of UV from sunlight in the water. However, wildfowl can occupy the storage pond, either permanently or seasonally, and contribute bacteria in faeces. This also increases nutrients that encourage algae growth and sludge accumulation. Wildfowl deterrents are unlikely to be effective over a large storage pond.

Opportunities to minimise the effects on storage.

There are several methods employed to reduce the risks above. Consideration can be given to use of floating covers, such as Hexacover or floating plastic balls, that provide a deterrent for wildfowl and by blocking sunlight prevent algae growth. Where high solids are also transferred from the treated effluent the covers may decrease oxygen transfer into the storage pond and odours and sludge accumulation become a bigger issue. In this situation it is recommended to consider aeration of the storage pond. There are a wide range of aeration systems suitable that can use diffused air or floating surface aerators, some of which can be modular and use solar energy. Floating covers can be selected to be compatible with aeration systems.

6.3 Effects of growth on performance

From the performance data available and by assuming the pond system does not remove any additional load from the incoming wastewater, it is considered unlikely that any significant changes in effluent quality will result from growth to the Ratana WWTP as flow and loads are within normal design limits for a pond based system.

A concern raised in the production of this report is the Ratana Festival. As identified in the section above on flow to the works, there is information that shows for a two week period the population substantially increases and exerts an elevated organic and nutrient load on the pond system.

It is recommended that RDC undertake a monitoring programme to assess the influent and effluent of the plant over the summer and festival period.

6.4 Future performance standards

The following standards at the WWTP are proposed for the Ratana WWTP treated effluent.

- Samples are to be taken as spot samples at the designated final effluent monitoring point before flow leaves the Ratana WWTP. A minimum of 12 samples per year shall be collected, with no more than 5 weeks between samples.
- Flow shall be measured on the incoming sewer line and on the discharge to irrigation. For consent purposes, the discharge flow meter shall be used for compliance, with backup from the incoming meter should failure occur.
- All incoming wastewater flow shall be treated, with an annual mean daily Flow not to exceed 200 m^3/d.
- Total Nitrogen daily load not to exceed 4.3 kg/d in 8 of 12 consecutive samples. TN load shall be calculated by taking each sample result x daily flow on day of sampling.
- Total Nitrogen concentration not to exceed 25 mg/l in 8 of 12 consecutive samples, with an upper limit of 35 mg/l in no more than 2 of 12 consecutive samples.
- Total carbonaceous BOD (cBOD) shall not exceed 30 mg/l in 8 of 12 consecutive samples, with an upper limit of 50 mg/l in no more than 2 of 12 consecutive samples.

Note that a total nitrogen load standard may be applied for the whole land irrigation system, and this will be monitored at the irrigation discharge.

The following parameters should be monitored

- E coli
- Ammoniacal Nitrogen
- Nitrate N
- Nitrite N
- pH
- Total Suspended Solids

It is considered that the Ratana WWTP will achieve these standards within the expected long term development without immediate treatment upgrades.

7 Potential Solutions If required.

7.1 Nitrogen Removal

If additional nitrogen removal is required there are a number of solutions that provide conditions for nitrifying bacteria to flourish and remove ammonia. To achieve a lowering of total nitrogen it is also necessary to remove nitrates, the by product of ammonia removal.

An in pond system that has been demonstrated at Paihia WWTP (Far North District Council) is the Bioshells system. This consists of plastic rings within shells arranged in the pond. These are fed with air to create the ideal conditions and high levels of ammonia removal are achievable.

A similar approach is to use moving bed bioreactors as a tertiary treatment unit that will grow nitrifying bacteria on plastic floating pellets. This process is kept always moving by the air that provides the aerobic condition for ammonia removal.

To denitrify, the removal of nitrates, it is necessary to have anoxic conditions. At Paihia a degree of denitrification was achieved by a zone of unaerated pond after the Bioshells. This is a passive denitrification system. Similar passive systems may use submerged woodchip, or surface flow wetlands.

Active denitrification can be used to achieve very low levels of nitrate consistently, and this involves growing bacteria in a tank and feeding a source of carbon, such as sugar or molasses to drive the removal of nitrate. Unlike the passive systems, this can achieve low nitrogen levels all year, and not be affected by colder weather.

All these approaches to nitrogen removal can be applied if required later at the Ratana WWTP.

7.2 Phosphorous Removal

phosphorous can be removed by chemical addition to produce an inert solid using aluminium or iron salts. These solids need to be settled from the effluent stream before discharge and this is usually by gravity settlement. When adding chemicals to a pond effluent, the additional salt reactions form hydroxides and phosphates that create an elevated suspended solids concentration. Recent trials of dosing have demonstrated that TSS in the effluent may reach 250 mg/l or more at times as a result of adding chemicals. This level of TSS is unacceptable to the irrigation system and will cause odour issues in the storage and in the irrigation areas.

Consequently, when chemical addition is used TSS must be reduced. The two main technologies used in New Zealand for TSS removal after a wastewater pond are Dissolved Air Flotation (DAF) and use of membrane systems. Suppliers of membranes recommend that a DAF is used as pre-treatment of membranes to optimise performance. Hence a DAF is most likely to achieve the required TSS concentration.

An alternative to chemical dosing is to use biological nutrient removal. For this to be achieved with no chemicals, the wastewater treatment plant must be an activated sludge plant with areas of anaerobic, anoxic, and aerobic conditions. This would replace the pond system at Ratana with substantial increase in operational costs and capital expenditure.

7.3 Suspended Solids (TSS)

Suspended solids can contribute to elevated total nutrient levels and risk of odour generation as they degrade. High solids content can enable greater microbial contamination to occur.

If TSS are to be reduced, due to the buoyant nature of the algae present from the ponds, they must be removed by either Dissolved Air Flotation (DAF) or filtration by membrane as described in phosphorous removal above.

The sludge produced must be captured and separated from the water fraction rather than being returned to the treatment pond as returning both fractions result in excessive pond loading, excessive sludge build up and reduction in treatment quality. Commonly on a small treatment site such as Ratana the sludge will be managed by Geobags, with offsite disposal periodically.

7.4 E Coli.

The historic data show that Enterococci are able to achieve 1000 cfu/100ml or below as an annual median. If further disinfection is required then it is recommended to either use UV disinfection or tertiary membranes. For the UV system to be effective a reduction in TSS may be required. This is described above.

7.5 Multiple parameters

Should multiple parameters require process upgrade on the site consideration must be given to the whole life cost of construction of a new treatment facility. Modern activated sludge plants offer consistently high effluent quality, ease of operation and costs similar to the multiple plant upgrades such as in pond treatment and tertiary solids removal.

7.6 Maintenance

To ensure that the existing plant can continue to perform, it is necessary to undertake several maintenance activities. These are

- Refurbish/ replace screen
- Sludge survey and if needed, desludge ponds
- Replace gravel at outlet of pond 2.
- Minor repairs to outlet chamber structure.
- Ensure both flow meters are calibrated regularly

8 Recommendations

At this time in the resource consent application, it is not known what the full requirements of the environment will be, but it is anticipated that in the short term that the existing process can achieve the typical quality required for land irrigation to land. The following actions are recommended to maintain the existing process to achieve the recommended wastewater standards.

1 Replace/refurbish existing screen. This asset is at the end of its life and will become less reliable. A good screen will protect all downstream assets from blockage.

2 Pond sludge survey It is considered unlikely that the ponds have been desludged in recent years and a sludge survey should be undertaken. It is recommended that this is undertaken every 3 years to monitor sludge levels and if sludge is accumulating, initiate contracts to desludge where needed. This optimises the pond retention time and reduces the risk of sludge inversion in high loading and high temperature periods that will result in large odour problems. The sludge risk is greatest at the festival period as the oxygen levels are lowest in the pond. A survey at this time will allow costs to be included in the LTP.

3 Outlet Maintenance. The outlet structure and gravel have evidence of being sludged up and should be cleaned out. The chamber should be inspected and if corroded, refurbished. Routine maintenance is recommended that the outlet weir chamber and flow meter chamber are cleaned weekly.

4 Data records. In the preparation of this document records for flow were not readily available. Going forward it is expected that the resource consent will make it a condition for flow measurement on the incoming and outgoing flows, requiring data to be reported daily. Regular calibration and certification of flow meters is required.

5 Monitoring. Sampling of the effluent has been as required by the resource consent. This low level of 4 samples per year is considered insufficient to reliably show the performance of the plant. A greater sampling frequency is recommended, with a minimum of monthly sampling. Additionally, to understand population changes that will occur a monthly composite incoming sewage sample is recommended. This provides information that can be used to understand odd plant performance and trigger capital investment.

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