Tablelands Regional Council

Atherton STP Environmental Evaluation

Atherton STP: Planning Report

June 2019

Executive summary

GHD were commissioned by Tablelands Regional Council (TRC) to develop a Planning Report for the Atherton Sewage Treatment Plant (STP) with a planning horizon to 2041 that also assesses scope for short-term facility enhancements. An Environmental Evaluation report was also developed for the receiving waterway. This Planning Report should be read in conjunction with the parallel Environmental Evaluation Report.

Historically the STP treats an average of 2,030 kL/d of sewage. Since 2015, the process has shown improved compliance with the limits of the EA with exceedances leading to the Atherton STP Environmental Evaluation (EE) process related to short-term maximum concentrations.

Based on the current or more stringent future License, the investigation identifies the existing STP infrastructure has limited capacity and will likely require an upgrade within the next 5 years. Limitations within the existing tankage and constructability issues preventing access to the heavily loaded process units pose a risk to effluent quality and prevented options to upgrade the existing process. Three short-listed options were developed to construct a new treatment process parallel to the existing SBR, which will ultimately be retrofitted and repurposed as the new Aerobic Digester. Based on the Multi-Criteria Analysis, the new treatment process is likely to be a four Stage Bardenpho membrane bioreactor, with chemical phosphorous removal.

The key recommendation arising from this investigation is for TRC to enter into License negotiations / discussions with the Department of Environment and Science (DES) to agree the future License as the growth projections will exceed the current limit of 10,000 EP in the next 5-10 years. The future License is the key factor driving the process selection and whilst it is appreciated that water quality is critical, achieving this has an environmental cost through increased power and chemical usage.

A timeline of ~5 years to complete a major STP upgrade is expected, therefore, a residual risk to the environment remained. In order to manage this, the Planning Report recommends short/medium term improvements, which include infrastructure improvements and management practices to mitigate the discharge of lower quality effluent prior to the major upgrade being completed. Considering the Environmental Evaluation Report did not identify any long term environmental harm from the STP historic exceedances, this approach minimises the short/medium terms risk to the environment.

The dry season when creek flows are at the lowest represents the highest risk to the receiving environment. TRC have implemented a beneficial re-use scheme to irrigate treated effluent. Diversion of the nutrient load from Priors/Mazlin Creek during the high-risk season is a significant step taken to protect the environment. During the 2018 dry season, an average of ~50% of effluent produced was irrigated and TRC have reported extended periods (2-3 months) where no discharge to the creek occurred.

Although Mazlin Creek forms part of the Barron River catchment, a Great Barrier Reef Catchment, it discharges into Tinaroo Falls Dam, which is 165 km upstream of the discharge to the Coral Sea in Cairns. The dam was constructed in 1958 as an irrigation storage dam supplying the Mareeba-Dimbulah irrigation area, with a reported 205 000 ML/a assured irrigation supply.

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1. Introduction

1.1 Atherton STP

The Atherton Sewage Treatment Plant (STP) is a Sequencing Batch Reactor (SBR) process that is operated by Tablelands Regional Council (TRC) to meet a specific effluent quality prior to discharge into Priors/Mazlin Creek. In recent years, despite the plant operating well below the design effluent quality, periodic non-compliant discharges have occurred and have triggered this investigation to identify the cause.

As part of an Environmental Evaluation of the Atherton STP, GHD has prepared a detailed Planning Report that includes process and hydraulic models for the existing STP to identify key issues and improvements required to manage future growth in the catchment. The Planning Report was delivered in a staged manner as described by Table 1.

Table 1 Summary of Detailed Planning Report and Objectives

Milestone	Description	Key Objective of Stage
1	Process model and calibration	• Information review and gap identification; • Investigations to close gaps i.e. intensive site testing and site survey; • Develop current load model and growth projections. • Develop and calibrate process and hydraulic models based.
2	Capacity Assessment	• Run current and future loads in models to identify areas inhibiting process performance;
3	Options Assessment	• Based on the outcomes of the Capacity Assessment, investigate options to upgrade the existing process to maintain / improve the treatment performance. • Undertake an NPV assessment of the options; • Undertake an Multi-criteria analysis of the options to identify the most preferred upgrade path;
4	Planning Report	• Develop a Planning Report to enable TRC to stage the upgrade to ensure capacity is in place to accommodate the load growth in the catchment.

This Environmental Evaluation Planning Report is a summary report presenting the key findings of Stages 3 and 4 concluding with the adopted strategies to manage effluent discharged to Priors/Mazlin creek into the future. Where specific details were required as part of the Environmental Evaluations, this information is carried over from the Detailed Report as detailed in Table 2 below.

Table 2 EE requirements pertaining to the Planning Report

Item	
A.3.	Over the last twelve months, the STP has been non-compliant with prescribed release limits in the EA. Exceedance notifications of the release limits for contaminants were provided as follows: a. 21 April 2017 - for Free Residual Chlorine; b. 7 August 2017 - for Ammonia Nitrogen and 5-Day Biological Oxygen Demand; c. 5 January 2018 - for Ammonia Nitrogen and Total Nitrogen.
A.4.	The current on-site treated effluent release practices do not align with the requirements of the EA, with final treated effluent quality monitoring occurring prior to indeterminate storage of treated effluent in an on-site irrigation storage dam. Actual release (quality and accurate quantity) is unmeasured, limiting the ability of the operator or the department to determine the potential for environmental harm to occur in Mazlin Creek.
A.12.	High concentrations of ammonia nitrogen in freshwater is known to be toxic and can lead to nutrient enrichment of water and lead to changes in biotic community structure (page 49, Australian and New Zealand guidelines for fresh and marine water quality. Volume 2, Aquatic ecosystems / Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand).
A.14.	The department considers that the activity conducted by you on the premises (sewage treatment) is likely to cause environmental harm due the concentrations of ammonia and total nitrogen measured in some treated effluent and the water quality monitoring undertaken in Mazlin Creek.
B.4	a. A review and assessment of the current and likely future service demand needs of the plant in accordance with the Planning Guidelines for Water Supply and Sewerage April 2010 including amendments dated March 2014 (the guidelines); and b. A determination on the current plants' capacity and performance to meet the defined service needs.

1.2 Summary of Current Treatment Processes

The Atherton STP consists of the following process units:

- Inlet works with a mechanical step screen, manually screen by-pass channel, grit chamber, screenings handling and odour control
- Septage receival screen, upstream of the inlet works.
- Septage balancing system to gradually feed tanker discharges into the main treatment stream, to minimise shock loads on the STP (previously identified as a key risk).
- A distribution chamber to alternate flow to the two Sequencing Batch Reactors (SBRs).
- Two SBRs, each with a dedicated selector, pre-aeration and main aeration zones.

- Aeration is achieved via two blowers and diffused aeration.
- Return Activated Sludge (RAS) recycling from the SBR main zones to the selector zones.
- Alum dosing to the distribution chamber, SBR main zones and equalisation tank to chemically trim phosphorus.
- An Effluent Balance Tank (EBT) to buffer intermittent effluent SBR decants ahead of filtration.
- A filter by-pass, discharging to the CCT is installed in the manhole immediately upstream of the EBT for peak flow events.
- Pressure sand filtration. Backwash water is discharged to the adjacent general purpose pump station (GPPS).
- Final disinfection with sodium hypochlorite prior to irrigation / discharge.
- Waste Activated Sludge (WAS) is pumped from the respective SBR aeration zones to the Gravity drainage deck (GDD) for pre-thickening ahead of the Aerobic Digester.
- A retrofitted primary clarifer operating as an aerobic digester for sludge stabilisation.
- A Belt Filter Press (BFP) for dewatering.
- Two sets of sludge drying beds are installed on site.
- Shared polymer preparation and dosing system for the GDD and BFP respectively.
- Filtrate from the GDD and BFP is diverted to the GPPS and returned to the head of the plant.

A process flow diagram illustrating the above is presented in Figure 1. A site layout of the existing facility is provided in Appendix A.

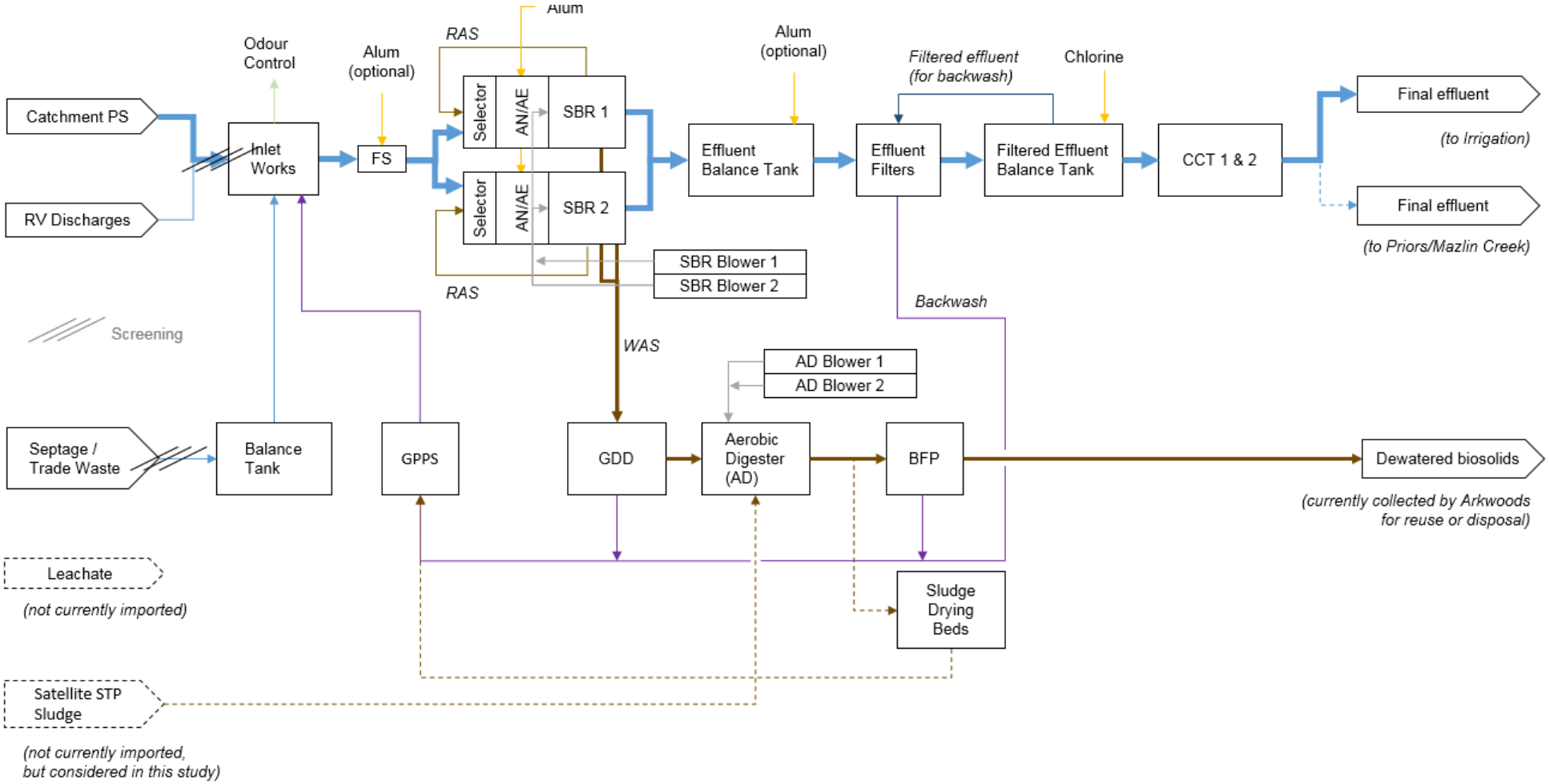


Figure 1 Existing plant process flow diagram

1.3 Atherton STP

The overall objective of this project is to minimise environmental impact and meet Licence requirements now and for the planning horizon (2041). This is to be achieved by:

- Developing a better understanding of the capacity and operations of the existing facilitiy;
- Formulating options for both short term improvements and a major plant upgrade;
- Investigate beneficial reuse of effluent from the treatment facility for irrigation; and
- Assessing nutrient discharges to the environment.

1.4 Purpose of this report

The purpose of this report is to summarise the planning study for the operation of Atherton STP until the year 2041.

The planning study has developed an understanding of the existing operation of the plant, a design basis for future upgrades, a bioglogical and hydraulic model for the site, a capacity assessment of the existing infrastructure, recommendations for staged improvements to the plant and an options assessment and preferred option development for the proposed upgrade to Atherton STP.

1.5 Scope and limitations

This report: has been prepared by GHD for Tablelands Regional Council and may only be used and relied on by Tablelands Regional Council for the purpose agreed between GHD and the Tablelands Regional Council as set out in Section 1.4 of this report. GHD otherwise disclaims responsibility to any person other than Tablelands Regional Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report. The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared. The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Tablelands Regional Council and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

GHD has prepared the preliminary cost estimate set out in this report using information reasonably available to the GHD employee(s) who prepared this report; and based on assumptions and judgments made by GHD.

The Cost Estimate is a preliminary estimate only. Actual prices, costs and other variables may be different to those used to prepare the Cost Estimate and may change. Unless as otherwise specified in this report, no detailed quotation has been obtained for actions identified in this report. GHD does not represent, warrant or guarantee that the works can or will be undertaken at a cost which is the same or less than the Cost Estimate.

Where estimates of potential costs are provided with an indicated level of confidence, notwithstanding the conservatism of the level of confidence selected as the planning level, there remains a chance that the cost will be greater than the planning estimate, and any funding would not be adequate. The confidence level considered to be most appropriate for planning purposes will vary depending on the conservatism of the user and the nature of the project. The user should therefore select appropriate confidence levels to suit their particular risk profile.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

1.6 Reliance information

The data and information pertaining to Atherton STP supplied by TRC may be summarised as follows:

- Environmental Evaluation
  - Historic water quality monitoring data
  - Copies of the 3 x Notification of Exceedances to DES;
- Existing STP infrastructure and operations data
  - ESI As-constructed drawings
  - (Operator) Daily logs (1 January 2017 to 31 October 2018)
  - Intensive testing data site and NATA Lab Results (20, 22 and 25 November 2018)
  - 2018 Biosolids disposal data for TRC STPs (WAS volume and discharged volumes)
  - TRC Site survey
    - Levels and dimensions of Effluent Balance Tank to CCT discharge;
    - Survey of existing levels to confirm accuracy of as-constructed details;
  - Operational description and process settings
  - Access to the site SCADA and Operation and Maintenance Manuals (on site);
  - Reports
    - ESI Design Concept Issue 2 (*circa* 2000)
    - Condition Assessment Report (Aecom, January 2019)
- Future Load Data
  - Atherton GIS data, including Lots, sewer and manhole layouts
  - 2018 rates charges for sewerage connection
- Atherton Landfill Leachate Data
  - Atherton Landfill Development Plan (Golder, May 2018)
  - Atherton Landfill Leachate Management Strategy (Golder, June 2018)
  - Leachate test results from 2011;

2. Current Loading

2.1 Daily Flows

Influent and effluent (tertiary) flow meter records are presented in Figure 2. The data shows two sets of seasonal peaks. The first is attributed to the wet season, typically from December to March. The second being due to tourism, typically June to August.

The median of 2018 flows, 2,030 kL/day was adopted as the Average Daily Flow (ADF) for this Report.

Two key issues arising from the assessment of flow meter records bring their accuracy into question:

- A wet weather peak factor of ~1.8x ADF was calculated from the records.
- Heavy rainfall events show very low impact on daily flow rates.

In GHDs experience, a peak wet weather factor of 4-7xADF would be more representative of a catchment similar to that of the Atherton STP. To investigate this perceived discrepancy, GHD assessed the installed flow meters and identified the following possible contributers:

a. The influent flow meter is an ultrastonic meter upstream of the inlet step screen.

   The inlet channel is 1,000 mm deep and 500 mm wide, with an overflow weir to the manual screen channel set 700 mm above floor level. Based on a typical screen approach velocity of 0.3 m/s the automatic screen channel has a capacity of 100 L/s before overflowing to the manual screen channel. Both inlet channels merge prior to the grit tank and downstream treatment.

   As a result of these channel configurations, it is believed that flows entering the STP via the manual screen channel are unlikely to be detected, and may therefore be masking the true extent of peak flows experience at the Atherton STP.

b. The tertiary flow meter is a magnetic flow meter installed to the filter discharge, but does not record flows which by-pass the filters.

   The installed filter feed pumps have a reported capacity of 80 L/s. Under peak wet weather conditions, sustained flows in excess of the installed capacity will by-pass the filters and discharge to the chlorine contact tank.

2.1.1 Average Daily Flows

Under average daily flow conditions, all treated effluent is filtered and measured by the tertiary flowmeter providing confidence in these records. A close correlation between the influent and tertiary flow meters is evident.

2.1.2 Adopted Peak Wet Weather Factor

As a result of the potential flow metering discrepancies described above under peak flow conditions, the FNQROC peak wet weather factor of 5xADF was adopted. When this factor was applied to the Hydraulic Model, theoretical bottlenecks were identified. The hydraulic bottlenecks were discussed with TRC operators and were not found to be observed in real performance based on anecdotal information. This indicates that a peak factor < 5 occurs.

Improved flow metering has been adopted by TRC, which is more likely to record the peak flow events.

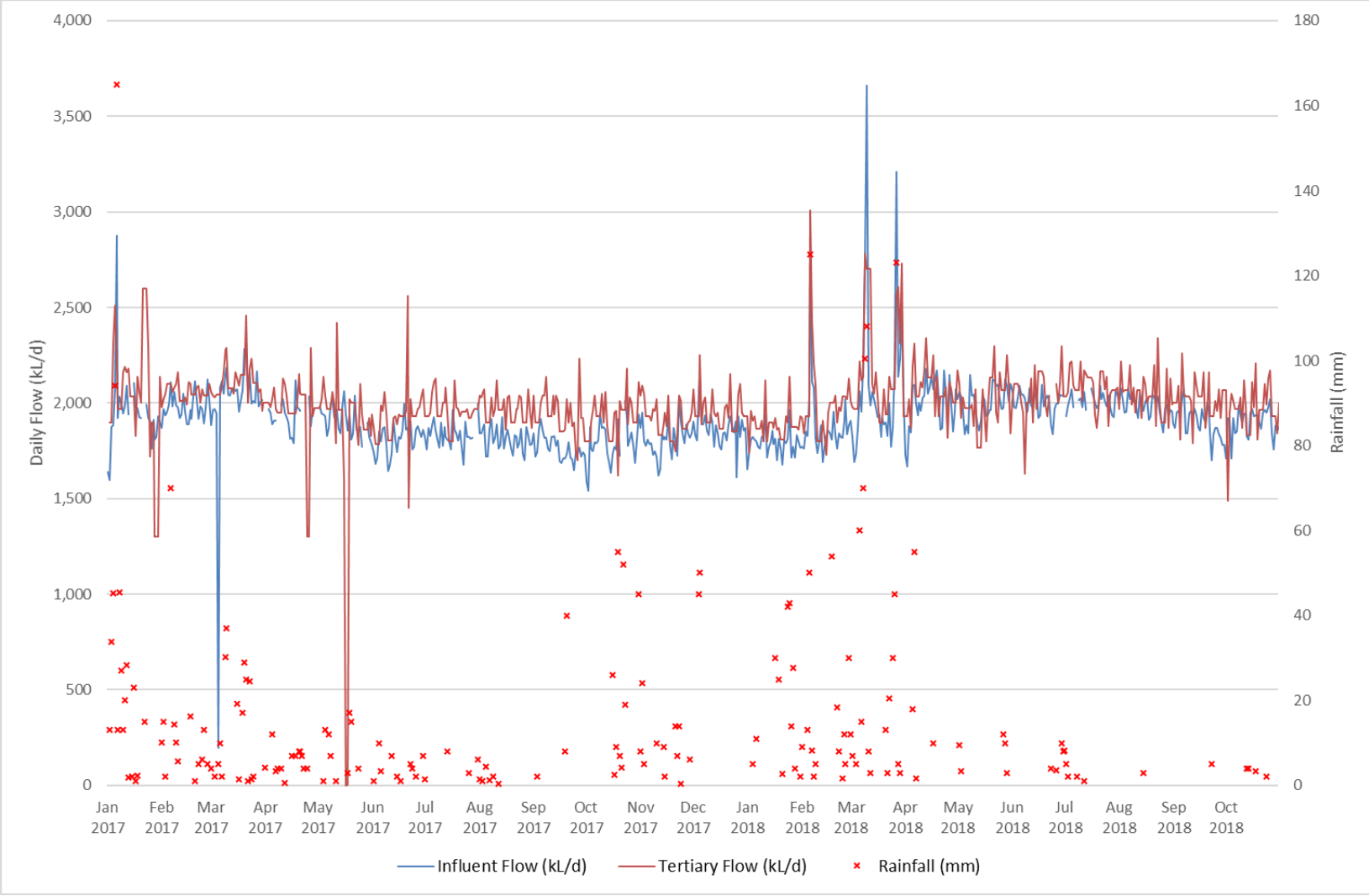


Figure 2 Daily Flow Meter Records

2.2 Influent Characterisation

2.2.1 Historical Influent Data

Ongoing routine influent sampling data from January 2015 to March 2019 has been undertaken by TRC. Sampling improvements were implemented by TRC in October 2017 changing from a single daily grab sample to a 24-hour composite sampling. Influent data is presented graphically in Appendix B.

The following conclusions regarding the influent characterisation have been determined:

- The sewage characteristics are generally typical of waterborne sewage.

  There are occasions of very high loads, particularly BOD_5 and COD. There are outlying, isolated events and may have coincided with septage discharges. TRC have subsequently upgraded the Septage Receival, with a new screen and balancing tank to improve Septage Receival load management. The impact of Septage Balancing is described in Section 6.1.1.

- The 24-hour composite sampling detected a significantly higher nitrogen load (TN and ammonia), than detected with grab sampling. The higher concentrations remain within typical sewage characteristics.

2.2.2 Intensive Site Testing Data

The historical data reports the total daily load; however, for the dynamic process model (Biowin™) load variations across the day were required. In addition, sampling at interim stages through the treatment process were required as reference points to align the model to actual site performance. TRC undertook an intensive sampling regime in the dry season between 20-26 November 2019. The testing included three twenty-four hour periods of two-hour frequency site testing across the site. This snapshot of performance forms the basis of the Biowin™ model.

Influent flow data

Hourly interval flows from the SCADA system during the sampling program, as presented in Figure 3, were recorded and used to calculate the diurnal flow basis.

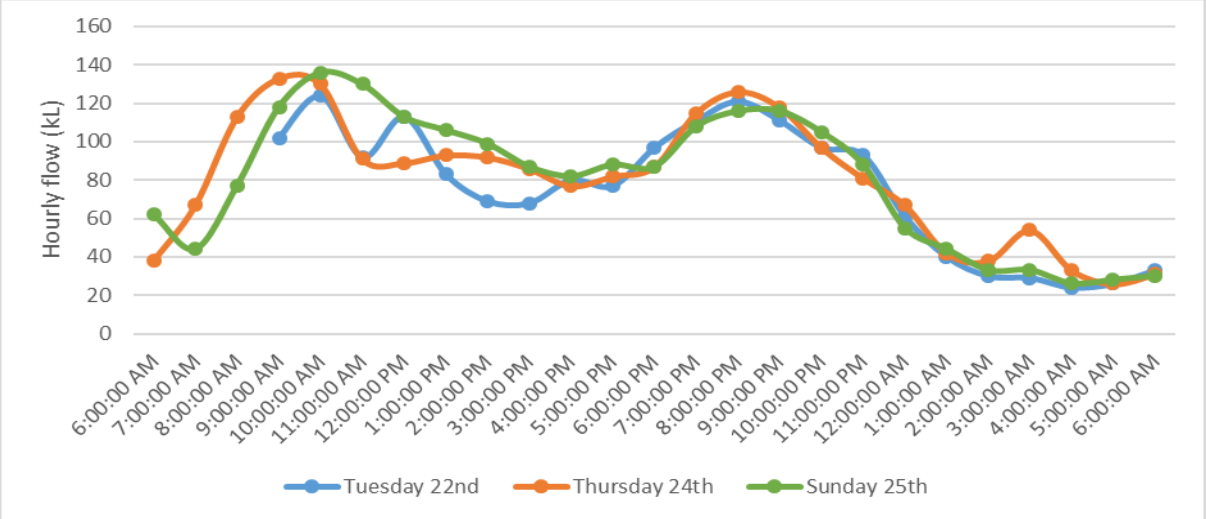


Figure 3 Hourly flow data for sampling period

The hourly flow data was averaged to generate an indicative diurnal pattern for the plant and was adopted as the diurnal flow basis for the model (refer Figure 4). Long term, instantaneous

data collection will provide data to interrogated to consider seasonal variations in the diurnal loading.

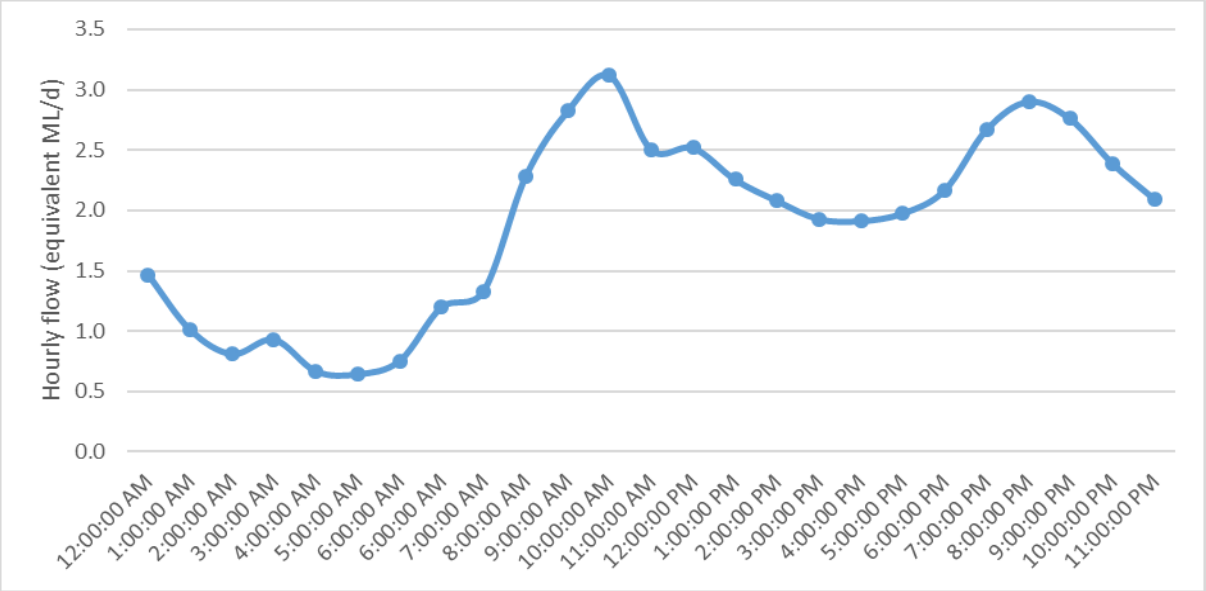


Figure 4 Adopted diurnal flow pattern

Daily Influent concentrations and loads

The influent wastewater concentrations (downstream of the inlet screening) measured during the sampling program is summarised in Table 3 below. When compared to the historical daily composite sampling described in Section 2.2.1 a close correlation between the 90th percentile concentrations from the intensive sampling exists.

Daily loads based on the median and 90th percentile concentrations from the sampling program and the average daily flowrate (during the sampling program only) of 1.9 ML/d are presented in Table 4.

Table 3 Influent concentrations

Parameter	Min	10%ile	50%ile	Ave	90%ile	Max
BOD, mg/L	130	151	275	271	379	520
COD, mg/L	300	374	635	685	1100	1100
Total Suspended Solids (TSS), mg/L	119	139	270	280	412	574
Volatile Suspended Solids (VSS), mg/L[1]	112	123	239	250	365	528
Alkalinity, mg/L	210	227	275	278	333	340
Ammonia, mg/L	15.0	26.1	33.0	36.7	57.9	64.0
Total Kjeldahl Nitrogen, mg/L	37.0	39.1	50.5	55.2	80.9	94.0
Total Phosphorus, mg/L	3.8	7.6	10.0	10.5	13.7	16.0

[1] Calculated from measured %VSS and TSS concentration

Table 4 Daily Influent loads

Parameter	Current load (50th percentile; kg/d)	Design load (50th percentile; kg/d)[2]	Current load (90th percentile; kg/d)	Design load (90th percentile; kg/d)[2]
BOD	519	575	629	725
COD	**1199**	968	**2076**	1280
Total Suspended Solids (TSS)[3]	**510**	460	**778**	600
Ammonia	***62.3***	-	***109.3***	-
Total Kjeldahl Nitrogen (TKN)	95.3	104	**152.7**	115
Total Phosphorus	18.9	20.7	**25.9**	23

From Table 4, it is evident the plant is organically overloaded when compared to the original design. The high TKN is a key concern as that would indicate a higher than expected ammonia load. The ammonia load was not specified in the original design. The elevated Total Phosphorous is of less concern for Atherton STP, as this is chemically removed and can be managed by increasing dosing rates.

These findings, at least partially, account for the periodic effluent exceedances experienced by the Atherton STP.

Diurnal loads

A more in-depth assessment of the data was undertaken using the two-hourly data to assess the short-term load variations across a day. This data provides valuable insight into the daily peak loads and how the treatment process was managing the peaks.

The two-hourly composite sample concentrations and associated flows were multiplied, to yield an average hourly mass load for the BOD, COD and TKN as plotted on Figure 5, Figure 6 and Figure 7 respectively.

As a reference, the original design capacities (50th and 90th percentile) (kg/hr) were plotted on the respective graphs (red pen). The adopted diurnal peak factor is not specified in the original design; as a reference a diurnal peak factor of 2x the 90th percentile load has been plotted. This would be best case as biological peak factors are typically 1.3-1.8 x average loads.

The data indicates that plant receives significantly higher peak COD and TKN loads than the design peak loading, despite significantly lower loads at other times in the day.

SBR Performance

TRC Operators have reconfigured the SBR blowers from a duty/standby configuration to a duty/assist configuration in an effort to meet the peak oxygen demands. The results of the SBR decants presented in Figure 8 identifies ammonia breakthrough despite the augmented blower configuration, confirming the process has limited aerobic capacity to manage the peak diurnal loads.

[2] From ESI Design Concept Report

[3] Referred to as non-filterable residue (NFR) in ESI Design Concept Report

The ammonia breakthrough was detected in SBR decant samples specifically selected part-way through treatment to enable the actual SBR performance to be assessed before downstream improvements through filtration, disinfection and blending occurred. The 24-hour composite sample at the licensed monitoring point was compliant throughout the intensive sampling period.

Ammonia breakthrough is indicative of the following, which were carried forward as a key investigation area in the Options Assessment:

- Shortfall in aeration capacity or low oxygen transfer;
- Inhibition due to low Alkalinity; or
- Short Sludge Age.

2.3 Biological Model Calibration

Based on the intensive testing data and performance, the Biowin™ model was configured to reflect the monitored performance.

It is noted that Biowin is a theoretical tool, which cannot be calibrated to mimic performance under all scenarios. Secondly, as the Atherton model is based on the sample data set, its accuracy across seasonal variations could not be validated to actual performance. Whilst not conclusive, the findings produce performance trends that identify process limitations and assess the likely performance under future loads, and the efficiencies achieved with the improvement strategies considered.

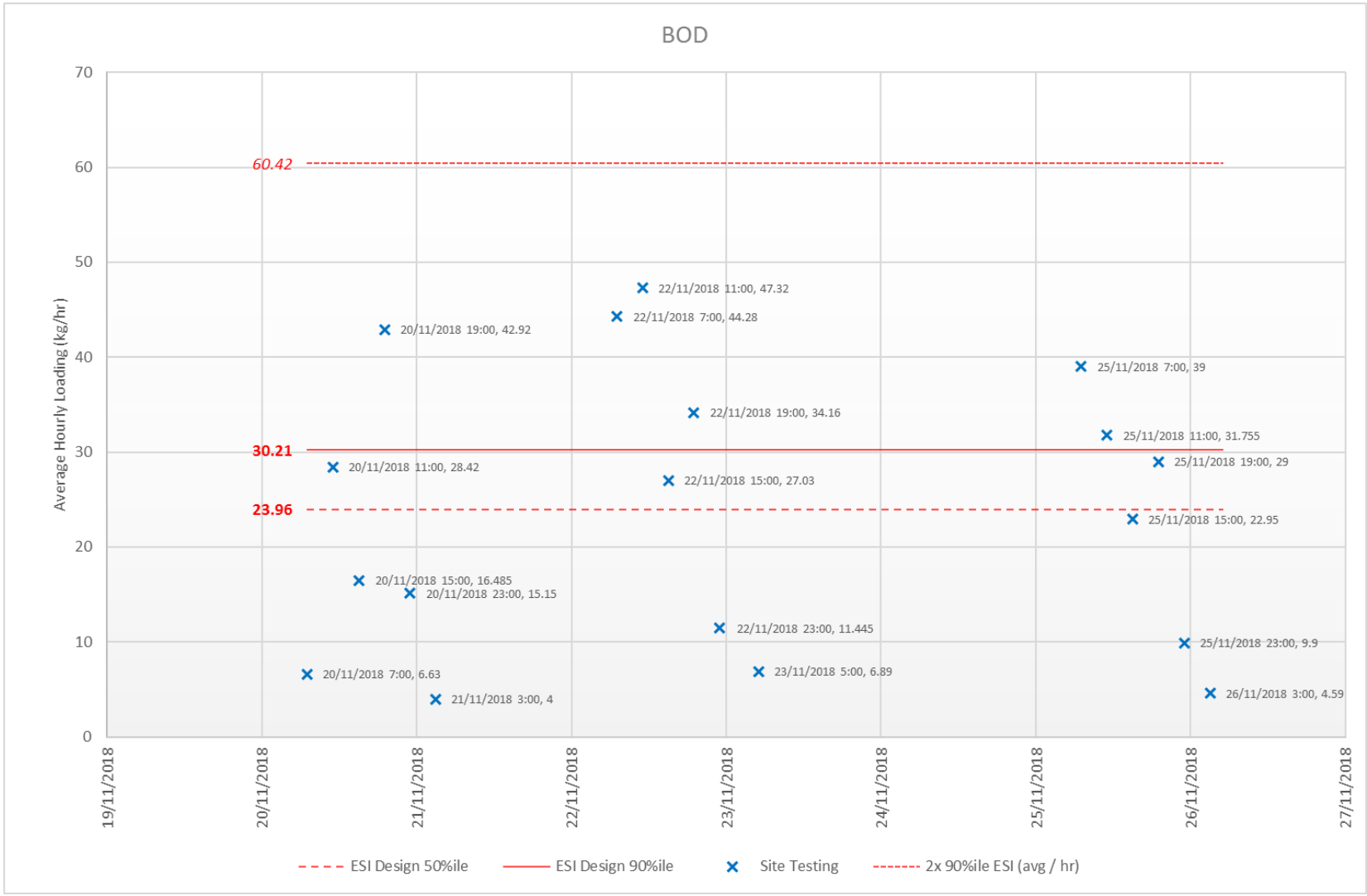


Figure 5 BOD Load

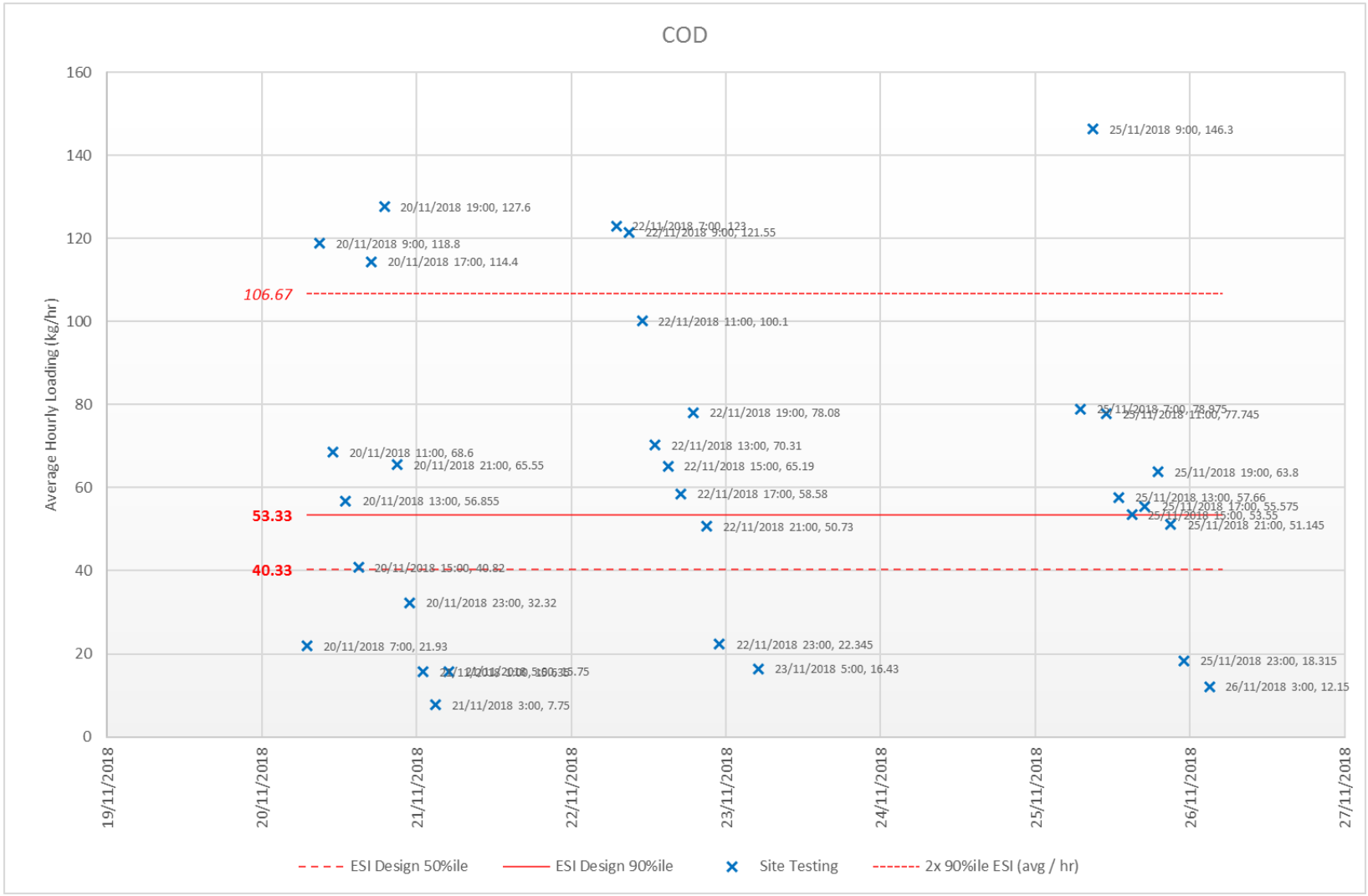


Figure 6 COD Load

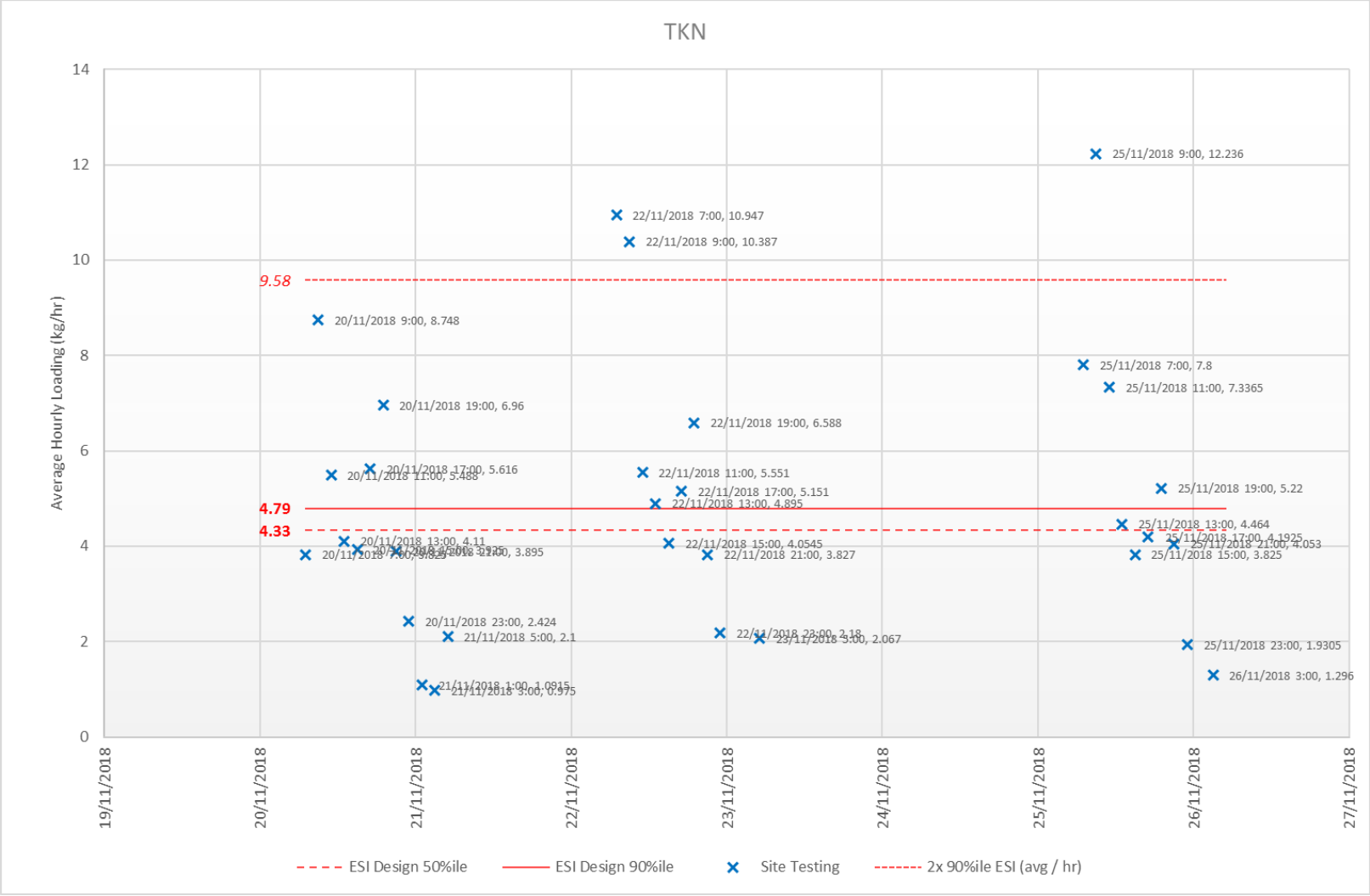


Figure 7 TKN Load

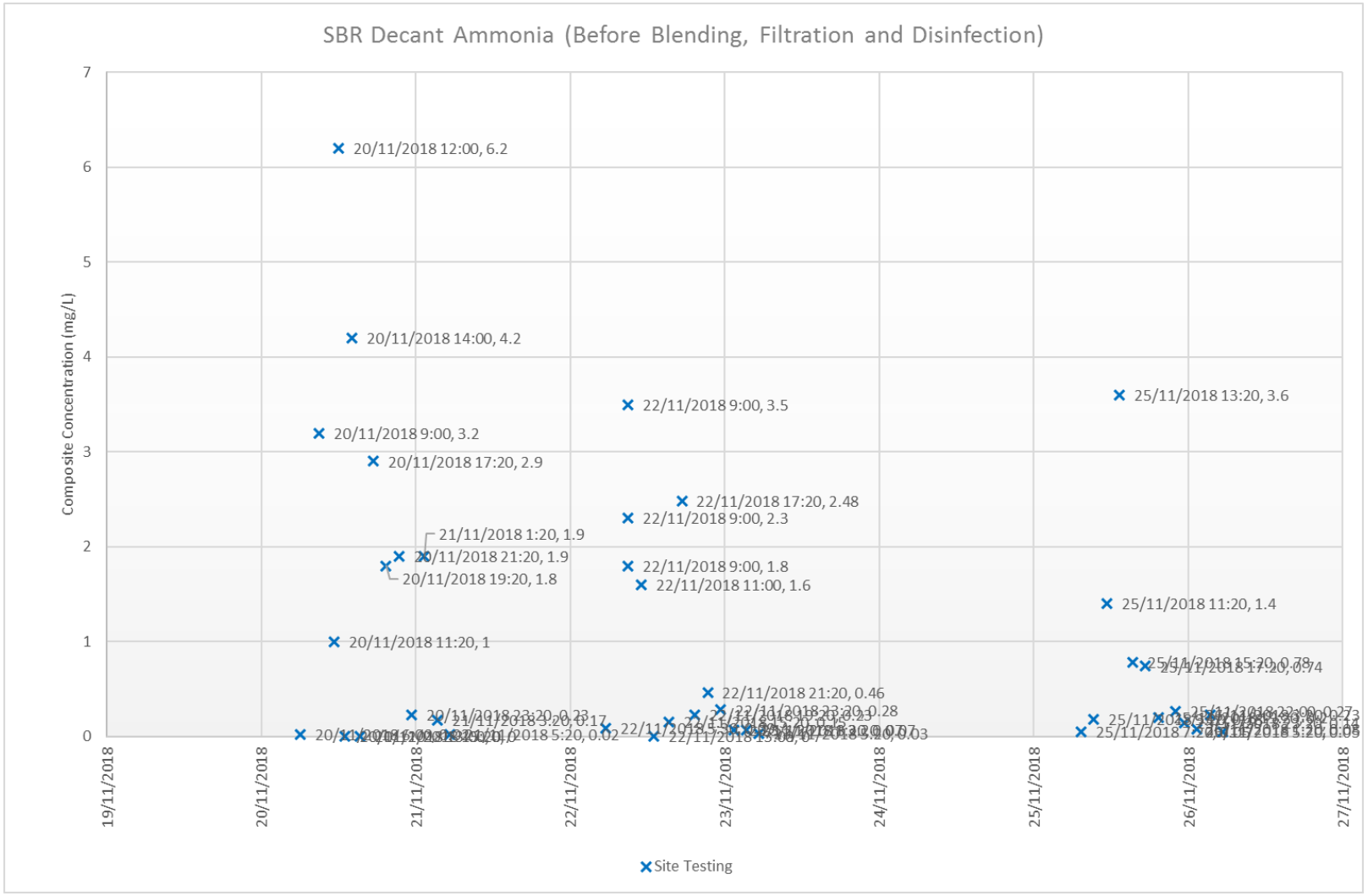


Figure 8 SBR Decant Ammonia (before blending, filtration and disinfection)

3. Historical Performance

3.1 Historical Performance Data

3.1.1 Current License

Atherton STP is required to produce 24-hour composite samples that comply with the effluent quality requirements in the Environmental Authority; EPPR00584813, as summarised in Table 5 below.

Table 5 Atherton STP Current EA

Description	Units	Current License	Limit Type
Max ADWF	kL/d	2,200	
5-day Biochemical Oxygen Demand	(mg/l)	5	80th %ile (long term)
		10	80th %ile (short term)
		20	Max
Suspended Solids	(mg/l)	7	80th %ile (long term)
		15	80th %ile (short term)
		30	Max
Ammonia Nitrogen	(mg/l)	2	80th %ile (long term)
		4	Max
Total Nitrogen	(mg/l)	5	50th percentile
		10	Max
Total Phosphorus as P	(mg/l)	1	50th percentile
		2	Max
Oil and Grease	(mg/l)	10	Max
pH	(pH Units)	6.5	Min
		8.5	Max
Dissolved Oxygen	(mg/l)	2	Min
Free Residual Chlorine	(mg/l)	0.7	Max
Faecal Coliforms	(Organisms/100 ml)	150	Median
		600	80th percentile

3.1.2 Compliance Limits

Historical performance for the key process characteristics including BOD_5, Effluent Suspended Solids, Total Nitrogen, Ammonia, Total Phosphorous and Faecal Coliforms are presented for the period January 2015 to April 2019 in Appendix C.

Definition of Short and Long Term Compliance

Atherton STPs EA does not include a definition for short and long-term compliance.

In the interim the short and long term definitions in the EA for Mareeba STP were adopted as it is a recent EA of similar size to Atherton STP and therefore likely to be representative. The results presented are therefore indicative only and should be re-evaluated once the percentile definitions are defined.

The adopted definitions are summarised as follows:

Long-Term 50th percentile means not more than any six (6) of the measured values of the quality characteristics are to exceed the stated release limit for any twelve (12) consecutive samples for a release / monitoring point at any time where:

a. The consecutive samples are taken over a twelve (12) month period;

b. The consecutive samples are taken at approximately equal periods; and

c. The time interval between the taking of each consecutive sample is not less than thirty (30) days or greater than thirty-four (34) days;

Short-Term 50th percentile means not more than any three (3) of the measured values of the quality characteristics are to exceed the stated release limit for any six (6) consecutive samples for a release / monitoring point at any time where:

a. The consecutive samples are taken over a six (6) month period;

b. The consecutive samples are taken at approximately equal periods; and

c. The time interval between the taking of each consecutive sample is not less than thirty (30) days or greater than thirty-four (34) days;

Historically TRC have undertaken routine fortnightly sampling, which is twice the sampling frequency. To apply the short-term (6 months) percentile compliance, the previous 12 samples have been assessed, similarly for the long-term (12 months) the previous 24 samples have been assessed. Atherton STPs long term compliance refers to the 80th percentile, which was calculated instead of the 50th percentiles in the reference definitions.

Discussion of Performance

Atherton STP performance results show the following:

- Outside of the occasional short-term effluent exceedance, the STP has operated within its License limits. The results show a step change in performance after 2015, highlighting the operational efforts to manage the process.
- **Maximum Concentration Compliance**

  Atherton STP has generally complied with all maximum concentration requirements of the License, except the reported exceedances. A reduction in the frequency of exceedances since 2015 is evident, particularly if the event of 29 November 2017[4] (exceptionally high TN and ammonia) is not considered.
- **Short-Term (6 Month) Percentile Compliance**

  Atherton STP has complied with the short-term percentile compliance requirements.
- **Long-Term (12 Month) Percentile Compliance**

  Effluent typically exceeds the long-term compliance requirements for BOD_5, with a recent increasing trend in effluent Suspended Solids. All other characteristics have been within the compliance requirements since ~March 2017.

  BOD_5 and Suspended solids is unusual in that the STP is generally well within the maximum and short term requirements, but exceeds the interpreted long term definition. The Long Term 80th percentile requirement is ~½ the concentration of the 80th percentile Short Term, and effectively makes the short term requirement redundant.

Clarification from DES is recommended to be sought during License updates as, in GHD's experience, it is not common to have an 80th percentile requirement for both long and short

[4] This event was not detected in the treatment process but only in the irrigation pond, and was suspected to be caused by inversion of the dam.

term. As a reference the Long Term 50th percentile trend has been plotted as the brown series on the Long Term BOD_5, and Suspended solids graphs in Appendix C; which shows improved correlation between the short and long-term limits.

4. Service Demand Needs

4.1 Permanent Loads and Growth Projections

4.1.1 Theoretical STP Load

GHD undertook an assessment of the current and likely future service demand needs of the plant in accordance with the Planning Guidelines for Water Supply and Sewerage April 2010 including amendments dated March 2014 (the guidelines).

The theoretical approach calculated flows and loads significantly higher than data recorded on site. Furthermore, the theoretical loads (population) did not align with recent statistical data. The theoretical estimate of loads were therefore abandoned in lieu of actual site testing, sewerage connection data and statistical population data, as described hereafter.

4.1.2 Current STP Loads

Atherton STP receives sewage from both Atherton and portions of Tolga, as illustrated in Appendix D. Atherton has a well-developed sewerage network, servicing the majority of the town. Tolga has a partially developed network servicing the industrial area, and the recent development in the north-west of town with the majority of residential areas not currently serviced. Back-sewering to these areas has been considered in future load projections aiming to achieve 90% service by 2041. The residual 10% allows for peripheral properties that are not practical or cost effective to service.

The number of existing properties with sewerage rates charges was provided by TRC and are summarised in Table 6. Vacant lot sewerage charges were omitted from the current loads, but factored in as part of the future growth.

Table 6 Atherton and Tolga sewerage charges

Rates service code	Atherton (# connections)	Tolga (# connections)	Total (# connections)
SewAthNonP	307	1	308
SewAthNonS	233	1	234
SewRes	2832	62	2894
Total Connections	3372	64	3436

Residential sewerage charges are single charges per Lot. Non-residential charges includes multiple charges per Lot, based on the number of pedestals. The data indicates 20% of Atherton connections are non-residential.

4.1.3 Permanent Population

LGIP population data was interpolated to estimate the 2018 population. For this assessment the medium growth scenario was adopted as this is available at SA2 level. Low and high growth scenarios are only available at Local Government Area level and therefore not sufficiently detailed for consideration of specific areas.

The residential population in the sewer service catchment is 7,200 persons in Atherton and 502 persons for Tolga. Non-residential loads of 19.2% and 29.1% for Atherton and Tolga respectively, were used to calculate a total catchment load.

Based on the rates charges and the typical occupancy of 2.3 EP/Lot[5], the total catchment load was calculated. The sewerage rates charges, the 2018 flow records and the load testing data from the sampling program in November 2018 were used to calculate the typical per EP loading adopted for the capacity assessment and future load projections, as presented in Table 8.

Based on the tertiary flowmeter and the 2018 EP, a reference sewage production of 251 L/EP/day was calculated. This sewage production rate aligns with industry accepted guidelines and was adopted for this report.

Future catchment growth is the sum of general statistical area growth and back-sewering, to yield the long-term growth projections summarised in Table 7 and presented graphically in Figure 9. Based on the growth projections, the existing License (10,000 EP) would be exceeded in ~2025, whilst the process will exhibit major biological overloading by 2021-22. The biological overload triggered the short / medium term improvements detailed in Section 6.

Table 7 Atherton STP growth projections

	2018	2021	2026	2031	2036	2041
Total Permanent EP	**8,081**	**8,515**	**9,234**	**9,988**	**10,718**	**11,385**
Residential EP	6,780	7,144	7,748	8,380	8,993	9,552
Non-residential EP	1,301	1,371	1,486	1,608	1,725	1,833
Total Seasonal EP	***9,081***	***9,515***	***10,234***	***10,988***	***11,718***	***12,385***

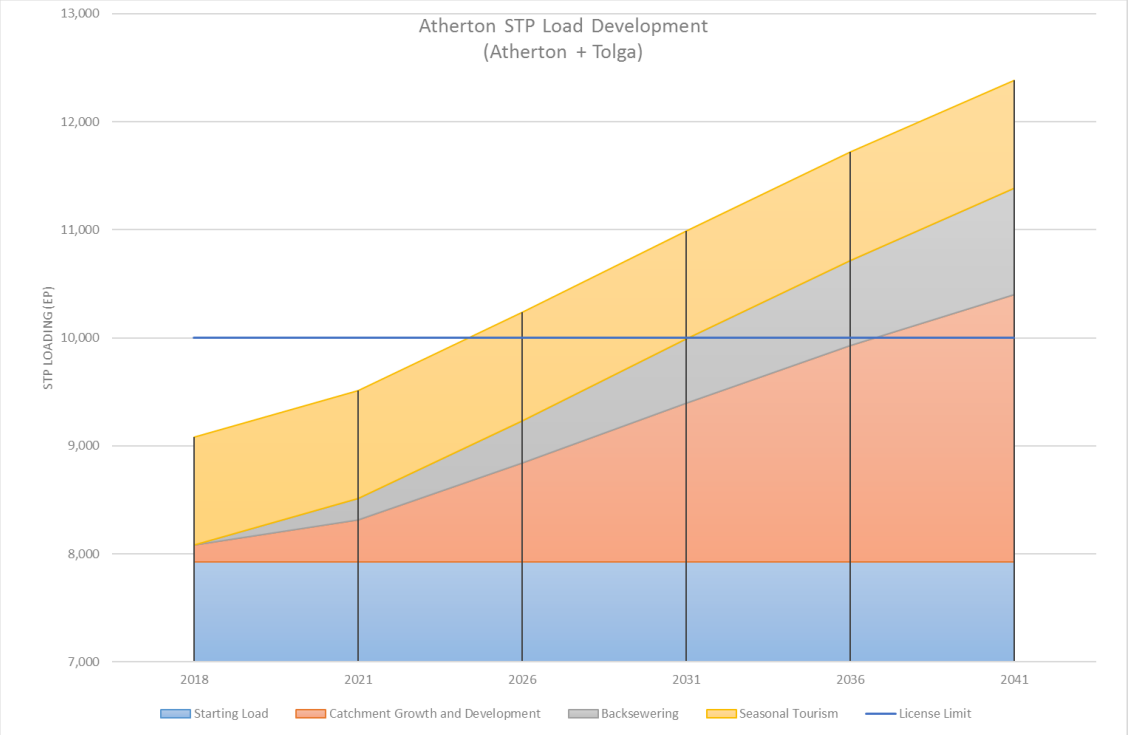


Figure 9 Atherton STP growth projections

[5] 2016 Census stats

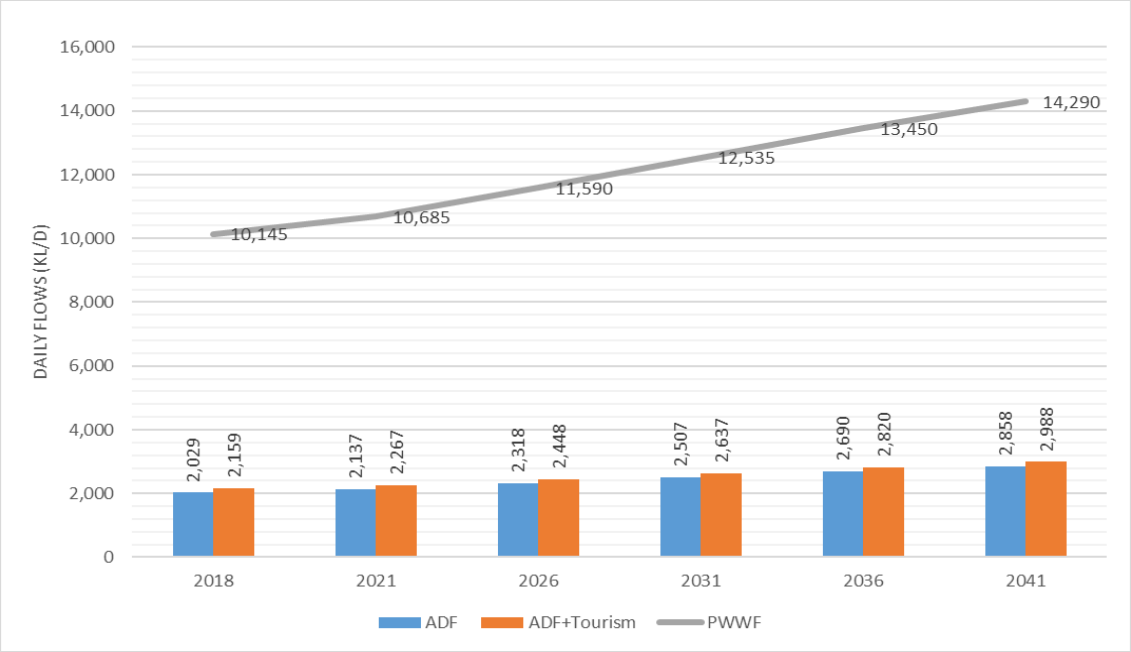


Figure 10 Projected Average and Peak Daily Flow Rates

Table 8 Summary of adopted future loading

YEAR			2016	2018	2021	2026	2031	2036	2041
Atherton			**7,778**	**7,933**	**8,228**	**8,802**	**9,411**	**9,996**	**10,519**
Serviced Residential EP			6,526	6,656	6,904	7,385	7,896	8,387	8,826
Serviced Non-residential EP		19.2%	1,252	1,277	1,324	1,417	1,515	1,609	1,693
Tolga			**145**	**148**	**287**	**432**	**577**	**722**	**866**
Residential EP			122	124	241	362	484	606	727
Non-residential EP		29.1%	23	24	46	70	93	116	139
Total EP (Atherton + Tolga)			**7,923**	**8,081**	**8,515**	**9,234**	**9,988**	**10,718**	**11,385**
Residential EP			6,648	6,780	7,144	7,748	8,380	8,993	9,552
Non-residential EP			1,275	1,301	1,371	1,486	1,608	1,725	1,833
Total EP on Atherton STP Catchment			**7,923**	**8,081**	**8,515**	**9,234**	**9,988**	**10,718**	**11,385**
STP ADWF (kL/d)			**1,989**	**2,029**	**2,137**	**2,318**	**2,507**	**2,690**	**2,858**
Residential	251	L/EP/d	1,669	1,702	1,793	1,945	2,103	2,257	2,398
Non-residential	251	L/EP/d	320	327	344	373	404	433	460
PWW Factor Greater of 5xADWF or C1			*5.00*	*5.00*	*5.00*	*5.00*	*5.00*	*5.00*	*5.00*
PWWF (Greater of x ADWF)			9,945	10,145	10,685	11,590	12,535	13,450	14,290
Biological Load (50th %ile load)									
BOD (kg/d)	64.2	g/EP/d*	509	519	547	593	641	688	731
COD (kg/d)	148.4	g/EP/d*	1,176	1,199	1,263	1,370	1,482	1,590	1,689
Total Suspended Solids (TSS) (kg/d)	63.1	g/EP/d*	500	510	537	583	630	676	719
Total Kjeldahl Nitrogen (kg/d)	11.8	g/EP/d*	93	95	100	109	118	126	134
Ammonia (kg/d)	7.7	g/EP/d*	61	62	66	71	77	83	88
Total Phosphorus (kg/d)	2.3	g/EP/d*	19	19	20	22	23	25	27
STP Tourist Season Load (EP)	**1,000**	**EP**	**8,923**	**9,081**	**9,515**	**10,234**	**10,988**	**11,718**	**12,385**
STP ADWF (kL/d)	**130**	**L/EP/d**	**2,119**	**2,159**	**2,267**	**2,448**	**2,637**	**2,820**	**2,988**
BOD (kg/d)	Production		573	583	611	657	705	752	795
COD (kg/d)	rates as		1,324	1,347	1,411	1,518	1,630	1,738	1,837
Total Suspended Solids (TSS) (kg/d)	above		563	573	600	646	693	739	782
Total Kjeldahl Nitrogen (kg/d)			105	107	112	121	130	138	146
Ammonia (kg/d)			69	70	74	79	85	91	96
Total Phosphorus (kg/d)			21	21	22	24	25	27	29

5. STP Assessment

5.1 Condition Assessment

A Condition Assessment report for Atherton STP was undertaken in 2018, a copy of which was issued to GHD for consideration in this Planning Report. Residual life assessments have been added to the Equipment List in Appendix G. Items with a residual life < 5 years were highlighted in red, to illustrate the extent of refurbishment or replacement likely being required.

The most critical aspects identified is the condition of the SBR tanks stating the sealant has an expected residual life of < 2 years and internal blockwork (particularly the grout between blocks) is < 5 years.

The estimated costs for refurbishment stated by the previous condition assessment did not factor in the costs to gain access to the tank, whilst maintaining STP functionality. This Planning Report identified the following constraints that impact the ability to implement the recommended works:

- Atherton STP does not have sufficient capacity to take half of the SBR offline (50% capacity and no flow balancing); and
- Structurally, half of the circular SBR tanks cannot be completely emptied without compromising the structural stability.

Therefore, to gain access to the reactor for the refurbishment, temporary treatment capacity would be required to maintain the STP functionality, however suitably sized “rental” units do not exist. TRC would therefore need to construct and commission a new process stream of similar capacity to gain access for the refurbishment. This would ultimately achieve a doubling in installed capacity of ~4,000 kL/day, 25% higher than the projected loads.

The complexity and costs of integrating a second SBR tank and new control without disrupting the day-to-day operations was identified as a significant risk to the environment, with high costs that offer limited process advantage or alignment with the ultimate site planning. Further, the general condition of all mechanical and electrical infrastructure require replacement in the short/medium future.

Considering the extent of improvements required and the complexity in undertaking improvements whilst maintaining day-to-day operations, it is expected to cost a similar order of magnitude to a new, purpose built process. The approach to construct a new treatment process in parallel to the existing SBR was therefore adopted. The new process can be constructed and commissioned in parallel, enabling a staged switchover from the existing to the new process and represents the lowest process and environmental risk. This afforded the opportunity to decommission the old SBR process unit and retrofit it as the new Aerobic Digester, thereby making optimal use of existing infrastructure and managing the day-to-day operations and the risk to the environment.

5.2 Capacity Assessment

A Capacity Assessment of the STP was undertaken based on information gathered and collated from the following sources:

- The ESI Basis of Design report;
- As-constructed drawings, with near complete details of the process from the inlet works to the SBR tanks;

- Limited information downstream of the SBR Tanks exists, as this was partially upgraded retained infrastructure (old Humus Tank and Chlorine Contact Tank) from earlier treatment processes. TRC subsequently carried out a site survey and measure up, which was incorporated in this assessment. A discrepancy between the survey and as-constructed drawings of ~368mm was detected. Survey levels were adjusted to align with the as-constructed drawings to ensure the hydraulic model was based on a single datum.
- A site equipment list was developed through the course of the project from all available sources including information on replaced/upgraded equipment issued by TRC, and extracted data from the Operation and Maintenance Manuals on site;
- Where insufficient information exists, GHD used best judgement to progress the project.

5.2.1 SBR settings

Treatment cycle settings are detailed in Table 9 below. The SBR tanks have start times staggered as blowers are shared and cannot simultaneously provide air to both tanks. In addition, simultaneous decants would hydraulically overload downstream processes.

Aeration control within the "Fill and Aerate" phase under a "Normal Cycle" is further subdivided, according to the time of day as detailed in Table 10 and Table 11 respectively.

Table 9 SBR Treatment Cycle Settings

		Normal Cycle	High Flow Cycle	Storm Flow	Contact Stabilisation Mode
Flow Range	(kL/d)	0-4,800	4,800-6,900	6,900-10,200	>10,200
Fill and Aerate	(hr)	2.00	1.00	0.50	N/A
Fill and Settle	(hr)	0.00	1.00	0.75	
Settle	(hr)	1.00	0.00	0.00	
Decant	(hr)	1.00	1.00	0.75	
Total Cycle Time	(hr)	4.00	3.00	2.00	
Total Batches per day	(No.)	12	16	24	

Table 10 SBR 1 Aeration Settings

SBR 1	Time (DO)	Time (DO)	Time (DO)
Start time	**08:00 / 12:00 / 16:00**	**20:00**	**00:00 / 04:00**
Interval 1	25mins @1.8 mg/L DO	25 (1.5)	25 (1.5)
Interval 2	*15 (off)*	*15 (off)*	*15 (off)*
Interval 3	20 (1.8)	20 (1.5)	20 (1.5)
Interval 4	20 (2.0)	20 (1.5)	20 (1.5)
Interval 5	*15 (off)*	*15 (off)*	*20 (off)*
Interval 6	25 (2.0)	25 (2.0)	20 (1.8)

Table 11 SBR 2 Aeration Settings

SBR 2	Time (DO)	Time (DO)	Time (DO)
Start time	**10:00 / 14:00 / 18:00**	**22:00**	**02:00 / 06:00**
Interval 1	25 (1.8)	25 (**1.8**)	25 (1.5)
Interval 2	*15 (off)*	*15 (off)*	*15 (off)*
Interval 3	20 (**2.0**)	20 (**2.0**)	20 (1.5)
Interval 4	20 (2.0)	20 (**2.0**)	20 (1.5)
Interval 5	*15 (off)*	***20 (off)***	*20 (off)*
Interval 6	25 (2.0)	**20 (2.0)**	20 (**1.5**)

Bold process settings illustrate settings that differ between SBR Tanks.

During GHDs site inspection, the following was noted:

- The blower speed control for SBR Tank 1 appeared to work well to meet the oxygen demands and control set points.
- The blower speed control for SBR Tank 2 was erratic with frequent call-in and drop out of the second blower and continuously ramping of the blower speeds. This could either be a control loop setting difference between the two systems, or a fault with the DO probe calibration or location detecting erratic DO profiles.

5.2.2 Biological Capacity

Details of the Biowin™ Model development and alignment to the three days of intensive site testing are included in Appendix H. Summarised details of the Capacity Assessment are also included in Appendix I.

The growth projections were applied to the process model to identify the required upgrades and improvements strategy. Considering the growth projections the model identified the SBRs would be significantly overloaded by 2025, with frequent effluent non-compliances, particularly effluent ammonia and Total Nitrogen likely to occur.

Options to augment the capacity of the existing process to meet the future demands using the existing treatment tanks were investigated; however due to the infrastructure limitations (tank dimensions), the existing STP could not be cost effectively and practically modified to meet the future service demand needs, and a major upgrade of the STP is recommended.

The existing SBR control and process settings offers nominal capacity for optimisation for short/medium term improvements. The optimisations hinge around improving aeration, as follows:

- The blowers should be replaced to provide more air to increase the aerobic treatment capacity;
- The diffusers should be replaced / upgraded to enable improved oxygen transfer to the process;
- The Return Activated Sludge (RAS) system should be upgraded to return more MLSS to the head of the SBR tanks to optimise usage of the first 30% of the SBR Tanks, as a denitrification zone. Denitrification offsets a fraction of the oxygen demand, to reduce the peak oxygen demand in the aerobic zones.

- By de-coupling a portion of the denitrification, currently undertaken by intermittent aeration, the blower on time (during the aeration cycle) can be extended, to improve aeration.

These efforts will improve the processes capacity to handle the current and nominal short/medium term growth in the catchment, to reduce the likelihood of more frequent non-compliances.

5.2.3 Hydraulic Capacity

Process Capacity

This section considers the maximum hydraulic capacity of the SBR tanks for accepting and treating sewage.

With reference to Figure 11 below, the maximum treatment capacity per cycle in an SBR is the TWL-BWL x Area of the Tank. The original design capacity was (4.5-2.8 m) x 245 m^2 = 417 m^3 per batch. For 2 x SBR Tanks with 4 hour cycle settings, there is a total of 12 cycles per day. This equates to a theoretical maximum treatment capacity of ~4,800 kL/day, which formed the basis of the rated capacity of the STP under normal cycle settings.

This maximum capacity assumes all batches across the day are all equal. When the diurnal variations are considered, only a minority of cycles per day and completely loaded. Based on Atherton STPs diurnal curve the maximum batch capacity occurs at ~2,950 kL/d.

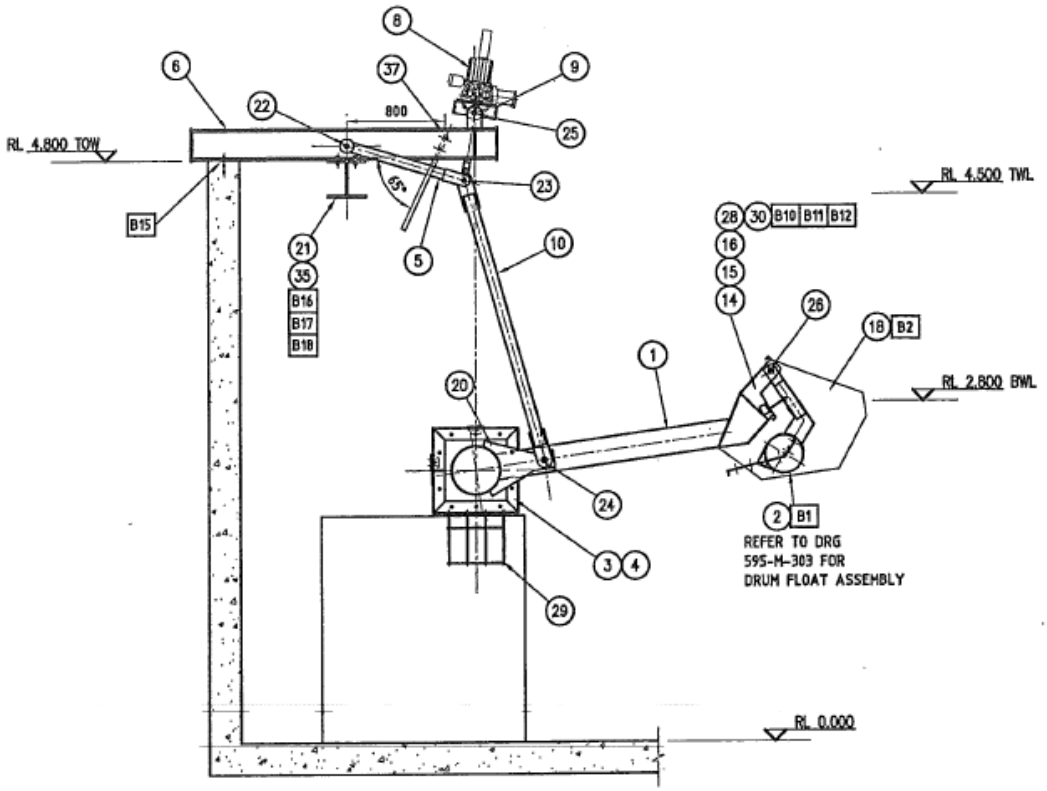


Figure 11 SBR Decanter Detail

Subsequent to the original design, the BWL has been increased to 3.0 m, which reduces the treatment capacity to 368 m^3 per cycle, a 12% reduction in capacity. It is noted the revised water level aligns with current industry trends, to reduce the risk of skimming the sludge bed at the end of the decanter travel.

Based on a filling time of 2 hours per cycle, an average inflow rate < 51.13 L/s can be processed by the SBRs in “Normal Cycle” mode as detailed in Section 5.2.1. For higher flow

rates the treatment cycle settings automatically adjust to enable more cycles per day, thereby increasing the processing capacity of the diluted sewage, during wet weather events.

5.2.4 Actual batch capacity

GHD reviewed the SCADA history for the SBR water levels for the wet weather period 20-25 March 2019, which had averaged daily treatment volume processed in the SBR Tanks of ~2,800 kL/d. This data was used to produce a peak day diurnal curve, which identifies a peak batches occur at 11:00 and 13:00 and are close to the maximum treatment capacity per batch. Extrapolating this diurnal curve to future flows indicate the Normal Cycle capacity is exceeded for select batches in a day for ADF > 2,950 kL/d i.e. not 4,800 kL/day as per the original design.

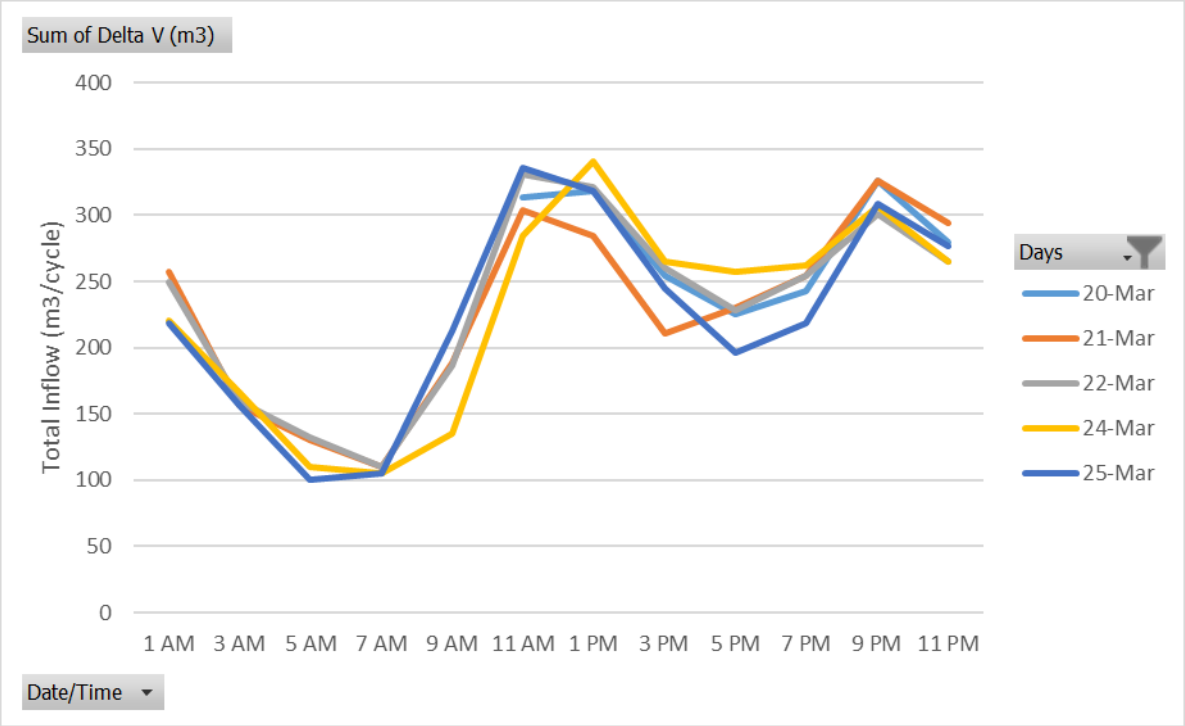


Figure 12 Peak Day Diurnal Variation (SBR TWL)

Infrastructure Capacity

This section considers the physical capacity of the installed infrastructure (such as channels, weirs, pipework etc.) to contain and convey flows through the treatment process. A HGL for the existing STP is included as Appendix J.

With all equipment operational, the installed infrastructure has sufficient capacity to contain and convey flows through the STP.

Operationally the following is likely to occur under peak flow conditions:

- The inlet works manual screen channel will form part of the duty capacity, and require regular clearing;
- The SBR tanks will enter storm mode; under which both decanters dock and the flow is split between the two tanks in a contact treatment mode only (no aeration);
- Flows > 80 L/s will by-pass the filters and the Filtered Effluent Balance Tank. If the filter feed pumps are offline, the filter by-pass has limited capacity and the Effluent Balance Tank and upstream manhole may overtop;
- The existing Filters and filter feed pumps would require an upgrade to accommodate future flows.

5.3 Upgrade Strategy

An implementation programme of at least 5 years is generally considered as practical for a major STP upgrade. The timeline is based on the following:

- **Negotiate New EA License** (1-2 years): Future growth will exceed the current License threshold of 10, 000 EP and will trigger a new License;
- C**oncept Design of Preferred Treatment Process** (6 months): Once the License is agreed, the preferred treatment process can be developed to Concept Design and cost estimates refined to seek funding;
- **Source Funding** (12-18 months): TRC will require funding assistance to complete a project of this magnitude.
- **Detailed Design** (6-8 months): Undertake detailed design phases of the upgrade and investigate alternatives to reduce capital and operating costs, to minimise ongoing costs to TRC and residents;
- **Construct and Commission** (12-18 months) Construct and commission the new STP;

To minimise the potential harm to the environment in the interim and enable time to complete the Major Upgrade, the staging strategy outlined in Table 12 has been developed to best manage the short / medium term risks, whilst considering expenditure which will not form part of the Major Upgrade.

Table 12 Staging Strategies

	Duration [Applicable EA]	Objective
Short Term	<12 months [Current EA]	Immediate strategies to manage current load and optimise the process to minimise the potential impact to the environment
Medium Term	1 year to <5 years [Current EA]	Maximise capacity of existing infrastructure, which may be incorporated to the Major Upgrade, to minimise / manage treated effluent discharged to Priors/Mazlin Creek
Long Term	>5 years [Future EA]	Undertake the Major Upgrade of the STP, to meet the new License;

Details of the two stages are discussed in further detail in Section 6 and Section 7 respectively.

Full details of the proposed staging and implementation programme are presented in Appendix E.

6. Short / Medium Term Upgrade

Short and medium term improvements are aimed to achieve the following:

1. *Manage short/medium sewage loads to avoid further overloading the treatment process;*
2. *Optimise the SBR process to reduce the likelihood of non-compliances in the interim, particularly improved aeration to minimise risk of COD, BOD_5 and ammonia breakthrough;*
3. *Preferential diversion of treated effluent less likely to meet License, to irrigation disposal;*
4. *Investigate opportunities to increase irrigation disposal; and*
5. *Improved flow metering and information gathering across the site for process control and to gather long-term load data as the basis of Major Upgrade (Long Term) design.*

6.1.1 Short / Medium Term Process Loading

As part of the short/medium term efforts, the management strategy to postpone the back-sewering program of unserviced areas has been adopted, to suppress the interim load. The growth projections have been revised and presented in Table 13, Figure 14 and Figure 15.

This strategy does not reduce the current load on the process or delay the need for the Major Upgrade. It aims to supress additional loads and reduce the risk of effluent quality exceedances prior to the Major Upgrade.

Table 13 Short/Medium Term growth projections (after Management)

	2018	2021	2026	2031[6]	2036	2041
Total EP	**8,081**	**8,318**	**8,840**	**9,988**	**10,718**	**11,385**
Residential EP	6,780	6,979	7,417	8,380	8,993	9,552
Non-residential EP	1,301	1,339	1,423	1,608	1,725	1,833
Total Seasonal EP	***9,081***	***9,318***	***9,840***	***10,988***	***11,718***	***12,385***

Septage Load

Historical septage receival data, prior to the implementation of the Septage Balancing process is presented in Figure 13. The graph illustrates a maximum of 32 kL of septage can be discharged to the Atherton STP per day, although the monthly daily average is 4-5 kL/day. The key issue with septage discharges is the high load and short discharge time overloading the treatment process. Concerns arise when the Septage discharges coincide with peak diurnal times, complete treatment may not occur.

To illustrate the potential impact of unbalanced Septage Load, Table 4 calculates the 50th percentile COD load at 1,199 kg/d which is treated over 12 batches at ~100kgCOD/batch ±50% depending on the time of day.

- A 32 kL septage discharge of 5,000 mgCOD/L (assumed) is an additional 160 kgCOD load. The pulsed septage discharge effectively doubles the load on a single batch;
    - If septage balancing is used to balance the load across a single day the septage load will be reduced to ~13 kgCOD\batch;
    - If septage balancing is used to balance across multiple days to achieve the monthly average of 4-5kL/day, the septage load can be reduced to < 2 kgCOD/batch;

[6] Greyed out text, future growth projections after Major Upgrade

The septage balancing process therefore achieves a major reduction process risk by managing the peak instantaneous loading.

Considering the balanced loading of the Septage at Atherton STP removal of the Septage Receival Station from Atherton STP will not delay the need for the Major Upgrade.

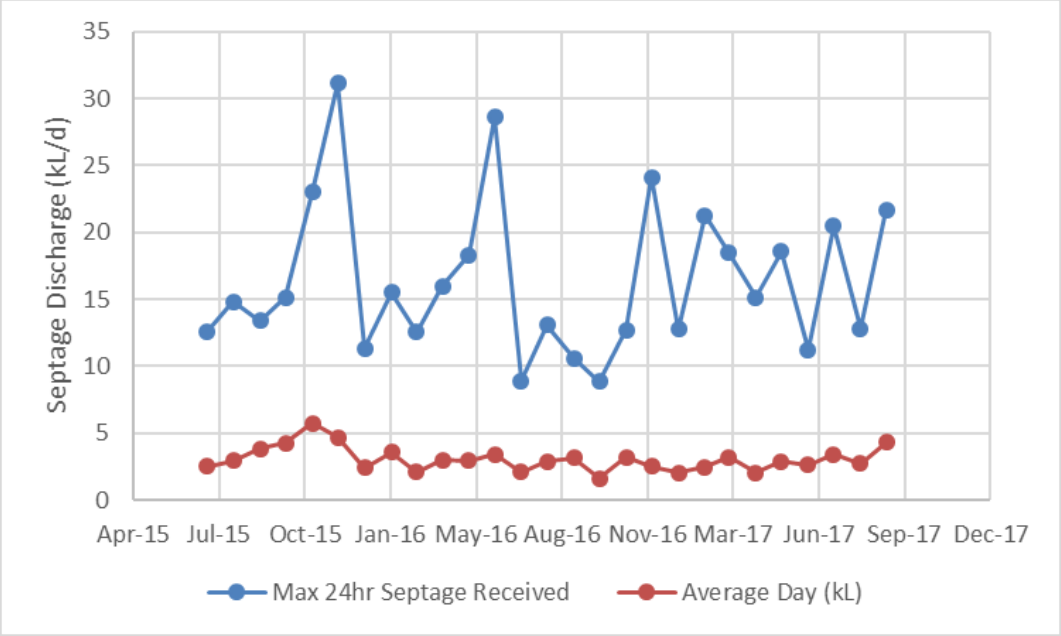


Figure 13 Atherton STP Septage Loads

6.1.2 Optimise the SBR Process

With reference to Item A.12 of the Notice of Environmental Evaluation summarised in Section 1.1 there is a key focus on the potential toxicity of ammonia nitrogen in freshwater. In terms of STP process operations breakthrough of ammonia is generally an indicator of a biologically overloaded system and is also a focus area.

The proposed short / medium term upgrades aim to supplement aeration in order to improve oxidation processes (COD, BOD_5 and ammonia treatment). The improvements outlined below have been adopted:

On average flow days the Atherton SBR has a total cycle time of 4 hours. This includes 1 hour for settling; when the blowers are turned off to allow sludge to settle to floor and a second hour, to decant the clarified supernatant from the reactor. The process therefore has 2 hours to inject the oxygen required to meet the biological demand. Currently the 2 hour aeration time includes 2 x 15 minute aeration “off cycles”, i.e. 25% of the aeration time is lost. The off cycles are currently required to balance nitrification during aeration and denitrification (with aeration off), to meet the License TN limit. This is a critical balance as under-aerating will result in ammonia breakthrough (short-term toxicity risk to riparian environment) and over-aerating will lead to TN breakthrough (long-term nutrient risk to riparian environment).

- The first improvement is to optimise the RAS system to optimise denitrification in the ~30% unaerated portion (anoxic zone) of the Reactor. The intent is to decouple denitrification from the aerobic zone to enable the 2 x 15 minute off times to be reduced or omitted, to make use of the 25% additional aeration time;
- By optimising denitrification in the anoxic zone, a portion of the oxygen demand is preferentially met with oxidised nitrogen to reduce the oxygen demand on the blowers. In

simple terms, bacteria utilise the oxygen (O_2) bound in the oxidised nitrogen (NO_3 or NO_2), and allows nitrogen (N_2) gas to disperse to the atmosphere.

- The blowers are being upgraded to deliver more airflow in the 2 hour aeration time;
- Next year, TRC will investigate the replacement or upgrading of the existing diffusers to improve oxygen transfer from the blower air supply to the process i.e. more efficient use of the upgraded air supply;

Each of these steps will improve the process performance and, in particular, minimise the likelihood of ammonia breakthrough and the potential threat to the receiving environment.

6.1.3 Preferential Diversion of Effluent

The process investigation identified heavily loaded batches (hours) within the day are most likely not to meet the License requirements. In terms of environmental risk, this is most critical in the dry season when low flows in the receiving creeks cannot dilute the treated effluent discharges.

An additional back-stop is proposed to manage the effluent discharges. The two SBR tanks will be equipped with continuous ammonia monitoring. If a batch does not achieve complete ammonia removal within the available aeration time; treated effluent from these batches will be preferentially diverted for disposal via irrigation. To ensure sufficient capacity exists to accept the diverted effluent, a portion of the existing irrigation dam will be set aside to receive the diverted flows during heavily loaded times, for subsequent disposal via irrigation.

- Online ammonia monitoring will also enable Operators to optimise the aeration settings, to manage energy costs and process performance.

6.1.4 Increased Opportunities for Irrigation Disposal

The existing irrigation areas are not Council owned, and operated only when needed by third parties. To improve Councils capacity to manage irrigation disposal TRC will re-instate treated effluent irrigation to the area demarcated on the existing EA. Council is also intending to implement effluent irrigation disposal (drip irrigation) to the Council owned field adjacent to the STP.

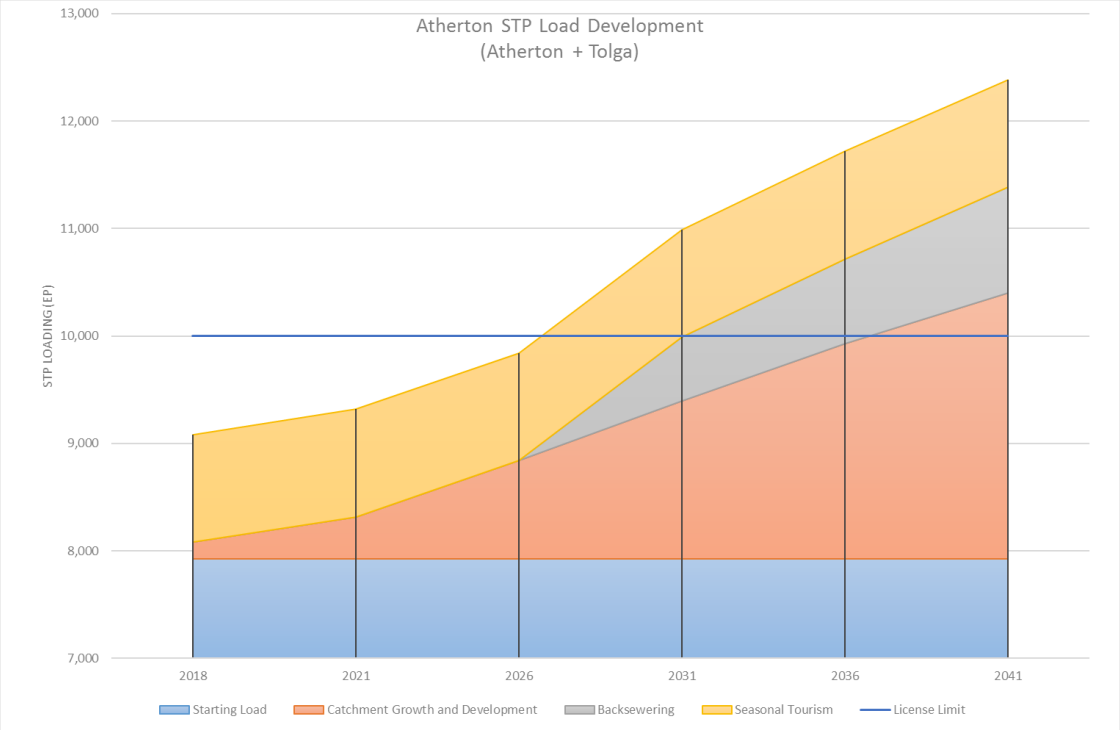


Figure 14 Atherton STP growth projections (After Management)

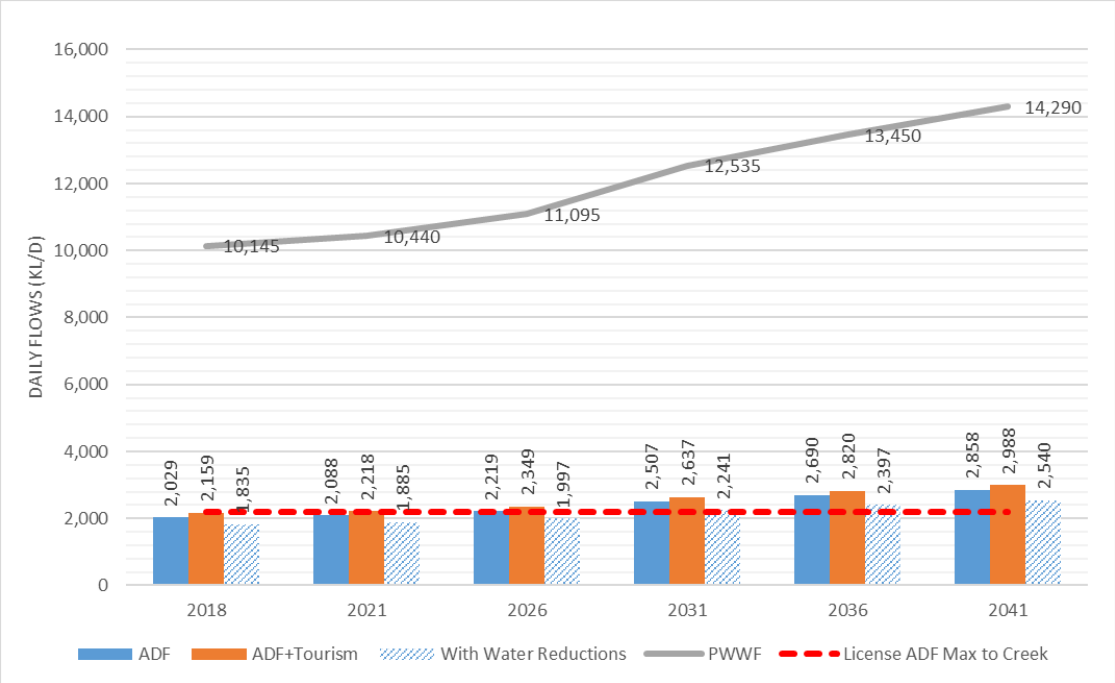


Figure 15 Projected Average and Peak Daily Flow Rates (After Management)

Table 14 Summary of adopted future loading (After Management)

YEAR			2016	2018	2021	2026	2031	2036	2041
Atherton			**7,778**	**7,933**	**8,166**	**8,678**	**9,411**	**9,996**	**10,519**
Serviced Residential EP			6,526	6,656	6,851	7,281	7,896	8,387	8,826
Serviced Non-residential EP		19.2%	1,252	1,277	1,315	1,397	1,515	1,609	1,693
Tolga			**145**	**148**	**152**	**162**	**577**	**722**	**866**
Residential EP			122	124	128	136	484	606	727
Non-residential EP		29.1%	23	24	24	26	93	116	139
Total EP (Atherton + Tolga)			**7,923**	**8,081**	**8,318**	**8,840**	**9,988**	**10,718**	**11,385**
Residential EP			6,648	6,780	6,979	7,417	8,380	8,993	9,552
Non-residential EP			1,275	1,301	1,339	1,423	1,608	1,725	1,833
Total EP on Atherton STP Catchment			**7,923**	**8,081**	**8,318**	**8,840**	**9,988**	**10,718**	**11,385**
STP ADWF (kL/d)			**1,989**	**2,029**	**2,088**	**2,219**	**2,507**	**2,690**	**2,858**
Residential	251	L/EP/d	1,669	1,702	1,752	1,862	2,103	2,257	2,398
Non-residential	251	L/EP/d	320	327	336	357	404	433	460
PWW Factor Greater of 5xADWF or C1			*5.00*	*5.00*	*5.00*	*5.00*	*5.00*	*5.00*	*5.00*
PWWF (Greater of x ADWF)			9,945	10,145	10,440	11,095	12,535	13,450	14,290
Biological Load (50th %ile load)									
BOD (kg/d)	64.2	g/EP/d*	509	519	534	568	641	688	731
COD (kg/d)	148.4	g/EP/d*	1,176	1,199	1,234	1,312	1,482	1,590	1,689
Total Suspended Solids (TSS) (kg/d)	63.1	g/EP/d*	500	510	525	558	630	676	719
Total Kjeldahl Nitrogen (kg/d)	11.8	g/EP/d*	93	95	98	104	118	126	134
Ammonia (kg/d)	7.7	g/EP/d*	61	62	64	68	77	83	88
Total Phosphorus (kg/d)	2.3	g/EP/d*	19	19	19	21	23	25	27
STP Tourist Season Load (EP)	**1,000**	**EP**	**8,923**	**9,081**	**9,318**	**9,840**	**10,988**	**11,718**	**12,385**
STP ADWF (kL/d)	**130**	**L/EP/d**	**2,119**	**2,159**	**2,218**	**2,349**	**2,637**	**2,820**	**2,988**
BOD (kg/d)	Production rates as above		573	583	598	632	705	752	795
COD (kg/d)			1,324	1,347	1,382	1,460	1,630	1,738	1,837
Total Suspended Solids (TSS) (kg/d)			563	573	588	621	693	739	782
Total Kjeldahl Nitrogen (kg/d)			105	107	110	116	130	138	146
Ammonia (kg/d)			69	70	72	76	85	91	96
Total Phosphorus (kg/d)			21	21	21	23	25	27	29

7. Long Term (Major) Upgrade

7.1 Load Projections

Loads to be adopted in the major upgrade assessment are described in Table 8.

7.2 Additional Loads Considered for the Major Upgrade

7.2.1 Centralised Sludge Handling

TRC operate a number of small satellite STPs that generally dry sludge on site with drying beds. During the wet season this is not practical and therefore TRC is considering centralised dewatering of sludge to reduce the costs associated with disposing of dilute sludge to landfill where a "$/tonne" disposal cost is applied.

The satellite STPs under consideration are listed and described in Table 15.

Table 15 Summary of Satellite STPs

Source	Typical Flow	Treatment Process
Yungaburra STP	200 kL/d 1,239 permanent residents*	2 x parallel SBR No chemical P removal at moment, but in process of implementing ACH dosing; Sludge aerobically digested and thickened with floating decanter, prior to pumping to a holding tank
Tinaroo STP	100 kL/d 312 permanent residents*	1 x IDEA tank ACH chemical P removal Sludge aerobically digested and thickened with floating decanter, prior to pumping to a holding tank
Ravenshoe STP	300 kL/d 1,400 permanent residents*	1 x IDEA tank PACL/PAC23 chemical P removal Sludge aerobically digested and thickened with floating decanter, prior to pumping to a holding tank

* 2016 Census quick stats

TRC provided the sludge disposal records for 2018 for GHD to calculate the typical sludge production rates. The average sludge production for each STP was calculated from the total sludge volume disposed over the time period / number of days to yield a "volume of sludge produced per day". The assumed concentration was applied to calculate a daily sludge production rate. This production rate was compared to typical sludge production rates of 0.2 kg MLSS/kgCOD and found to be in the correct order of magnitude, and was therefore adopted for this investigation.

Yungaburra STP was the exception with only one disposal event on 15 January 2018 of 70 kL. Without a second data point, the average production could not be calculated. Yungaburra has a similar loading rate to Ravenshoe, so a similar sludge production rate was adopted.

No information on the disposal concentrations was available and therefore typical concentrations for the sludge handling processes per site were adopted. Ravenshoe sludge volumes are based on the pre-thickened concentration currently being implemented by TRC. In order to minimise carting costs, TRC confirmed 27 kL tankers would be used to convey sludge.

The disposal frequency is simply the time to produce 27 kL of sludge for disposal.

Future sludge growth projections are based on the TRC Planning Assumptions. In the absence of projections for Tinaroo, the Yungaburra growth rate was adopted, as summarised in Table 16 below.

Table 16 Current and Future Sludge Production

Growth Projections			Units	2018	2021	2026	2031	2036
Ravenshoe STP			**EP**	**1150**	**1164**	**1187**	**1211**	**1235**
% Growth			%	0.79%	1.22%	1.98%	2.02%	1.98%
Average Daily STP Flow			**kL/d**	**250**	**253**	**258**	**263**	**268**
Daily Sludge Production			m3/d	1.26	1.27	1.30	1.32	1.35
27 kL Disposal Interval	**27**	**kL**	**Days**	**21.47**	**21.21**	**20.80**	**20.38**	**19.99**
Assumed disposal concentration			(mgMLSS/L)	12,500	12,500	12,500	12,500	12,500
Average Daily Sludge Production			(kgMLSS/d)	15.72	15.91	16.23	16.56	16.88
Sludge Disposed per Tanker			kgMLSS	337.50	337.50	337.50	337.50	337.50
Yungaburra STP			**EP**	**1171**	**1199**	**1247**	**1298**	**1351**
% Growth			%	1.65%	2.39%	4.00%	4.09%	4.08%
Average Daily STP Flow			**kL/d**	**200**	**205**	**213**	**222**	**231**
Daily Sludge Production			m3/d	2.81	2.88	2.99	3.12	3.24
27 kL Disposal Interval	**27**	**kL**	**Days**	**9.61**	**9.38**	**9.02**	**8.67**	**8.33**
Assumed disposal concentration			(mgMLSS/L)	5,500	5,500	5,500	5,500	5,500
Average Daily Sludge Production			(kgMLSS/d)	15.46	15.83	16.46	17.13	17.83
Sludge Disposed per Tanker			kgMLSS	148.50	148.50	148.50	148.50	148.50
Tinaroo STP			EP	317	325	338	352	366
% Growth			%	1.65%	2.39%	4.00%	4.09%	4.08%
Average Daily STP Flow			**kL/d**	**100**	**102**	**106**	**110**	**114**
Daily Sludge Production			m3/d	1.13	1.16	1.20	1.25	1.31
27 kL Disposal Interval	**27**	**kL**	**Days**	**23.87**	**23.31**	**22.41**	**21.53**	**20.69**
Assumed disposal concentration			(mgMLSS/L)	5,500	5,500	5,500	5,500	5,500
Average Daily Sludge Production			(kgMLSS/d)	6.22	6.37	6.63	6.90	7.18
Sludge Disposed per Tanker			kgMLSS	148.50	148.50	148.50	148.50	148.50

7.2.2 Solid Waste Landfill Leachate

Landfill leachate was not considered for the Major Upgrade strategy, due to uncertainty in the characterisation and volumes of leachate produced, and current uncertainty whether any contaminants (heavy metals, pesticides etc.) may impact the beneficial re-use of effluent (irrigation) and biosolids (land application).

A leachate investigation is included in Section 7.4.1.1. TRC may opt to accept the Leachate stream to the STP as part of the Major Upgrade, once the volume and characterisation is better defined and the risks can be accurately assessed.

7.3 Major Upgrade Options Analysis

The basis for the major upgrade includes:

- 2041 plus tourist flows (refer Section 4.1)
- Acceptance of sludge from satellite STPs (refer Section 7.2.1).
- No acceptance of leachate is currently considered in this assessment; although this may be incorporated during subsequent design stages once the volume and characterisation is better defined. Pre-treatment of leachate is common practice and would be recommended for the Atherton STP.

The options considered for the major plant upgrade aimed to meet the existing effluent licence requirements and where possible, provide flexibility for more stringent licence conditions in the future.

7.3.1 Options overview and shortlisting

The options considered for the Major Upgrade were selected to consider a cross section of robust treatment processes commonly adopted by Councils throughout Australia. The options are summarised as follows:

1. Upgrade using existing SBR technology;
2. Upgrade to a continuous treatment process with clarifiers; and
3. Upgrade to a Membrane Bioreactor (MBR) plant.

Several sub-options and configurations of each were also considered, as summarised in Table 17. Based on this three options were short-listed for more detailed assessment:

1. Option 1a – New SBR. Concept GA presented in Figure 16.
2. Option 2b – 4 Stage Bardenpho in new tank with clarifiers. Concept GA in Figure 17.
3. Option 3b – 4 Stage Bardenpho MBR in new tank. Concept GA in Figure 18.

7.3.2 Cost Estimates

A financial analysis was performed to compare the short-listed options and includes capital expenditure (CAPEX), operating expenditure (OPEX) and net present value (NPV) cost differentiation between the options.

The cost estimates have been developed for the purpose of comparing and evaluating the options. They are sufficiently accurate to serve this purpose and should only be used as indicative budgets, which should be refined once the design flows, loads and License requirements are concluded.

Capital cost

Capital costs were estimated using GHD's cost database and experience on recent similar projects. An allowance of 15% of the direct costs was applied to allow for engineering costs (incl. survey, investigations, design and project management). In addition an allowance of 30% was included as a contingency.

A summary of the capital cost estimates is listed in Table 18. A detailed breakdown of capital costs is given in Appendix K.

Table 17 Summary of major upgrade options and short-listing

Option No.	Option name	Sub-option no.	Sub-option name	Overview	Included in short-list?	Justification for excluding
1	Increase capacity of SBR	a	New SBR	• New SBR Tank (increased capacity) • Convert existing SBR to new Aerobic Digester • Increase capacity of Effluent Balance Tank • Increase capacity of existing Sand Filters (duplicate capacity) • New Inlet Works (increased capacity) • New alum dosing system (increased capacity) and new alkalinity dosing system • New sludge import facility • Modification to recycled water draw off location	✓	
		b	Duplicate existing SBR	• Duplicate existing SBR Tank • New Aerobic Digester (increased capacity) • New Effluent Balance Tank (increased capacity) • Increase capacity of existing Sand Filters (duplicate capacity) • New Inlet Works (increased capacity) • New alum dosing system (increased capacity) and new alkalinity dosing system • New sludge import facility • Modification to recycled water draw off location	✗	New SBR preferred given existing SBR tank can be repurposed as aerobic digester (similar volumes required) rather than construction of a new aerobic digester.
2	Convert existing facility to a conventional activated sludge plant	a	4 Stage Bardenpho using existing SBR (with clarifiers)	• Convert existing SBR Tank to 4 Stage Bardenpho Process with additional tankage • 2 new Clarifiers (approx. 20 m diameter each) • New Aerobic Digester (increased capacity) • Increase capacity of existing Sand Filters (duplicate capacity) • New Inlet Works (increased capacity) • New alum dosing system (increased capacity) and new alkalinity dosing system • New sludge import facility • Modification to recycled water draw off location	✗	New bioreactor preferred given existing SBR can be repurposed as aerobic digester (similar volumes required)

Option No.	Option name	Sub-option no.	Sub-option name	Overview	Included in short-list?	Justification for excluding
		b	4 Stage Bardenpho (or alternative) in new tank (with clarifiers)	• New 4 Stage Bardenpho Tank (or alternative activated sludge plant such as an oxidation ditch) • 2 new Clarifiers (approx. 20 m diameter each) • Convert existing SBR to Aerobic Digester • Increase capacity of existing Sand Filters (duplicate capacity) • New Inlet Works (increased capacity) • New alum dosing system (increased capacity) and new alkalinity dosing system • New sludge import facility • Modification to recycled water draw off location	✓	
		c	5 Stage Bardenpho using existing SBR (with clarifiers)	• Convert existing SBR Tank to 5 Stage Bardenpho Process with additional tankage • 2 new Clarifiers (approx. 20 m diameter each) • New Aerobic Digester (increased capacity) • Increase capacity of existing Sand Filters (duplicate capacity) • New Inlet Works (increased capacity) • New alkalinity dosing system • New sludge import facility • Modification to recycled water draw off location	✗	Preliminary modelling indicated biological phosphorus removal to TP <1 mg/L is limited by the available COD and the return of soluble-P from the aerobic digester. Methanol dosing and/or supplementary alum dosing would likely be required, increasing the capital and operating cost of this option. Chemical phosphorus removal has been selected for the purpose of this planning report.
		d	5 Stage Bardenpho in new tank (with clarifiers)	• New 5 Stage Bardenpho Tank • 2 new Clarifiers (approx. 20 m diameter each) • Convert existing SBR to new Aerobic Digester • Increase capacity of existing Sand Filters (duplicate capacity) • New Inlet Works (increased capacity) • New alkalinity dosing system • New sludge import facility • Modification to recycled water draw off location	✗	Refer comments for Option 2c

Option No.	Option name	Sub-option no.	Sub-option name	Overview	Included in short-list?	Justification for excluding
3	Convert existing facility to a membrane bioreactor plant	a	4 Stage Bardenpho within existing SBR (with MBR)	• Convert existing SBR Tank to 4 Stage Bardenpho Process with additional tankage with MBR • New Aerobic Digester (increased capacity) • New Inlet Works (increased capacity) • New alum dosing system (increased capacity) and new alkalinity dosing system • New sludge import facility • Modification to recycled water draw off location	✗	Retrofitting membranes into SBR tank and reconfiguring the plant into a 4 stage plant whilst maintaining operation is unlikely to be feasible. New bioreactor preferred given existing SBR can be repurposed as aerobic digester (similar volumes required)
		b	4 Stage Bardenpho in new tank (with MBR)	• New 4 Stage Bardenpho Tank with MBR; New membranes for MBR and associated equipment • Convert existing SBR to new Aerobic Digester • New Inlet Works (increased capacity) • New alum dosing system (increased capacity) and new alkalinity dosing system • New sludge import facility • Modification to recycled water draw off location	✓	
		c	5 Stage Bardenpho using existing SBR (with MBR)	• Convert existing SBR Tank to 5 Stage Bardenpho Process with additional tankage with MBR • New Aerobic Digester (increased capacity) • New Inlet Works (increased capacity) • New alkalinity dosing system • New sludge import facility • Modification to recycled water draw off location	✗	Refer comments for Option 2c
		d	5 Stage Bardenpho in new tank (with MBR)	• New 5 Stage Bardenpho Tank with MBR; New membranes for MBR and associated equipment • Convert existing SBR to new Aerobic Digester • New Inlet Works (increased capacity) • New alkalinity dosing system • New sludge import facility • Modification to recycled water draw off location	✗	Refer comments for Option 2c

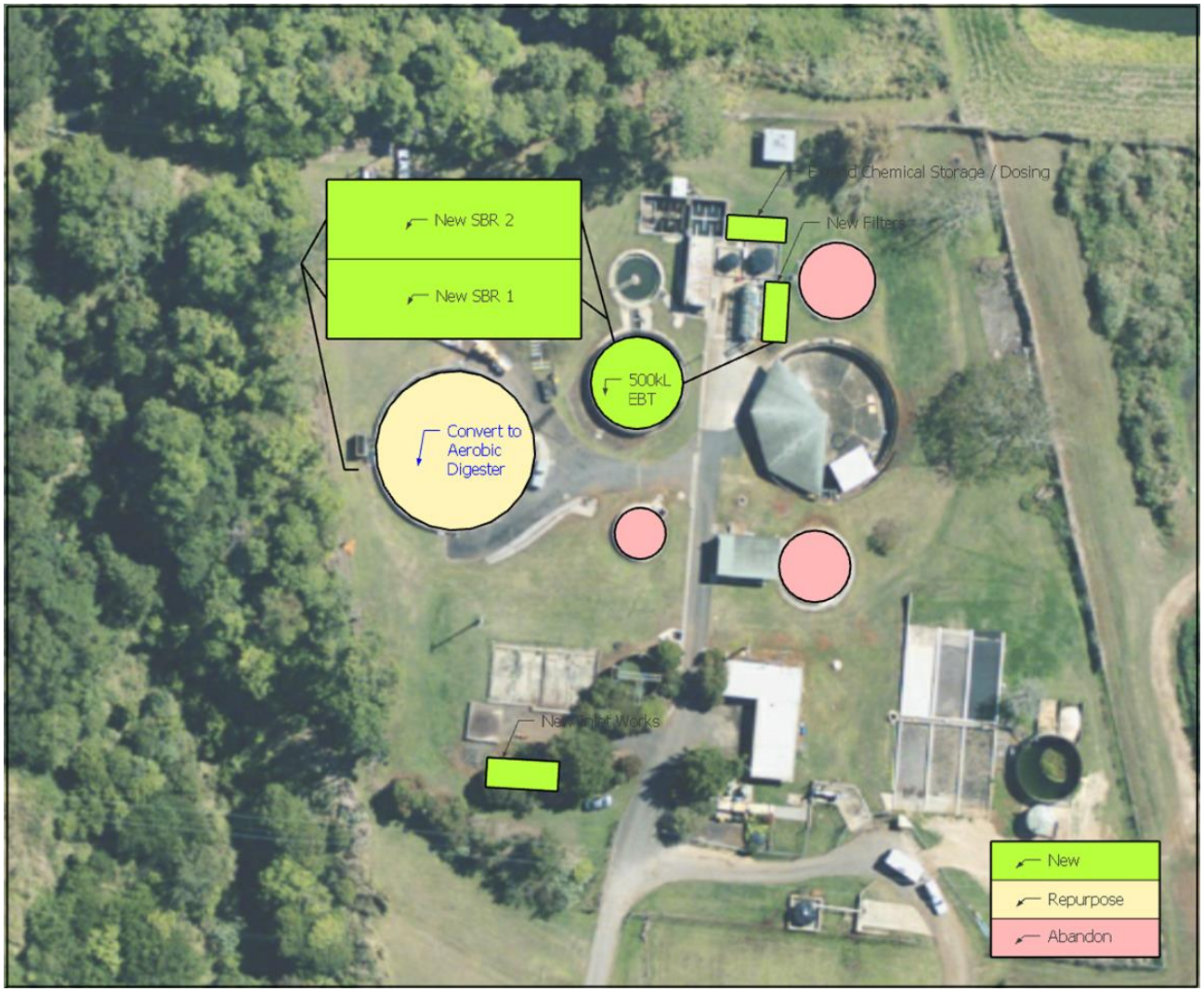


Figure 16 Concept Layout New SBR Option

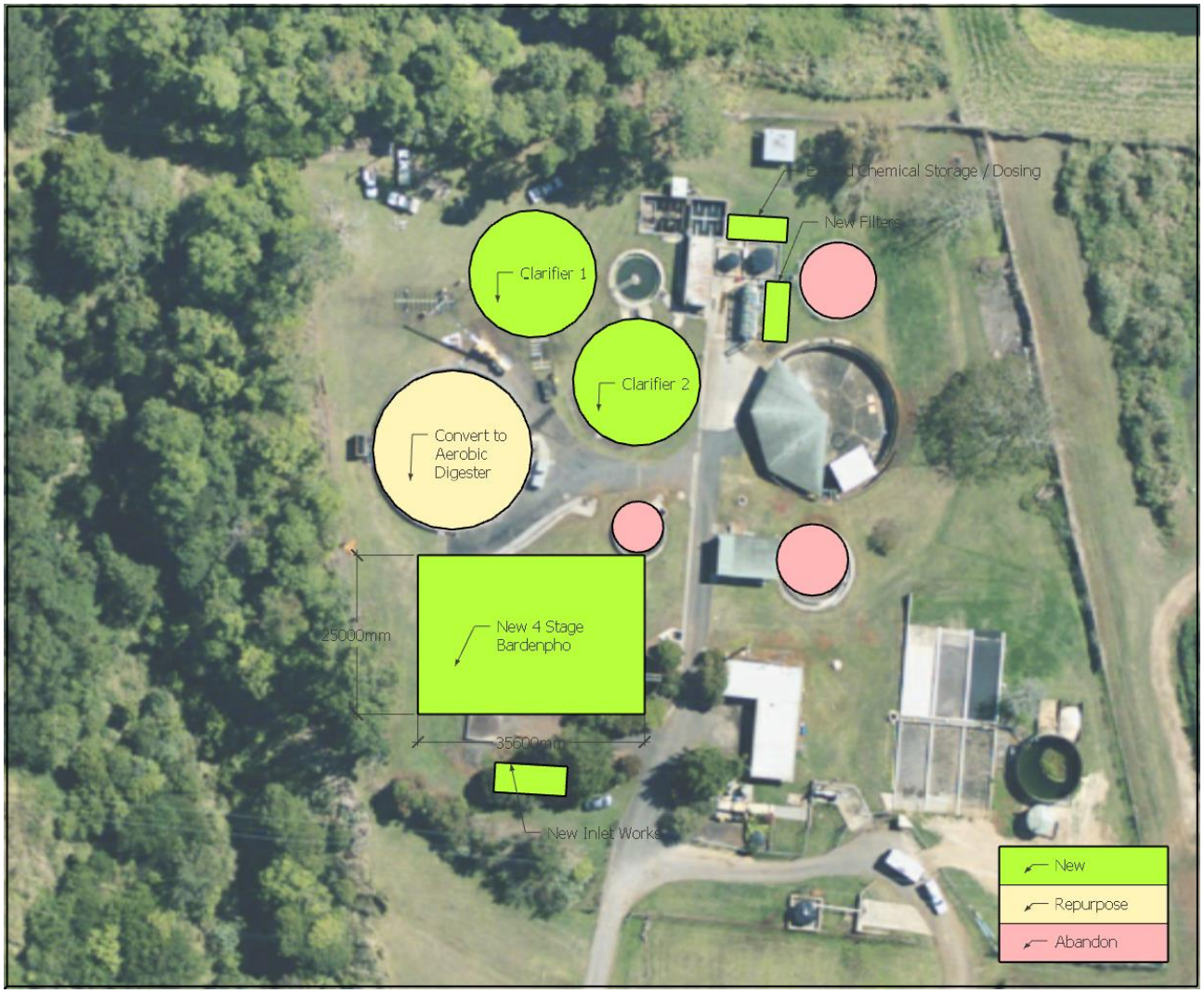


Figure 17 Concept Layout 4 Stage Bardenpho with Clarifiers Option

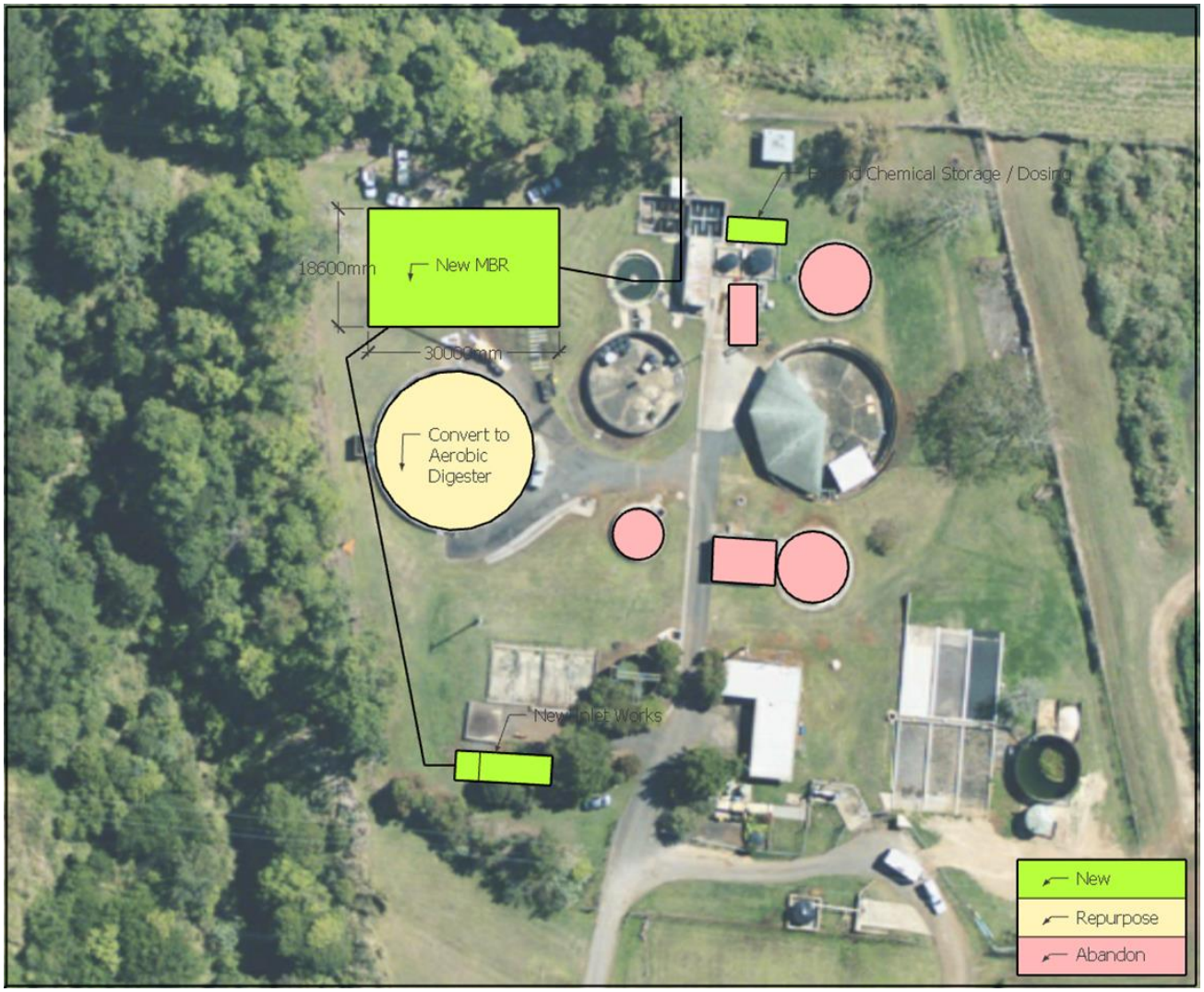


Figure 18 Concept Layout 4 Stage Bardenpho MBR Option

Table 18 Summary of comparative capital costs for shortlisted options

Option	Direct cost (2019; excl. GST)	Total cost including engineering and contingency (2019; excl. GST)
Option 1a - New SBR	$16.1 M	$24.1 M
Option 2b - 4 stage Bardenpho in new tank (with clarifiers)	$16.8 M	$25.1 M
Option 3b - 4 stage Bardenpho in new tank (with MBR)	$14.4 M	$21.6 M

These costs include a $400k direct cost allowance to cover only key odour sources (e.g. inlet works and septage holding tank areas) as discussed further in Section 7.5.

Operational costs

A summary of the operating expenses for the short-listed options is included in Table 19. Full details are included in Appendix K.

The operation and maintenance allowance was calculated based on:

- Operation & maintenance of civil infrastructure based on 1% of direct civil costs
- Operation & maintenance of mechanical & electrical (M&E) infrastructure based on 3% of direct mechanical and costs

The power cost adopted for the cost estimate was $0.15/kWh. This is based on the current (2019) cost charged to TRC for power use at Atherton STP (i.e. Ergon Tariff 45).

Operating costs that were consistent across all options were not included in the comparative estimates. This includes centralised sludge import costs, biosolids disposal, chemical usage and additional labour.

Net present value

In order to compare the three options on a whole-of-life basis, a net present value analysis (NPV) was undertaken for a 20 year period (2019 to 2041). Capital costs were included, based on an assumed construction year of 2026. Operating costs were assumed to commence in 2027.

The following assumptions were made for the NPV assessment:

- Cost escalation allowed is 2% per year (based on average building price index (BPI) over the past 5 years);
- A discount rate of 4% was adopted.

The cost of replacement for the membrane modules every seven years was included in the NPV. These costs have not been included in either the CAPEX or OPEX values presented in the previous subsections but have been incorporated into the NPV presented below.

A summary of the differential NPV for the three options is shown below in Table 20. Full details are included in Appendix K.

Table 19 Summary of comparative operating costs for shortlisted options

Option	Operating cost in 2019 $ (excl. GST)	Inclusions
Option 1a - New 4.5 ML SBR	$570,000	Operation and maintenance of new facilities, civils and M&E Electricity usage
Option 2b - 4 stage Bardenpho in new tank (with clarifiers)	$590,000	Operation and maintenance of new facilities, civils and M&E Electricity usage
Option 3b - 4 stage Bardenpho in new tank (with MBR)	$598,400	Operation and maintenance of new facilities, civils and M&E Electricity usage Savings from sand filter, sand filter feed pumps and GDD decommissioning (operation and maintenance)

Table 20 Summary of comparative NPV for shortlisted options

Option	NPV (excl. GST)
Option 1a - New 4.5 ML SBR	$48.2 M
Option 2b - 4 stage Bardenpho in new tank (with clarifiers)	$50.1 M
Option 3b - 4 stage Bardenpho in new tank (with MBR)	$47.6 M

7.3.3 Multi-Criteria Analysis

A Multi-Criteria Assessment (MCA) was undertaken to determine a preferred option from the short-listed options. The criteria and weightings used developed in collaboration with TRC to evaluate and select a preferred option are summarised in Table 21. As the Major Upgrade is needed, a business as usual (BAU) scenario was not included, and the options evaluated against each other. The scoring and results for each option is detailed in Table 22.

Table 21 Evaluation criteria for preferred option selection

Criteria	Interpretation	Low Score Definition (1)	High Score Definition (5)	Weighting
Environmental				
Ability to meet stringent license conditions	Does the process have sufficient flexibility to meet potential tightening of the nutrient license limits.	Major improvements required	Sufficient flexibility to meet tightened nutrient license discharge limits with only minor works	20%
Effluent re-use opportunity	Quality of effluent produced	Low quality recycled water produced	High quality recycled water produced	15%
Technical				
Ease of operation	Is the process easy to operate? Are there existing council guidelines?	Difficult to operate, new process with limited experience from council operators	Well established practice, Council currently have sufficient guidelines, operating procedures etc. to operate this infrastructure	15%
Technical reliability / Process Stability	Is this process robust and able to reliably treat variable influent loading and achieve the current licence limit?			20%
Economic				
Construction cost		High cost	Low cost	20%
Operating cost		High cost	Low cost	10%

The short-listed options were evaluated using the scoring system shown in the table below. A maximum score of 4 was adopted for the financial criteria with the lowest cost option scoring 4. The higher cost options were compared (linearly scaled) to the lowest cost option.

RATING	
5.0	Excellent
4.0	Good
3.0	Moderate
2.0	Limited
1.0	Poor

Table 22 MCA scoring and results

		Option 1a New SBR		Option 2b Installation of new tank for 4 stage Bardenpho with clarifiers		Option 3b Installation of new tank for 4 stage Bardenpho with MBR	
Criteria	Weighting	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Environmental							
Ability to meet tightening license conditions	20%	2.0	0.40	4.0	0.80	4.0	0.80
Effluent re-use opportunity	15%	4.0	0.60	4.0	0.60	5.0	0.75
Technical							
Ease of operation	15%	4.0	0.60	3.5	0.53	3.0	0.45
Technical reliability to achieve licence	20%	2.0	0.40	4.0	0.80	4.0	0.80
Economic							
Construction cost	20%	3.6	0.72	3.4	0.69	4.0	0.80
Operating cost	10%	4.0	0.40	3.8	0.38	3.8	0.38
TOTAL	**100%**		**3.1**		**3.8**		**4.0**
RANKING			**3**		**2**		**1**

7.3.4 Preferred Major Upgrade Process

Based on the results of this MCA, the preferred option recommended to be taken forward is Option 3b, which is the construction of a new 4 stage Bardenpho MBR treatment process, and associated improvements across the site.

7.3.5 Preferred option development

The preferred 4 Stage Bardenpho MBR process has been further developed to include the following:

General arrangement drawings

General arrangement drawings for the main process units are provided in Appendix L.

Process flow diagram

A process flow diagram of the preferred option is provided in Appendix M.

Modified hydraulic grade line

A concept HGL of the preferred option is provided in Appendix N. The HGL is based on the as-constructed levels. A full site survey should be completed as part of the detailed design process to ensure accuracy of the HGL.

Conceptually the new inlet works has been set ~1m lower than the existing to allow more pipe grade and cover in the proposed new DN750 gravity pipe to the STP designed by Jacobs [Ref

marked up Drawing H107300-0000-Cl-DRG-0021 Rev A]. The increased grade should enable a smaller diameter pipe to be selected; reducing construction costs and operational risks associated with grades > 1:1,400.

Equipment summary

A summary of the new and existing equipment that form the preferred option are detailed in Table 23 below.

Table 23 Preferred option equipment summary

Process component	Size	Units	Comments
Design capacity			
Design Year	2041	-	
Design EP	12,385	EP	Includes peak tourist season loading
Design ADWF	3.0	ML/d	
	34.7	L/s	
Design PWWF*	14.3	ML/d	** Assumed 5x ADWF, to be verified with improved flow metering.*
Inlet works			
Screening and grit removal	New		Secondary fine screening to suit membrane supplier requirements.
Peak flow capacity	170	L/s	** Assumed 5x ADWF, to be verified with improved flow metering.*
Bioreactor (new 4 stage Bardenpho with MBR)			
Bioreactor tank	New		Existing SBR to be repurposed as new aerobic digester
Volume	2.5	ML	
Anoxic zone 1	0.7	ML	
Aerobic zone 1	1.0	ML	
Anoxic zone 2	0.4	ML	
MBR zone	0.4	ML	
Depth	4.5	m	
Dimensions	19 by 30	m by m	Nominal
Target MLSS	8,000	mg/L	
Maximum MLSS	9,500	mg/L	
Aerobic zone DO setpoint	2	mg/L	
MBR zone DO setpoint	2	mg/L	
Aerobic zone blower requirements	3	No.	Operating duty / duty / standby Nominal – blower sizing to be optimised in future stages of design
	30	kW	Nominal (to be confirmed with subsequent design)
MBR blower requirements	2	No.	Operating duty / standby Nominal – blower sizing to be optimised in future stages of design

Process component	Size	Units	Comments
	55	kW	Nominal (to be confirmed with subsequent design)
WAS pumps	2	No.	Operating duty / standby
	5	L/s	100 kL/d in 6 hours
RAS pumps	2	No.	Operating duty / standby
	70	L/s	Sized for 2x ADWF (2041 plus tourist flows)
A-recycle pumps	2	No.	Operating duty / standby
	200	L/s	Sized for ~6x ADWF (2041 plus tourist flows)
Tertiary filtration			
Existing sand filtration			Existing sand filters and tertiary filtration balance tank decommissioned
Membranes			
Design flow	165	L/s	PWWF
Design flux	30	L/m^2.hr	
Membrane area required	19,900	m^2	
Disinfection			
Number of CCTs	2	No.	Existing
Volume of CCTs	175	m^3, total	Volume includes CCT volume, filtered effluent balance tank, discharge pipe to manhole and discharge pipe to from manhole to CCT inlet channel
Contact time at ADWF	83	min	
Contact time at PWWF	18	min	The suitability of the existing CCTs should be reassessed in detailed design once the actual peak wet weather inflow to the plant is known.
Sludge handling			
Sludge thickening			Existing GDD to be decomissioned
Import sludge facility *(Tanker connection to WAS pump, similar to Malanda STP)*	6	m^3/d	Occasional tanker discharges of 27 kL
	7,100	mg/L	Average concentration of import sludge
	42	kg/d	Solids mass
Aerobic digester feed	75	m^3/d	Feed flowrate - Includes import sludge and thickened WAS
	1	%DS	Feed concentration
	762	kg/d	Feed solids load
	85	%VS	Volatile solids concentration (VS/TS)
Aerobic digester capacity	2.25	ML	Digester volume, repurpose existing SBR

Process component	Size	Units	Comments
	30	days	Hydraulic retention time
Aerobic digester target VS destruction	38	%	
Aerobic digester DO setpoint	2	mg/L	
Aerobic digester blower requirements	3	No.	Operating duty / duty / standby Nominal – blower sizing to be optimised in future stages of design
	55	kW	
Feed solids concentration	0.8 – 1	%DS	Thickened sludge wasted directly from MBR compartment
Belt filter press solids loading rate	250	kg DS/hr	Based on 15 hours per week operation
Target dewatered solids concentration	13-15	%DS	
Balance of plant			
Alum dosing	600	L/d	
Alkalinity dosing	TBA	L/d	To be confirmed following alkalinity sampling at existing plant

7.4 Major Upgrade Influencing Factors

7.4.1 Future License

The Major Upgrade strategy is based on the existing stringent License being maintained and is the key primary factor selecting the 4 Stage Bardenpho MBR process. The existing License appears to be on the basis that Atherton STP discharges to the Great Barrier Reef, where in fact it discharges to Tinaroo Falls Dam; built primarily for irrigation.

Discussions with the Department of Environment and Science

A meeting was held between the Department of Environment and Science (DES), TRC and GHD on 1 March 2019, to discuss the potential for future amendments to the License. In this meeting, DES indicated that an increase in total nutrient load discharge to Mazlin Creek is unlikely to be considered, with reference to the Reef 2050 Water Quality Improvement Plan. Based on a theoretical mass loading approach, an indication of the Licence was prepared as summarised in Column D in Table 24. This indicative License is very stringent and effectively precludes any other treatment processes than an industry best practice MBR.

This indicative License has also been compared to recent Licenses issued to TRC, for Ravenshoe STP (Column B) and Tinaroo STP (Column C) respectively. The indicative License is more stringent than the two new Licenses barring ammonia. In line with general trends a 80th percentile long term median of 1.0 mg/L for ammonia is likely to be implemented, considering the potential toxicity at low concentrations in tropical waters.

Future license with diverted irrigation loads considered

Atherton STP has a beneficial re-use system to irrigate the Atherton Golf Course and a nearby farm to:

i) make best use of the available water; and

ii) minimise discharges to Mazlin Creek.

Beneficial re-use aligns with the DES strategy to divert nutrient loads from receiving waterways. The added benefit is that irrigation of nutrients in treated effluent offset the need for fertiliser application, another key water quality risk. The irrigation practices have not been formalised with DES, hence credit for diverting loads from Mazlin Creek does not appear to be considered in the current License.

To illustrate the efficiency of diverting nutrient loads from Mazlin Creek, three scenarios have been modelled; 75%, 50% and 25% of dry day flows irrigated. The current "Licensed Load discharge to the Creek (kg/annum)" was calculated using long-term License characteristics for BOD_5, Suspended Solids, Total Nitrogen and Total Phosphorous and the current License maximum dry daily flow of 2,200 kL/d.

As additional nutrient discharge to the environment is unlikely to be accepted in future, the data presented in Figure 19 compares the current Licensed nutrient discharge with the discharge loads based on the ultimate flow of 2,900 kL/d in 2041.

Figure 19 shows that provided more than 25% of effluent is irrigated, there will be no nett increase in nutrients discharged to Mazlin Creek. For optimised effluent irrigation of 50 and 75% of effluent respectively, a significant reduction in nutrients discharged to Mazlin Creek could be achieved.

Based on the re-use flow records for the period 1 Jan 2018 to 31 October 2018, the STP produced 611 ML of effluent, of which 239 ML was reused (39%). If wet season months are omitted from the assessment, during May to October, 367 ML of effluent was produced whilst 208 ML (56.6%) was disposed of via irrigation. Considering the potential to optimise preferential disposal via irrigation, the actual load discharged to Mazlin Creek is significantly lower than currently allowed for in the License.

Columns (E), (F) and (G) in Table 24 consider what License concentration would be required to "not increase" the existing nutrient load.

In conclusion, by considering the alternative irrigation disposal of effluent there is potential to negotiate a less stringent License without increasing the risk to the environment.

Point Source Water Quality Offsets

The Environmental Evaluation identified water quality exceedances upstream of the STP discharge point. This presents the opportunity to consider offsets to yield an improved environmental outcome, rather than focussing purely on the STP.

The potential offsets are presented in the Environmental Evaluation Report.

Impact of license on Atherton STP upgrade

The future License is the key driver in process selection to upgrade the Atherton STP. If neither beneficial use of effluent nor offsets policy actions are factored in, and the current or more stringent License is issued by DES, this will drive the process to a complex treatment process (such as MBR) with high operating costs, particularly power consumption and chemical dosing; which has a direct environmental cost.

If beneficial re-use of effluent is factored into the License negotiation and TRC is credited for diverting load from Mazlin Creek, there is scope to negotiate a load based License (excluding ammonia which is concentration sensitive) which considers both the actual load discharged to Mazlin Creek, during the dry season.

Considering the sensitivity of the selected process and upgrade costs based on the revised License, TRC should investigate the merits of:

- expanding effluent reuse opportunities
- identifying candidate green infrastructure solutions as part of the offsets Policy and their implications on a new negotiated license with DES.

The remainder of this report has been based on the current license as it represents the infrastructure only solution to the anticipated major upgrade of the Atherton STP (and upper end of the forecasted costs).

Figure 19 Projected Nutrient Load to Mazlin Creek

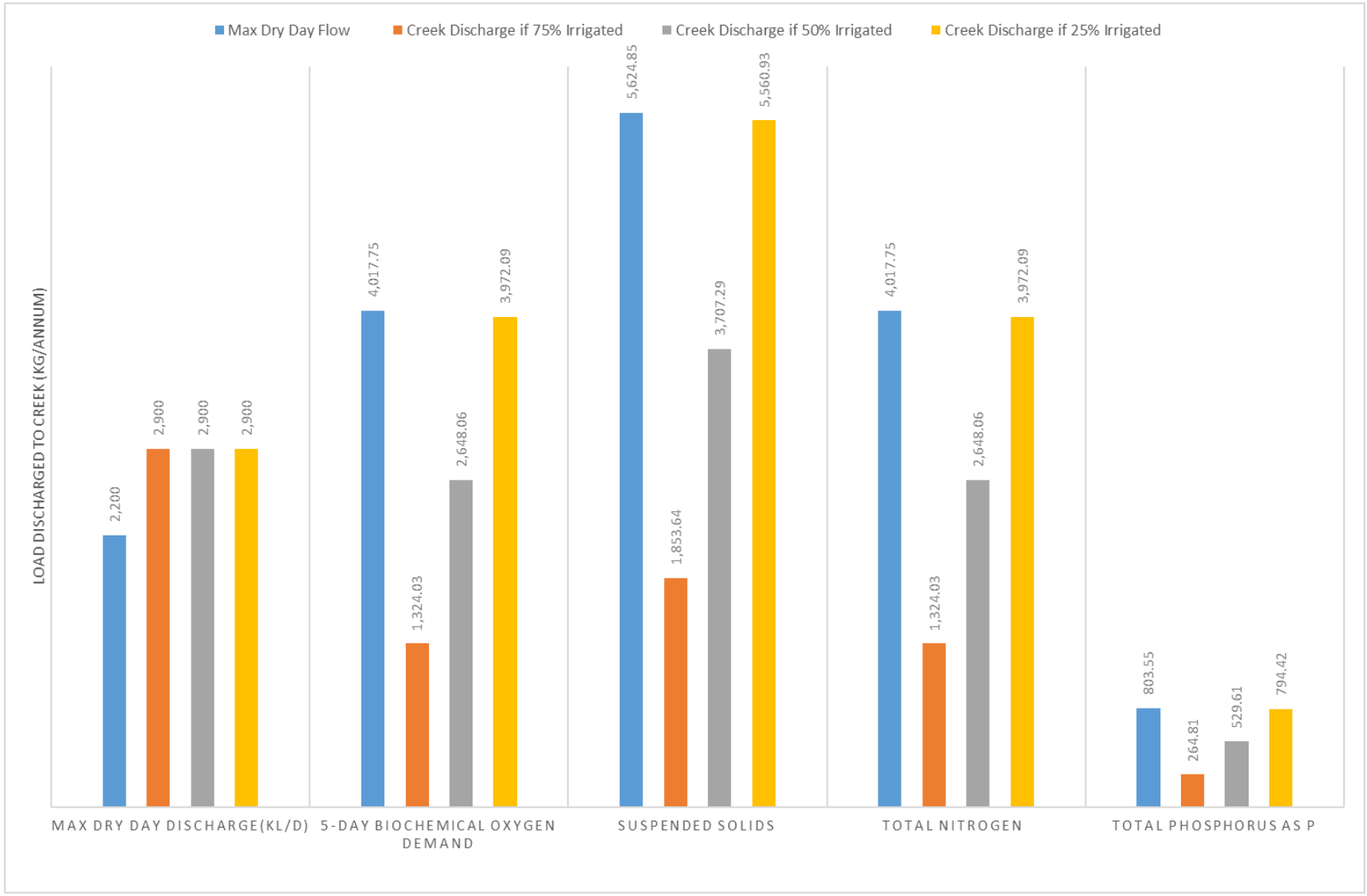


Table 24 Indicative Future Licenses

Quality Characteristic	Units	(A) **Atherton Current License**	(B) R/shoe New License	(C) Tinaroo New License	(D) **Indicative Mass Loading Based License (without Re-use Credit)**	(E) Indicative Mass Loading Based License (with Re-use Credit) 75% irrigated	(F) **50% irrigated**	(G) 25% irrigated	Limit Type
Max Dry Day Discharge(kL/d)	kL/d	**2,200**	950	190	**2,900**	725	**1,450**	2,175	
5-day Biochemical Oxygen Demand	(mg/l)	**5**	5	5	**3.8**	15.17	**7.59**	5.06	80th %ile (long term)
		10	10	10	**7.6**				80th %ile (short term)
		20	25	25	**15.2**				Max
Suspended Solids	(mg/l)	**7**	10	10	**5.3**	21.24	**10.62**	7.08	80th %ile (long term)
		15	20	20	**11.4**				80th %ile (short term)
		30	30	30	**22.8**				Max
Ammonia Nitrogen	(mg/l)								
		2	1	1	**1**[7]		**1.0**[8]		80th %ile (long term)
		4	3	3	**3**				Max
Total Nitrogen	(mg/l)								
		5	5	5	**3.8**	15.17	**7.59**	5.06	50th percentile

[7] Based on Mass Balance a new 80th %ile of 1.5mg/L would apply. This however does not comply with recent trends, in tropical areas to tighten ammonia limits. GHD have included the more stringent 1.0mg/L as per recent License.

[8] As ammonia toxicity can occur at low concentrations, a mass loading approach cannot be considered particularly in the dry season, with low dilution in receiving waters.

Quality Characteristic	Units	(A) **Atherton Current License**	(B) R/shoe New License	(C) Tinaroo New License	(D) **Indicative Mass Loading Based License (without Re-use Credit)**	(E)	(F)	(G)	Limit Type
						Indicative Mass Loading Based License (with Re-use Credit)			
						75% irrigated	**50% irrigated**	25% irrigated	
		10	15	15	**7.6**				Max
Total Phosphorus as P	(mg/l)								
		1	1	1	**0.8**	3.03	**1.52**	1.01	50th percentile
		2	3	3	**1.5**				Max
Oil and Grease	(mg/l)	**10**	10	10	**7.6**				Max
pH	(pH Units)	**6.5**	6.5	6.5	**6.5**				Min
		8.5	8.5	8.5	**8.5**				Max
Dissolved Oxygen	(mg/l)	**2**	2	2	**2**				Min
Free Residual Chlorine	(mg/l)	**0.7**	0.7	0.7	**0.7**		**0.7**		Max
Faecal Coliforms	(Organisms /	**150**	500	500	**150**				Median
	100 ml)	**600**	1000	1000	**600**				80th percentile

7.4.1.1 Solid Waste Leachate

Atherton landfill is located on Lot 100 SP 252409, on the southern-most extent of the existing sewerage catchment. One of the leachate treatment options considered in Golders Leachate Management Strategy (2018), is to pump leachate from the landfill into the sewerage catchment for subsequent treatment at Atherton STP. The landfill site is located on the extreme southern extremity of the sewerage system, and would be well blended before being discharged to the STP.

Atherton STP has an ERA 58 for Regulated Waste Treatment (operating a facility for the receiving and treating regulated waste. Condition W3-1 adds regulated waste may only be accepted into the sewerage system serving the licensed place (Atherton STP) either commingled with normal domestic sewage, or in accordance with TRCs trade waste policy, therefore provision to treat leachate at the STP already exists, provided there is capacity factored in to undertake this treatment.

Leachate characterisation

Occasional leachate testing completed out by TRC since 2011 is summarised in Table 25. The COD, BOD_5, Ammonia, nitrate, nitrite, pH and sulphate are lower than typical leachate, particularly in regard to nitrogen. All nitrogen species (nitrate, nitrite and ammonia) are very low. Due to the significant discrepancies the accuracy of the information is uncertain.

TRC carry out recirculation of leachate via irrigation / recirculation across the landfill. This, in combination of rainfall and possibly groundwater, may dilute the leachate. If leachate is discharged to the sewer, and current irrigation / recirculation practices are stopped, the nature of leachate is likely to change significantly.

In addition to the results presented in Table 25, twenty-three other pesticides and contaminants are tested with all being below the detectable limits, except Dieldrin and Endrin. Elevated results were detected on 27 February 2017 of 4.5 and 3.0 µg/L respectively. These were re-tested two weeks later, with no detection above the test limits of 2.4 µg/L detected.

It is noted that PFAS/PFOS testing has not been carried out.

Table 25 Summary of Leachate Testing Data

Description	Units	Count	Min	Median	Max
Lab pH	pH Units	11	5.4	6.9	10.6
COD (mg/L)	mg/L	15	37	250	1000
BOD_5	mg/L	15	4	66	620
Ammonia	mg/L	1	1.77	1.77	1.77
Nitrate (mg/L)	mg/L	15	0.005	0.021	3.2
Nitrite (mg/L)	mg/L	14	0.0037	0.0075	1.8
Lab EC (uS/cm)	µS/cm	10	14	755	1300
Sulphate	mg/L	13	1.9	17	174
DO	mg/L	10	0.05	0.75	7.5
Lab TDS (mg/L)	mg/L	0	No record		
Calcium (mg/L)	mg/L	15	14	40	94
Chloride (mg/L)	mg/L	15	20	81	170
Sodium (mg/L)	mg/L	14	18	57.5	97
Lead (mg/L)	mg/L	15	0.001	0.004	0.06
Zinc (mg/L)	mg/L	15	0.005	0.07	0.313
Iron (mg/L)	mg/L	15	0.23	2.66	6.8
Total Petroleum Hydrocarbons C10-C14 Fraction	µg/L	9	25	190	1200

Description	Units	Count	Min	Median	Max
Total Petroleum Hydrocarbons C15-C28 Fraction	µg/L	9	190	1270	3970
Total Petroleum Hydrocarbons C29-C36 Fraction	µg/L	9	25	460	1510
Total Petroleum Hydrocarbons C10-C36 Fraction(sum)	µg/L	9	190	2060	5780
Total Organochlorine Pesticides	µg/L	2	0.025	0.6125	1.2

Leachate volumes

A geomembrane lined leachate storage pond was constructed in 2016. GHD have previously requested the Design Report for the pond, but have been informed this does not exist and the actual leachate production volumes are not known.

The Atherton Landfill Development Plan and Leachate Management Strategy (Golder, 2018) were reviewed. According to Section 4.6 of the Leachate Management Strategy, five (5) implementation phases exist, with the final being capping of the landfill, in addition to the transfer station.

Table 26 Estimated Annual Leachate Collection Volume

	Description	Median (kL/annum)	High (kL/annum)
Phase A	Current landfill operations, initial waste lift stages	2470	4,259
Phase B	Landfill toe extension	519	884.8
Phase C	Landfill toe extension, waste landform reshaping	2,671	4,562
Phase D	Final waste lift stages	2,603	4,491
Phase E	Post landfill rehabilitation works	53	100
Transfer Station		9,942	11,164

The highest leachate production is during Phase A, C and D, which all range between a median of 2,600 to high of 4,500 kL/annum, or an average of 7-12 kL/day. The Transfer station has a significantly larger leachate production ranging between 27 and 31 kL/day. The total leachate production proposed to be considered in the Planning Report is a peak of 50 kL/day.

TRC installed a flow meter in 2019, to allow the volume of leachate to be measured. GHD is not familiar with the proposed location of the meter, and whether it will re-measure leachate flows recirculated across the landfill. Flow records were not available for consideration in this report.

Leachate handling at Atherton STP

The available data on leachate is uncertain and should be investigated further by TRC prior to making a decision to accept this into the sewerage system. Of particular concern, is the presence of metals, hydrocarbons, pesticides etc. which, considering TRCs intent to maximise beneficial re-use of both the effluent and sludge the contaminants, may ultimately restrict beneficial uses.

In the short-term considering the currently limited treatment capacity; GHD recommend not to accept leachate for treatment at the STP until the actual volume and characterisation is known and the STP has been upgraded to provide capacity to accept this new load.

7.4.2 Sludge disposal requirements

7.4.2.1 Requirements for beneficial reuse

The NSW EPA Environmental Guidelines for the Use and Disposal of Biosolids Products[9] provide guidance of the required treatment and quality of biosolids for reuse. Based on the NSW guidelines, Table 27 summarises the required stabilisation grades for different reuse options.

Contamination grades have not been assessed within this capacity assessment given there is no data available on the quality of the sludge disposed. This information could be requested from Arkwoods to gain a better understanding of the biosolids quality they are currently achieving.

Table 27 Required biosolids stabilisation grade for reuse

Stabilisation grade	Reuse options
Grade C	Not suitable for reuse
Grade B	If Class D contamination grade is achieved: Soil and site rehabilitation If Class C contamination grade is achieved: Agriculture, Forestry and Soil and Site Rehabilitation
Grade A	If Class B contamination grade is achieved: As for Grade B, plus Urban Landscaping If Class A contamination grade is achieved: As for Grade B, plus Urban Landscaping and Public Contact Sites

It is understood that the current arrangement for biosolids management at Atherton STP sees all treated and dewatered sludge collected by Arkwoods for disposal or beneficial reuse. Following collection, Arkwoods test the biosolids to determine if the quality is suitable for beneficial reuse. If the biosolids are not of a suitable quality for beneficial reuse, Arkwoods dispose of the biosolids to landfill and invoice TRC for the disposal cost. TRC are not charged if Arkwoods are able to reuse the biosolids. TRC have advised that they have not been charged for sludge disposal in some time, indicating that the biosolids have been of a suitable quality for reuse.

Based on the sludge treatment process currently installed at Atherton STP (i.e. aerobic digestion), a maximum of Grade B biosolids stabilisation may be achieved[10]. Given it is unlikely the existing aerobic digester is achieving 38% volatile solids reduction (based on the required airflow) and there are no long term (6 months) sludge storage lagoons utilised onsite, one of the following must be achieved to meet the Grade B stabilisation requirements:

- No more than 15% further volatile solids reduction when incubated under aerobic conditions in a bench scale reactor for an additional 30 days at 20°C (typically used for extended aeration processes)
- Specific oxygen uptake rate for biosolids shall be less than 1.5 mg 0_2/hour/g total solids at 20°C

[9] QLD currently applies the NSW guidelines for Biosolids management

[10] Refer Table 3-3 of NSW EPA Environmental Guidelines for the Use and Disposal of Biosolids Products

- ? The pH value of the biosolids shall be raised to 12 and without the addition of further alkali shall remain at 12 or higher for two hours and then at 11.5 or higher for an additional 22 hours
- × The proportion of dry solids shall be at least 75%
- × Biosolids shall be treated in an aerobic process for at least 14 days. During that time, the temperature of the biosolids shall be >40°C and the average temperature >45° C. This option relates primarily to composted biosolids.

7.4.2.2 Recommendations

Prior to making any investments in upgrading the biosolids handling system at Atherton STP or implementing a centralised sludge facility, it is recommended that TRC engage with Arkwoods to understand how the biosolids are reused, the stabilisation grade and the testing process they undertake before reusing the biosolids.

Given the current aerobic digester is not meeting the design sludge age and is likely undersized to achieve >10% volatile solids reduction[11], a significant upgrade is likely required before addition sludge can be imported into Atherton STP.

7.5 Odour investigation

7.5.1 Relevant guidelines

Guideline for Odour Impact Assessment from Developments (Queensland Department of Environment and Heritage Protection)

This guideline by the Department of Environment and Heritage Protection (EHP) promotes the use of proper land use planning to avoid incompatible land uses in close proximity to odour causing industries. Section 6.6 of the guideline, which relates to buffer distances, explains that EHP adopts the current Victorian EPA approach to buffer distances for the purpose of this guideline.

EPA Publication 1518, Recommended Separation Distances for Industrial Residual Air Emissions (EPA Victoria 2013)

EPA publication 1518 responds to the Environment Protection Act 1970 (EP) and to Victoria Planning Provisions (VPP) for the need for regulation and management of separation distances from industries creating residual air emissions. The separation distance assessment in this report directly refers to the EPA publication 1518. This guideline specifies the methods to determine separation distances between industrial processes and sensitive receptors. Section 11 of publication 1518 refers to sewerage treatment plants specifically.

Environmental Guidelines for the Use of Recycled Water in Tasmania (Department of Primary Industries, Water and Environment 2002)

This guideline provides a framework for the re-use of recycling of wastewater in a way that is sustainable for agriculture, the environment and the general public. The guidelines specify separation distances for wastewater sources, including holding ponds, which are not included in EPA publication 1518.

7.5.2 Separation distance assessment

A separation distance is a planning instrument used to provide separation of sensitive land uses (i.e. residential, schools, hospitals) from existing industries with the potential for offsite

[11] To be confirmed following confirmation of blower capacity

emissions (odour or dust) that can cause disamenity in the event of an upset/malfunction. Under routine operations, impact is to be confined onsite so that an external separation distance should not be required. Buffers have been scribed in this report using method 1 in EPA publication 1518, which measures the buffer from the activity boundary of the STP to the distance at which the property boundary of a sensitive receiver may be placed (described in section 8.1 EPA publication 1518).

The Atherton STP upgrade is proposed to have three source types from which odour emissions may be generated. These include the treatment plant (inlet works and processing tanks), the existing and proposed irrigation ponds and the proposed irrigation area. The selection of separation distances for each source type is outlined below.

STP

Section 11 of EPA publication 1518 specifies the method of calculation of the default recommended separation distances for sewerage treatment plants. Sewage treatment plants are linked to the size of the population that they serve, so the larger the population being serviced by the plant, the larger the separation distance. An equivalent population (EP) is used as a standardised measure of population.

The type of treatment method or pondage system used contributes to the calculation of the separation distance of the STP. Publication 1518 lists several categories of sewerage treatment plants based on the treatment methods available. To determine the Atherton STP separation distance, GHD has used the equation given for Mechanical/ biological wastewater plants, given in Equation 1 below.

$$Separation\ Distance\ = 10n^{1/3} \quad (1)$$

Where *n* is the equivalent population (EP)

Table 28 shows the parameters considered for calculating the separation buffer distances for Atherton STP. Using the EP outlined in Table 7 for year 2041, the separation distance calculated is 231m and is shown in Figure 20.

Table 28 Separation distance for Atherton STP

Design horizon	EP	Buffer distance (m)
2041	12,385	231

Irrigation ponds

Publication 1518 does not stipulate a separation distance for odour generated from irrigation storage ponds. The Environmental Guidelines for the Use of Recycled Water in Tasmania specifies a separation distance of 250 m from storage lagoons/holding dams to the nearest sensitive receptor. This distance is recommended for odour mitigation specifically. The 250 m buffers in Figure 20 take into account both the current irrigation pond and proposed future irrigation pond.

Irrigation area

As outlined in Publication 1518, irrigation may occur in the form of spray irrigation or flood irrigation, and the potential for odour is higher for the former and lower for the latter. EPA publication 1518 specifies a 50 m separation distance for flood irrigation and a 200 m separation distance for spray irrigation. Both of these distances have been presented in Figure 20 to demonstrate the impact of each irrigation type.

7.5.3 Odour Management

The buffer distances included herein are based on industry standard practices to cover and treat key odour sources, such as inlet works and septage storage areas. An allowance of $400k for this is included in the Major Upgrade costs estimates.

In order to reduce the likely odour impact boundaries, additional odour management and treatment steps will be required including capturing additional odour sources and covering process tanks such as anaerobic reactors, sludge dewatering facilities and possibly digesters. This increases the volume of odorous air required to be treated as well as the extent of covers over process tanks. In GHD's experience, this would involve an additional CAPEX cost of $2-5M, and increased operational costs for Atherton STP.

The indicative odour management costs are subject to the:

- Adopted processes (aerobic/anaerobic),
- footprint (cover costs and extraction rates); and
- location on the site (proximity to odour receptors).

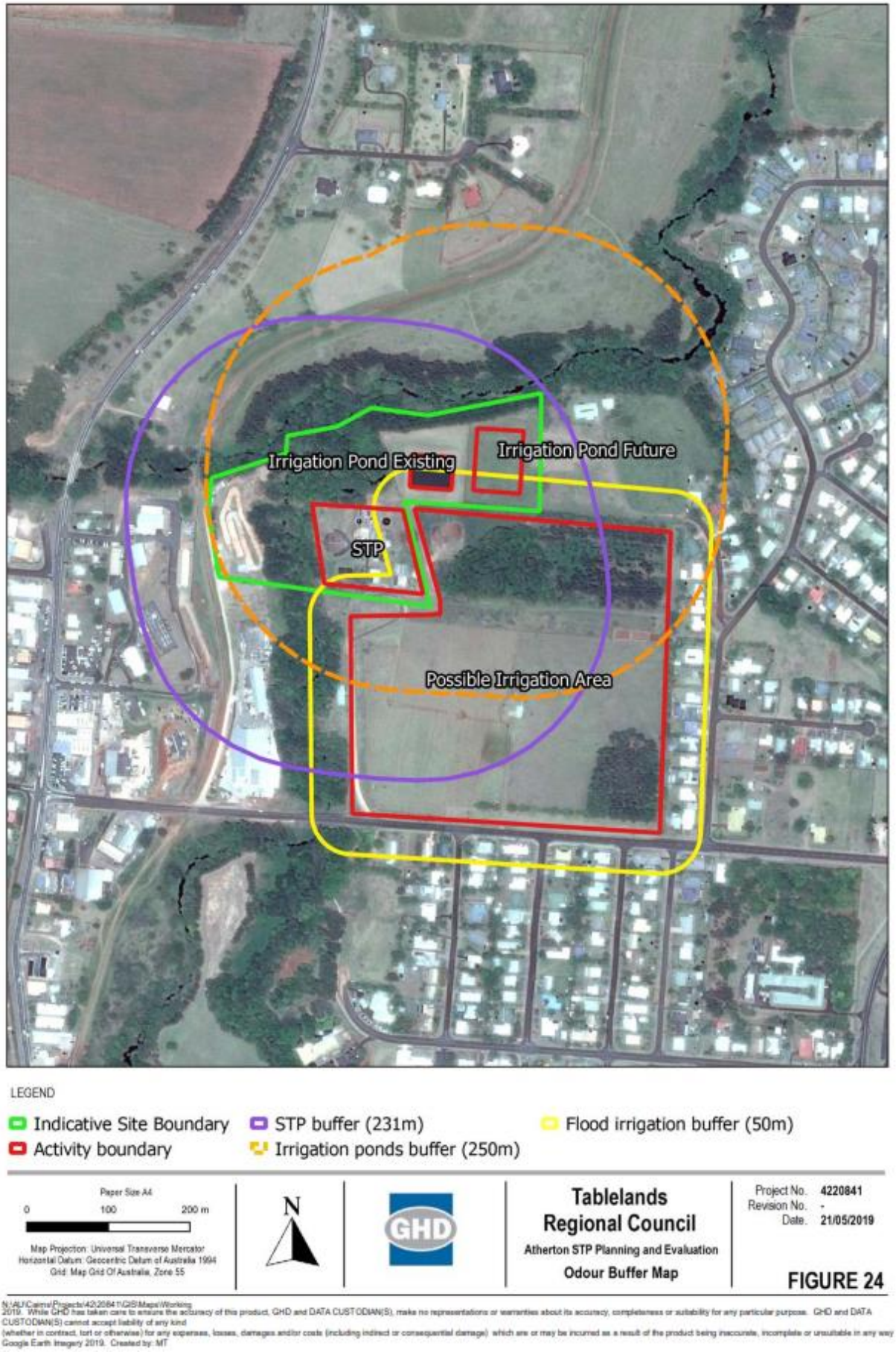


Figure 20 Separation distances for Atherton STP at 2041

7.6 Solar power

7.6.1 Peak Services Report

With reference to Peak Services "Solar Power Concept Design, for Tablelands Regional Council dated 13 July 2018, a 150 kW solar plant was recommended for Atherton STP. The main power use with the existing SBR process was the existing SBR blowers, at 55 kW each operating in a duty/assist configuration accounting for 73% of the solar load.

7.6.2 Major Upgrade Load

With reference to the preliminary equipment details listed for the preferred 4 Stage Bardenpho MBR solution (Option 3b), detailed in Section 7.3.5. The power usage for the site would increase significantly with 3x 30kW (D/D/S) blowers for the Reactor, 2 x 55 kW (D/S) blowers for membrane air scour (cleaning) and 3 x 55 kW (D/D/S) Blowers for the retrofitted aerobic digester; a total of 225 kW of peak duty demand. This is approximately double the existing load, therefore the proposed solar plant could be enlarged to serve the future load.

7.6.3 Solar Power Usage

Atherton STP loading has a major peak between 11:00 and 15:00, with a second peak from 18:00 to 22:00, with low flows overnight. Peak solar power in mid-morning to mid-afternoon would be well suited to the minimising power usage across the site.

8. Conclusion

In reviewing the historic performance improving trends in the percentile compliances illustrate the Tableland Regional Councils improved efforts and management of the Atherton STP. Historic exceedances are short-term, maximum exceedance events which have been timeously reported, investigated and resolved by TRCs managers and operators.

The actual performance and process models identify the process is over-loaded compared with the original design, further highlighting TRCs efforts which have managed, improved and optimised the process performance to protect Mazlin/Priors Creek.

The report identifies a major upgrade of the STP is required to meet the long-term service demands and the current License. The major upgrade is expected to take approximately 5 years to implement, therefore TRC have adopted short/medium term strategies as detailed in Appendix E, to ensure the risk to the receiving environment is managed prior to completing the Major Upgrade. These strategies include formalisation of existing TRC practices, as well as additional process improvements aimed to optimise the process performance.

The projected loads will exceed the current License limit of 10,000EP in the coming 5 years, and will trigger the need to negotiate a new License.

The Major Upgrade process selection is heavily dependent on the future EA requirements. It is proposed to consider a mass based License, which considers TRCs re-use practices for all nutrient based characteristics barring effluent ammonia, which should remain a concentration limit. Ammonia has the potential for short-term, low concentration toxicity, which needs to be managed by the process and as an absolute fall-back, dilution in the creek.

The report identifies that improved long-term flow metering and influent characterisation should be undertaken by TRC, to ensure the Major Upgrade can be optimised for actual loading *in lieu* of standard design values, such as the peak wet weather factor of 5x considered in this report.

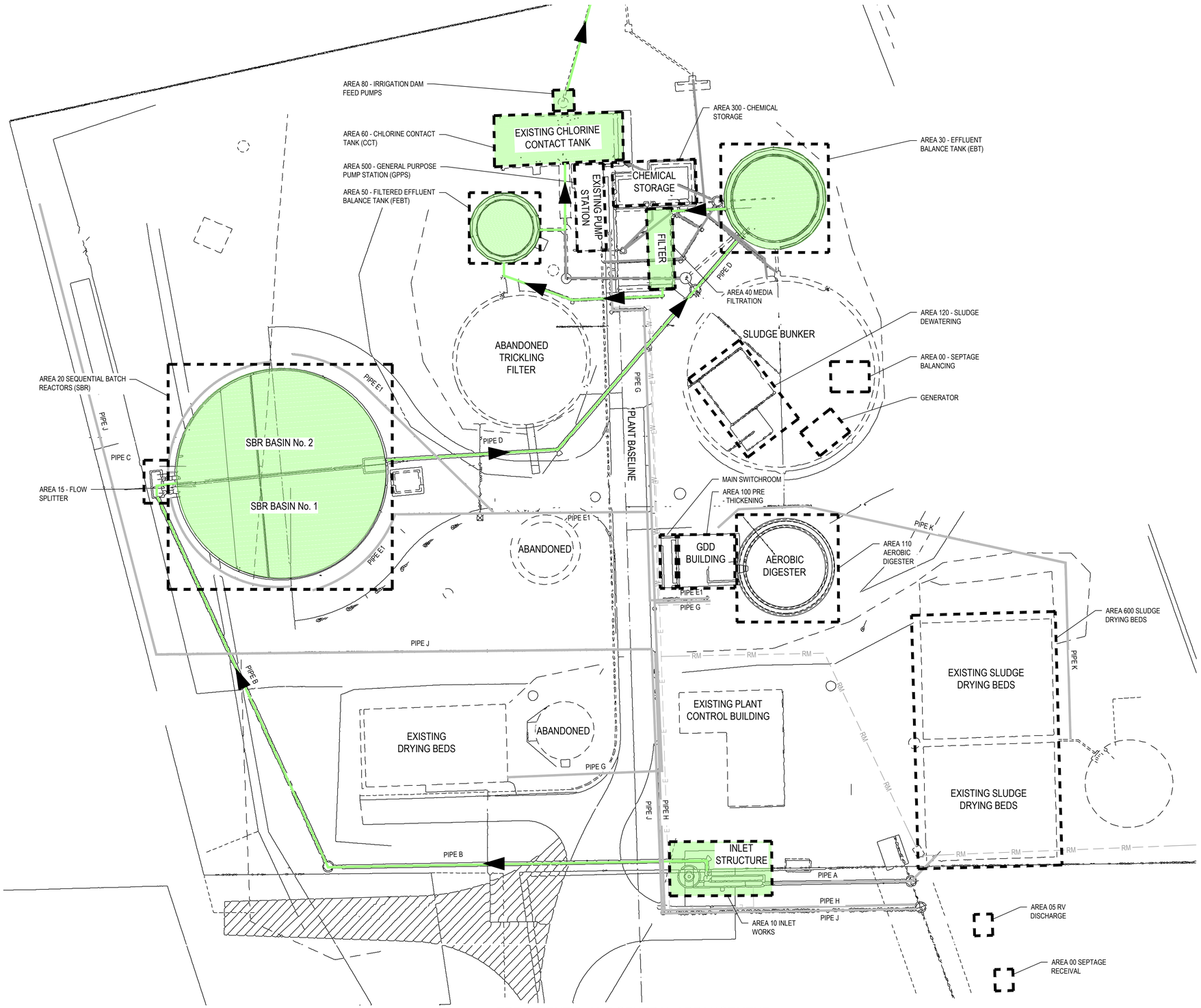
Appendices

Appendix A – Atherton STP Site Layout

N

LEGEND

MAIN TREATMENT FLOW PATH



TREATMENT PLANT GENERAL ARRANGEMENT

SCALE 1:250

PRELIMINARY

No	Revision	Drawn	Job Manager	Project Director	Date
A	PRELIMINARY ISSUE	EDJ	GG*	TMB*	28.05.19

Note: * indicates signatures on original issue of drawing or last revision of drawing

0 2.5 5 7.5 10 12.5m

SCALE 1:250 AT ORIGINAL SIZE

TRC TABLELANDS REGIONAL COUNCIL

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Drawn E.JOHNSON | Designer G.GADEMAN
Drafting Check | Design Check
Approved (Project Director)
Date
Scale AS SHOWN

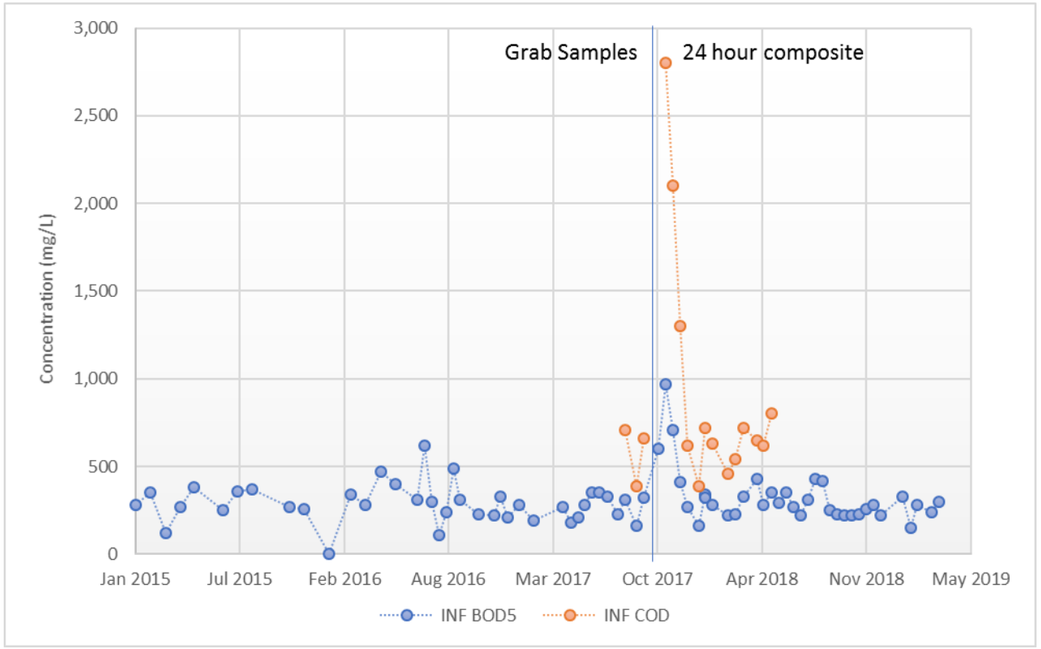
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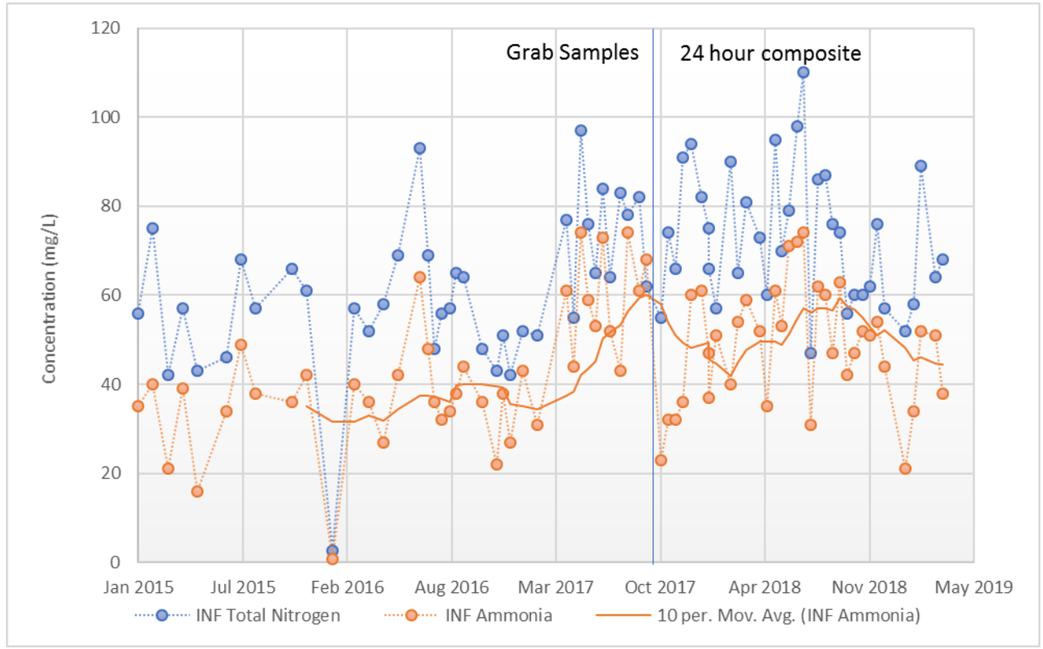
Client TABLELANDS REGIONAL COUNCIL
Project ATHERTON STP PLANNING AND EVALUATION
Title SITE GENERAL ARRANGEMENT

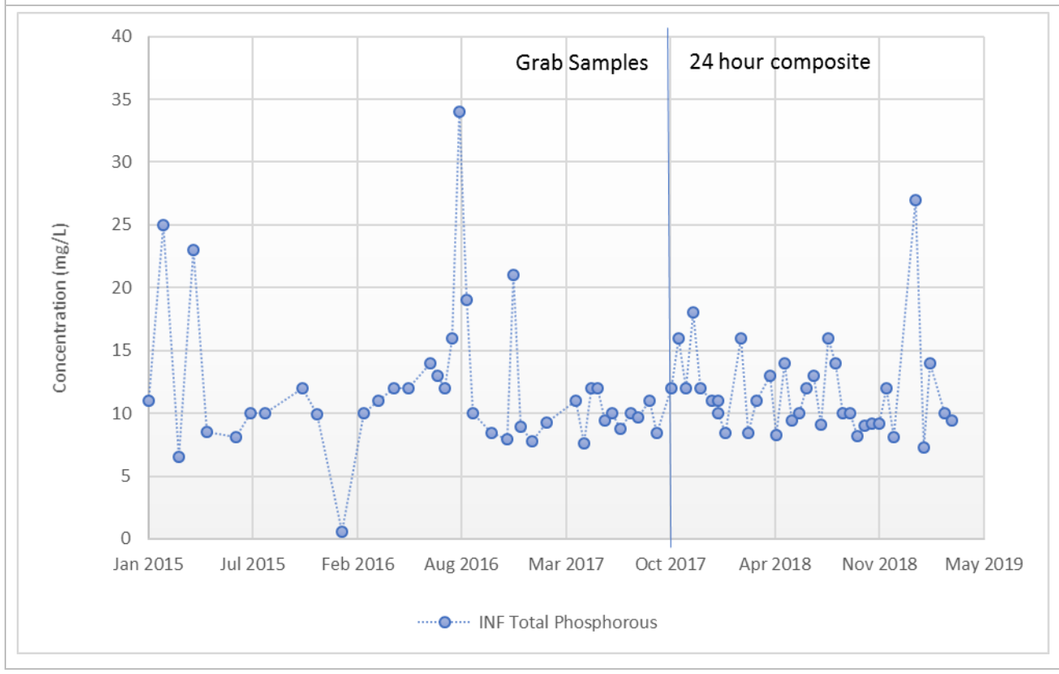
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Plot Date: 28 May 2019 - 3:27 PM Plotted by: Evan Johnson Cad File No: G:\42\20841\CADD\Drawings\42-20841-G002.dwg

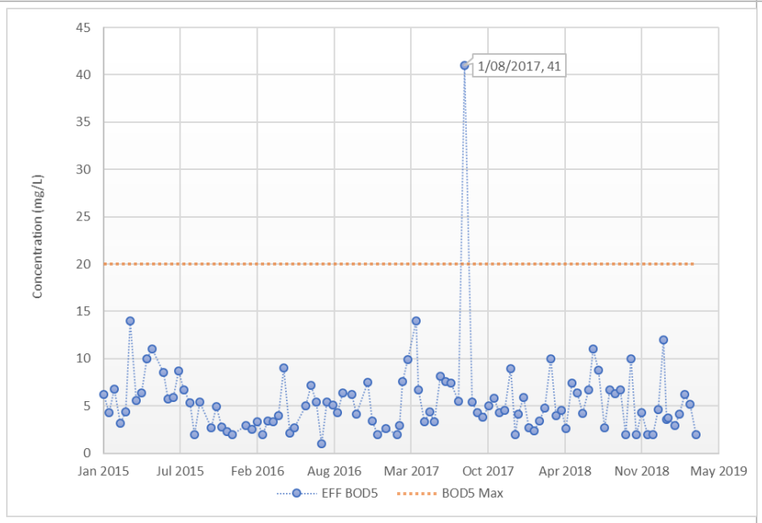
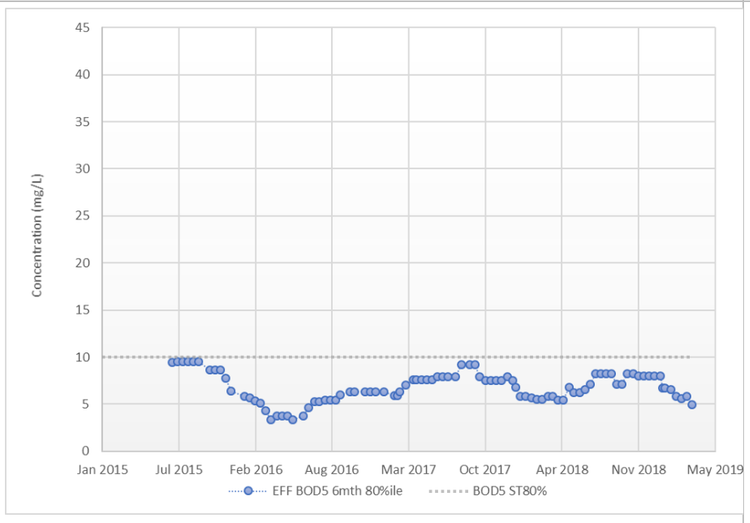
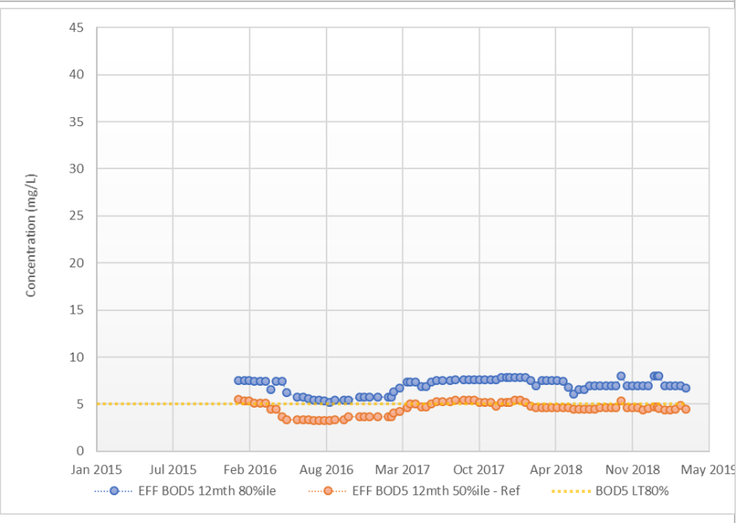
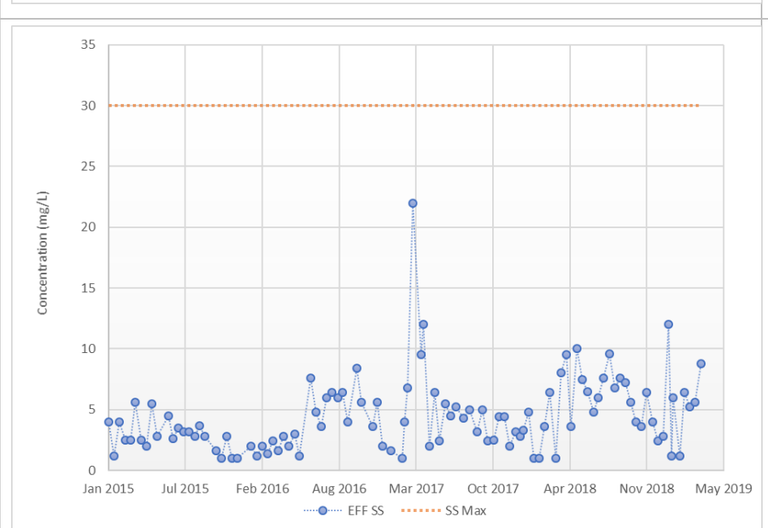
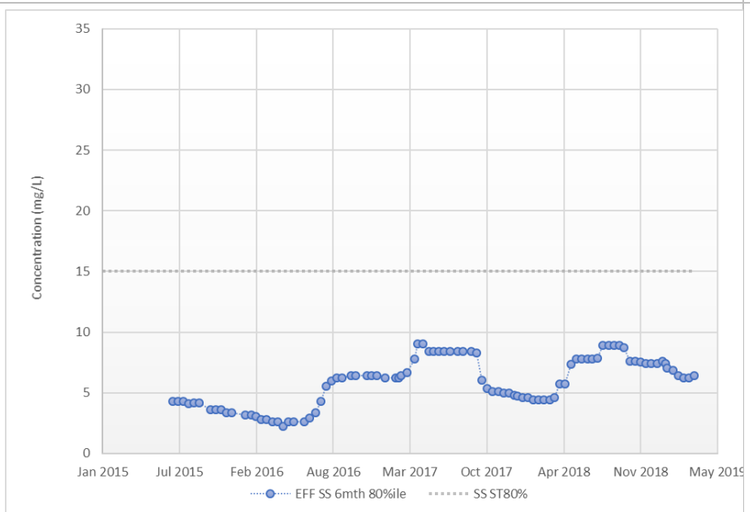
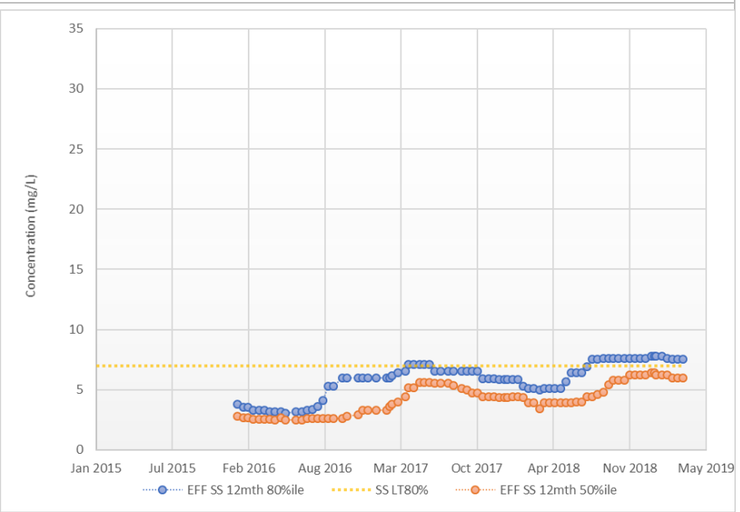
Appendix B – Historical Influent Data

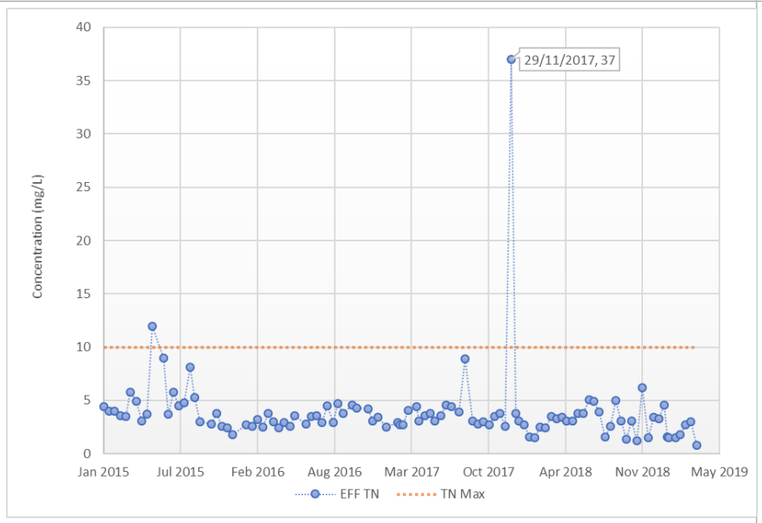
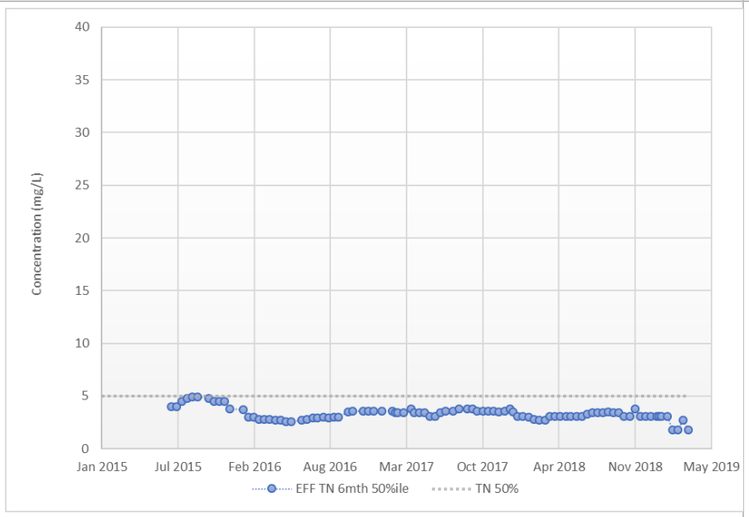
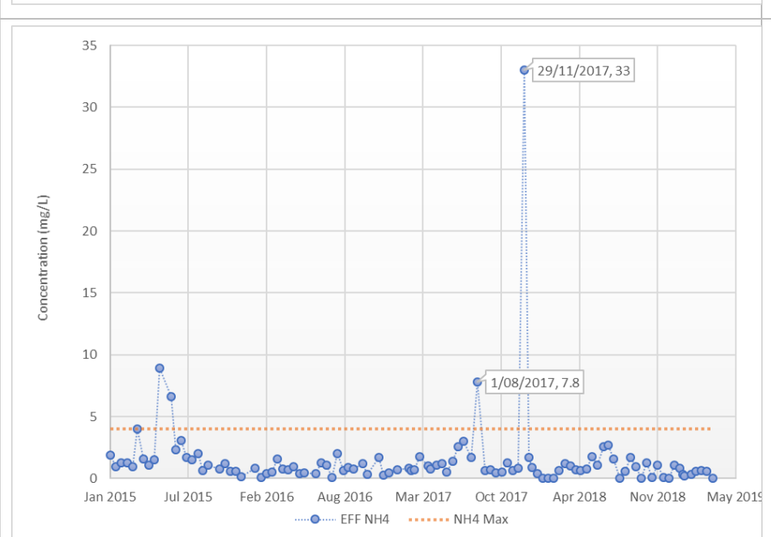
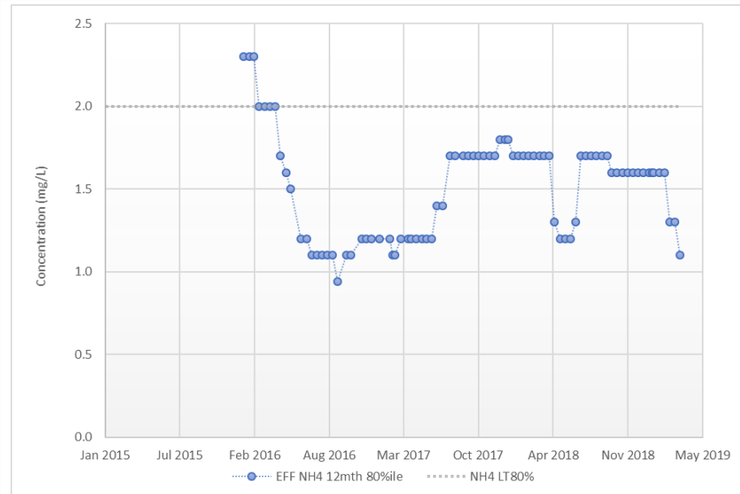

Grab Samples
24 hour composite
Concentration (mg/L)
3,000
2,500
2,000
1,500
1,000
500
0
Jan 2015
Jul 2015
Feb 2016
Aug 2016
Mar 2017
Oct 2017
Apr 2018
Nov 2018
May 2019
INF BOD5
INF COD

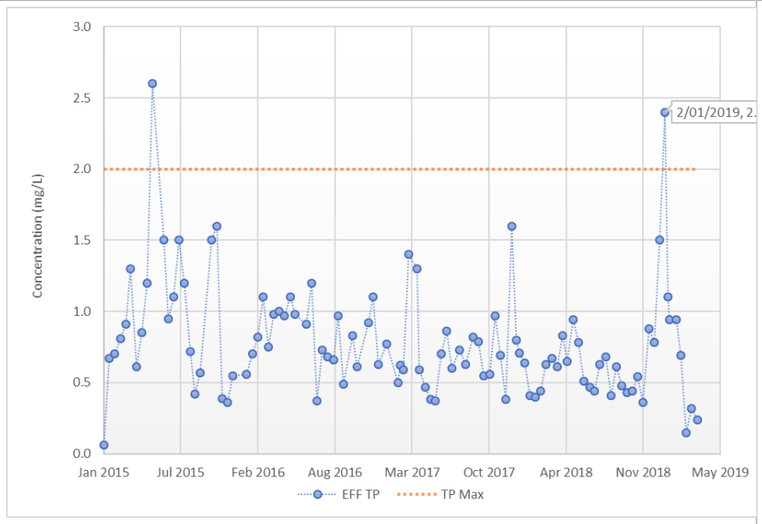
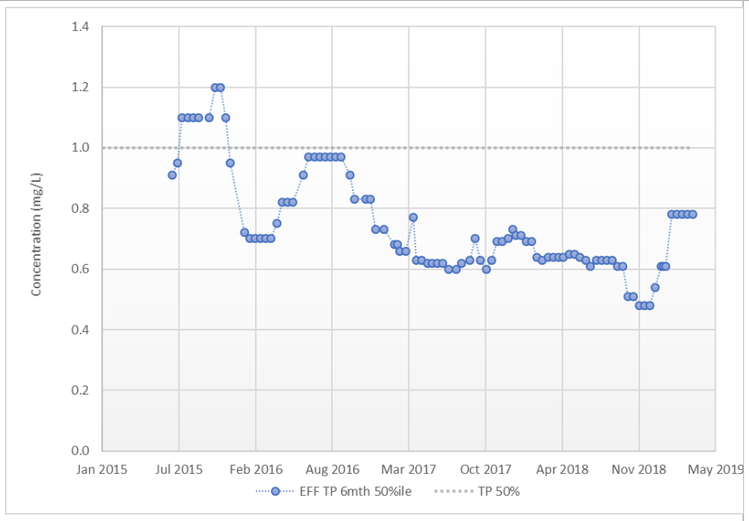
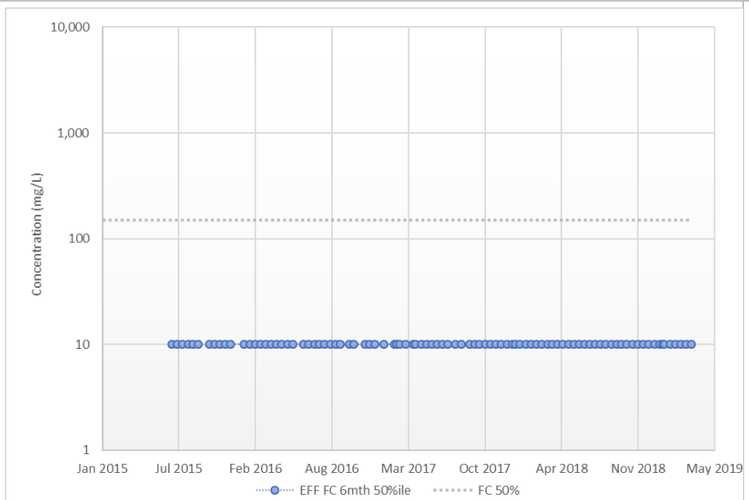
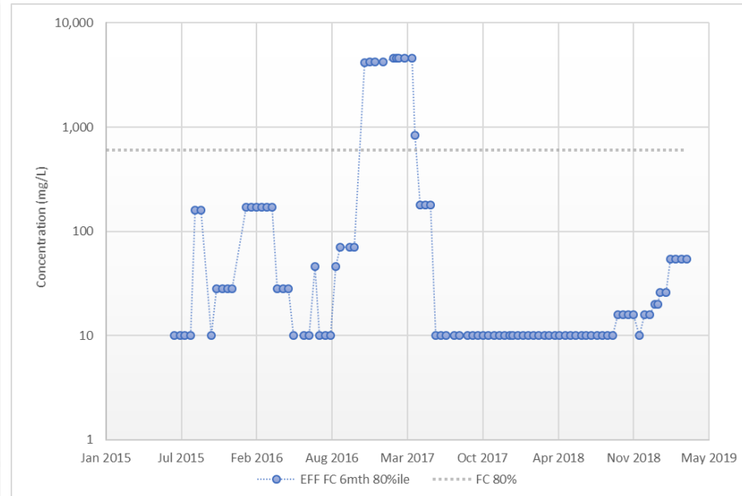

Grab Samples
24 hour composite
Concentration (mg/L)
120
100
80
60
40
20
0
Jan 2015
Jul 2015
Feb 2016
Aug 2016
Mar 2017
Oct 2017
Apr 2018
Nov 2018
May 2019
INF Total Nitrogen
INF Ammonia
10 per. Mov. Avg. (INF Ammonia)


Grab Samples
24 hour composite
Concentration (mg/L)
40
35
30
25
20
15
10
5
0
Jan 2015
Jul 2015
Feb 2016
Aug 2016
Mar 2017
Oct 2017
Apr 2018
Nov 2018
May 2019
INF Total Phosphorous

Appendix C – Historical Performance Data

	Historical performance data	Short Term - 6 Months	Long Term - 12 Months
Effluent BOD5			
Effluent Suspended Solids			

	Historical performance data	Short Term - 6 Months	Long Term - 12 Months
Total Nitrogen			
Effluent Ammonia			

	Historical performance data	Short Term - 6 Months	Long Term - 12 Months
Total Phosphorous			
Faecal Coliforms			

Appendix D – Sewered Areas

DRAFT

Legend

- Atherton STP Location
- Highway
- Secondary Road
- Recycled Main
- Rising Main
- Sewer
- Sewer-Private/On Maintenance
- Stub
- Priority Infrastructure Area
- Potential Development Areas
- Existing Sewer Catchment

Properties within Existing Sewer Catchment

- Water meter present
- No water meter present

Tolga
KENNEDY HIGHWAY
Atherton STP
TOLGA ROAD
MAUNDS ROAD
GILLIES RANGE ROAD
Atherton
MAIN STREET
LOUISE STREET
ROBERT STREET
HERBERTON ROAD
ATHERTON/HERBERTON ROAD
MALANDA ATHERTON ROAD

Based on or contains data provided by the State of QLD (DNRME) 2018. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

Paper Size ISO A3

0 0.25 0.5 0.75 1

Kilometres

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

Tablelands Regional Council
Atherton STP Planning and Evaluation

Project No. **42-20841**
Revision No. **A**
Date **25/02/2019**

Atherton and Tolga Properties within Existing Sewer Catchment

FIGURE 1

G:\42\20841\GIS\Maps\MXD\4220841_006_AthertonTolga_WaterMeter_TRC_RevA.mxd
Print date: 25 Feb 2019 - 16:44

Data source: DNRME: Cadastre (01/2019), Roads (2016), Place Name Gazetteer (2016); GHD: Atherton STP Location (2019), Existing Sewer Catchment (2019); TRC: Existing Sewer Catchment (2019), Priority Infrastructure Area (2016), Sewer Lines (2019) Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: knoble

Appendix E – Adopted Implementation Strategies

Priority	Improvement Horizon	Improvement Type	Description	Objective of improvement	Action	Status
SHORT TERM						
1	1 - Short Term	Infrastructure	**Upgrade septage receival screen**	Improve screenings removal to minimise downstream blockages and pump blockages.	TRC have installed a new septage screening unit to improve screenings capture; with swipe card access to enable TRC to trace the source of septage.	Completed
1	1 - Short Term	Infrastructure	**Implement septage balancing**	Septage can be high strength, discharged from a tanker as a 10min pulse. These loads could occur peak times in the day were identified as a key process threat. The balancing system accepts the pulsed tanker discharges and allows Operators control to slowly feed the septage into the process during off-peak times.	TRC have installed a 50 kL balancing tank and pumps to feed back to the process.	Completed
1	1 - Short Term	Infrastructure	**Inlet Works: Poor screenings capture**	Screenings in the process block pumps, and can interrupt the treatment process. The existing inlet works does not have capacity to upgrade the screens, without compromising the hydraulic capacity.	TRC are installing an in-channel grinder to break down screenings sufficiently small to not block pumps.	Underway
1	1 - Short Term	Infrastructure	**Optimise RAS Rate to ~ 1 x ADWF**	~30% of the SBR tanks are not being optimally used for denitrification due to a low Return Activated Sludge (RAS) rate. By "relocating" denitrification currently completed in the aerobic zone (blowers off) will enable extended aerated times. Increased aeration will improve BOD, COD and ammonia removal. Further, optimised denitrification reduces the oxygen demand and recovers process alkalinity.	TRC to upgrade the existing RAS pipework from DN63 to DN150 to achieve the higher RAS rate. Flow metering should be installed for improved process interrogation and control.	Underway
1	1 - Short Term	Infrastructure	**Upgrade SBR Blowers**	Site testing and modelling identified shortfalls in aeration capacity during peak loads times. Aeration is critical for BOD, COD and ammonia removal.	TRC to upgrade the blowers, to increase the aeration capacity.	Underway
1	1 - Short Term	Infrastructure	**Improve SBR Blower Redundancy**	To meet the peak oxygen demands the two blowers operate in a duty-assist configuration, with no redundancy.	TRC to retain one of the old blowers as an uninstalled stand-by, to minimise process disruptions.	Underway
1	1 - Short Term	Operational	**Optimise Aeration Control**	Nitrification (ammonia conversion to nitrate during aeration) and Denitrification (subsequent conversion of nitrate to nitrogen gas which dissipates to atmosphere, during unaerated times) currently requires the aeration to be cycled on an off. By improving the RAS rate the "aeration off" times can be reduced to improve aerobic process performance.	TRC to update SBR cycle settings, once the RAS is upgraded and the capacity verified.	Underway
1	1 - Short Term	Operational	**SBR Air Flow Metering**	Install air flow metering to the SBR blower feeds, to monitor the actual air flow rates delivered, and assessment of any difference in performances between the two SBR Tanks. Historic air flow will enable the aeration and diffuser efficiencies to be investigated.	TRC to install air flow meter probes to the existing blower pipework.	Not started
1	1 - Short Term	Operational	**Manage dewatering loads returned**	The process is overloaded for short periods of the day. Any loads which can be offset to off peak times will improve the treatment performance.	TRC have two avenues to manage this: i) Sequence dewatering to occur during off-peak times; ii) Dose alum (or other) to improve solids and P-capture on the BFP, to reduce returning load;	Underway
1	1 - Short Term	Operational	**Online ammonia monitoring of SBR Reactors**	Considering the sensitivity of tropical receiving waters to ammonia. Online monitoring will enable TRC to instantaneously monitor the ammonia, to manage aeration as well as identify high risk (heavily) loaded batches which will be diverted to irrigation disposal.	TRC to install online ammonia metering, linked back to the SCADA system.	Not started
1	1 - Short Term	Operational	**Diversion of high risk treated effluent to irrigation disposal.**	Modelling and site testing identified short term risk (hours in a day) of effluent less likely to meet the License. These times will be preferentially diverted to the irrigation disposal system.	TRC to set aside 25-50% of the existing irrigation dam, to accept "high risk" effluent.	Not started
1	1 - Short Term	Infrastructure	**Monitoring of actual discharges to Mazlin Creek**	Data for retrospective assessment of treated effluent physically discharged to Mazlin Creek, and the achieved dilution in Mazlin Creek is not possible with the current metering.	TRC to install a Flow meter to the effluent outfall pipe, to record volume and time of day Creek discharges occur.	Completed
2	1 - Short Term	Operational	**STP SCADA Historian**	The existing SCADA system retains records for ~12 months. Longer records of flow records, and diurnal variations will enable an optimised process design.	TRC to implement Historian (or other) to record and make available historical data.	Underway
3	1 - Short Term	Infrastructure	**Improved diurnal influent flow metering**	The existing influent flow meter records instantaneous peaks up to a point, before overflowing to the manual screen channel (which is not metered).	TRC to install a magflow meter to the SBR feed pipe, as this will record total flows entering the STP.	Underway
3	1 - Short Term	Infrastructure	**Improved treated effluent flow metering**	The existing flow meters do not capture the full extent of peak wet weather events. It is therefore proposed to improve flow metering, to ensure the actual PWWF can be confirmed, and adopted for the major upgrade.	TRC to install a flow meter to the CCT race entrance channel (V-notch) as this records all flows exiting the STP.	Underway
3	1 - Short Term	Infrastructure	**Estimate Mazlin Creek flows at STP Discharge location**	Data for retrospective assessment of treated effluent physically discharged to Mazlin Creek, and the achieved dilution in Mazlin Creek is not possible with the current metering.	TRC to install flow guaging to Mazlin Creek, to estimate the current Creek flow. The existing railway bridge is the proposed guaging point, to avoid the need for any new structures in the creek. This will be indicative of instantaneous flows as a pro-rata estimate of Priors Creek will need to be factored in. It does however minimise flow assumptions to be more accurate than the DNRME flow meter, 7.8km downstream,	Not started
3	1 - Short Term	Infrastructure	**Extend treated effluent irrigation disposal areas**	In order to maximimse the volume of treated effluent which can be beneficially re-used, and diverted from Mazlin Creek additional irrigation areas to be identified.	- TRC to re-instate drip irrigation to the site demarcated irrigation area, currently in EA. - TRC to investigate the potential to irrigate the paddock adjacent to the STP.	Underway
3	1 - Short Term	Management	**Postpone back-sewering**	Due to the limited capacity of the STP for additional loads existing areas not currently sewered should not be connected, until the major upgrade has been completed.	TRC to adopt policy to delay back-sewering.	Completed
3	1 - Short Term	Management	**Delay acceptance of satellite STP sludges**	In order to minimise the risk of nutrient loads returning from the BFP.	TRC to postpone acceptance of satellite STP sludges, until the impact of the proposed improvements can be assessed, and the capacity to accept additional loads can be re-considered.	Completed
3	1 - Short Term	Management	**Trade Waste Managemet**	By improving the control over trade waste discharged to the STP, heavy or loads which interfere with the treatment process will be minimised. In particular fats, oils and greases.	TRC to implement trade waste policies for improved control of influent to the STP, to minimise peak loads and contaminants which could disrupt the treatment process.	Underway

Priority	Improvement Horizon	Improvement Type	Description	Objective of improvement	Action	Status
3	1 - Short Term	Management	**EA Amendments**	Update the EA to reflect current site operations. The current License does not define how short/long term compliance is to be assessed.	TRC to alert DES of License updates; - STP discharges to Priors Creek - Recognition of currently irrigated areas - Definition of Short and Long Term %ile Compliance	Not started
3	1 - Short Term	Operational	**Influent characterisation**	In order to optimise operations as well as the future design, long term sewage characterisation is essential to reduce assumptions and indirect safety factors.	Long term influent characterisation data to be gathered to enable the major upgrade design to be optimised to the actual loading, with seasonal variations.	Ongoing
5	1 - Short Term	Infrastructure	**Alkalinity dosing**	Short term site sampling and modelling identified Alkalinity inhibition of nitrification may occur. The adopted optimisation of denitrification should recover Alkalinity, therefore this may not be required.	TRC to monitor effluent Alkalinity and assess the improvement achieved and whether seasonal variations impact the process. *- Only implement if required i.e. insufficient evidence to mtivate expense and proposed improvements should reduce need.*	Hold
MEDIUM TERM						
2	2 - Medium Term	Management	**Enter negotiations for Future EA**	The existing License is stringent and does not appear to consider the effluent disposed of via irrigation, or that Atherton STP in fact discharges into Tinaroo Falls dam.	Details of the Future EA are required, for the preferred treatment process to be selected.	Not started
3	2 - Medium Term	Infrastructure	**Upgrade SBR Diffusers**	Aged / fouled diffusers produce fewer, larger air bubbles which are less efficient at transferring air to the treatment process (less contact area, and float upwards more quickly). By replacing or upgrading the diffusers the availability of oxygen will be improved, for better BOD, COD and ammonia removal. - Improved transfer efficiency also reduces power demand as more air is transferred "per kW".	TRC to investigate upgrading or replacement of the diffuser for improved air transfer. Preference should be given to re-using the diffusers in the proposed future Aerobic Digester.	Not started
3	2 - Medium Term	Infrastructure	**Augment Irrigation Storage**	The existing irrigation dam limits the distribution of irrigation water, and the capacity to accept "high risk" effluent.	TRC to construct additional irrigation storage to optimise re-use.	Not started
5	2 - Medium Term	Infrastructure	**Supplementary aeration system**	The proposed improvements are expected to meet the current capacity limitations, however additional aeration could be achieved using surface or jet aerators during absolute peak times.	*Not expected to be needed, but TRC to monitor effectiveness of aeration improvements. Listed for future consideration if adopted improvements do not achieve theoretical performance.*	Hold
5	2 - Medium Term	Infrastructure	**Site Survey**	An electronic site survey of Atherton STP does not exist, and will be required for the STP design. Survey to pick up existing structures as well as ensure all levels are on the same datum, for finalising the Hydraulic Grade Lines.	TRC to appoint surveyor to survey the site and produce a site layout drawing.	Not started
5	2 - Medium Term	Management	**Detailed Design of STP**	Undertake detailed design of STP		Not started
LONG TERM						
5	5 - Long Term	Management	**Construct and Commission new STP**	Construct and commission new STP		

Appendix F – Estimated Tourism Load

Tourism Loads

The Tablelands Region hosts a variety of tourist attractions and receives an influx of tourists, particularly in the cooler, dry months of May to October. As this is an extended duration, tourism load has been factored into this Report. Limited data exists to quantify the load on the STP, therefore GHD undertook an assessment of available data to estimate the extended tourist load (3-4 months) on Atherton STP.

Available tourism data is prior to the de-amalgamation of Tablelands Regional Council from Mareeba Shire Council (2013) and therefore includes a greater area, and cannot be disseminated. The tourism data does not account for RVs passing through Atherton, which only make use of the RV discharge facilities and do not reflect on tourism numbers.

Census data

The 2006 census for the Tablelands as a whole (total for all towns) identified a 7.8% increase in population with 3,189 tourists in addition to the 40,910 usual resident population. Assuming this percentage is accurate for 2018 and applying it to the current population, Atherton would experience a tourist load of 630 persons.

Tablelands tourism data

Based on averaged tourism data for December 2009 to December 2012, prepared by Tourism and Events Queensland, the Tablelands Region hosted 731,000 tourist days. This equates to an annual average of 2,000 tourists per day, which is significantly lower than the 2006 census data.

This calculation does not consider the short peak season; for example if 60% of tourists visit the Tablelands over a 4-month period the daily tourist figure is in the order of 4,800 tourist EP. Assuming 25% of Tablelands tourists use Atherton or Tolga as their base, the tourism load is in the order of 1,200 persons.

Water meter data

Water meter data was provided by TRC for July and January for 2015, 2016 and 2017 respectively. The billing data was provided with land-use and was filtered to identify tourism related uses, including Caravan Parks, Guest House, Hotel Tavern, Licensed Clubs, Motels and Restaurants. The data, as summarised in Figure 21, only reflects a seasonal variation in water usage for Caravan Parks, with no notable trend for the other uses.

The Caravan Park data shows a seasonal increase of 33% at Atherton caravan park in July 2016, and 8.8% for the July 2017 season. Similarly, Tolga caravan parks experienced a 5.6% and 57% increase respectively for the same periods.

The data does identify the seasonal nature of the catchment, however as billing data is 6 monthly, short term peaks are diluted. Further, water usage data may not reflect the actual peaks as self-contained RVs with chemical toilets etc. would have a low water demand, but would ultimately discharge full biological loads at the STP.

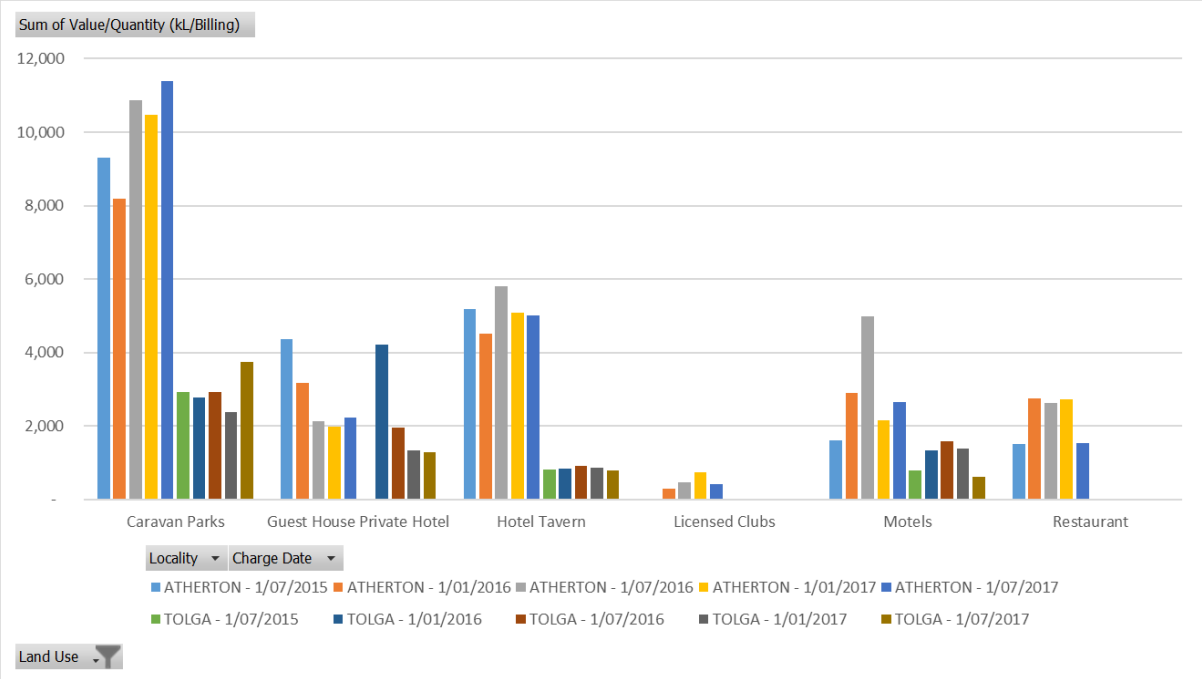


Figure 21 Water meter records for tourism functions

Atherton STP flow data

A 15-day moving average trendline was added to the tertiary flow meter data for 2017 and 2018 in Figure 22. The trendline highlights the wet season peak of January to April. Flows being lowest in May/June before increasing into the tourist season. The May/June flow data is likely the most representative of the permanent EP load, as summarised in Table 29.

Table 29 Seasonal STP flow variations

	April-May (kL/d)	Peak Tourism (kL/d)	Tourism Hydraulic Load (kL/d)
2017	1,880	2,000	6.4%
2018	1,940	2,120	9.3%

All flows based on 15 day moving average.

Adopted tourist load

The averaged seasonal loading data discussed above indicates a sustained additional load in the order of 8-15% of the estimated Atherton loading. For planning purposes the average has been adopted to estimate a tourism load of 1,000 EP. Based on the number of tourists and the daily increase of flows with tourisms an average sewage production of 130 L/Tourist/d was calculated.

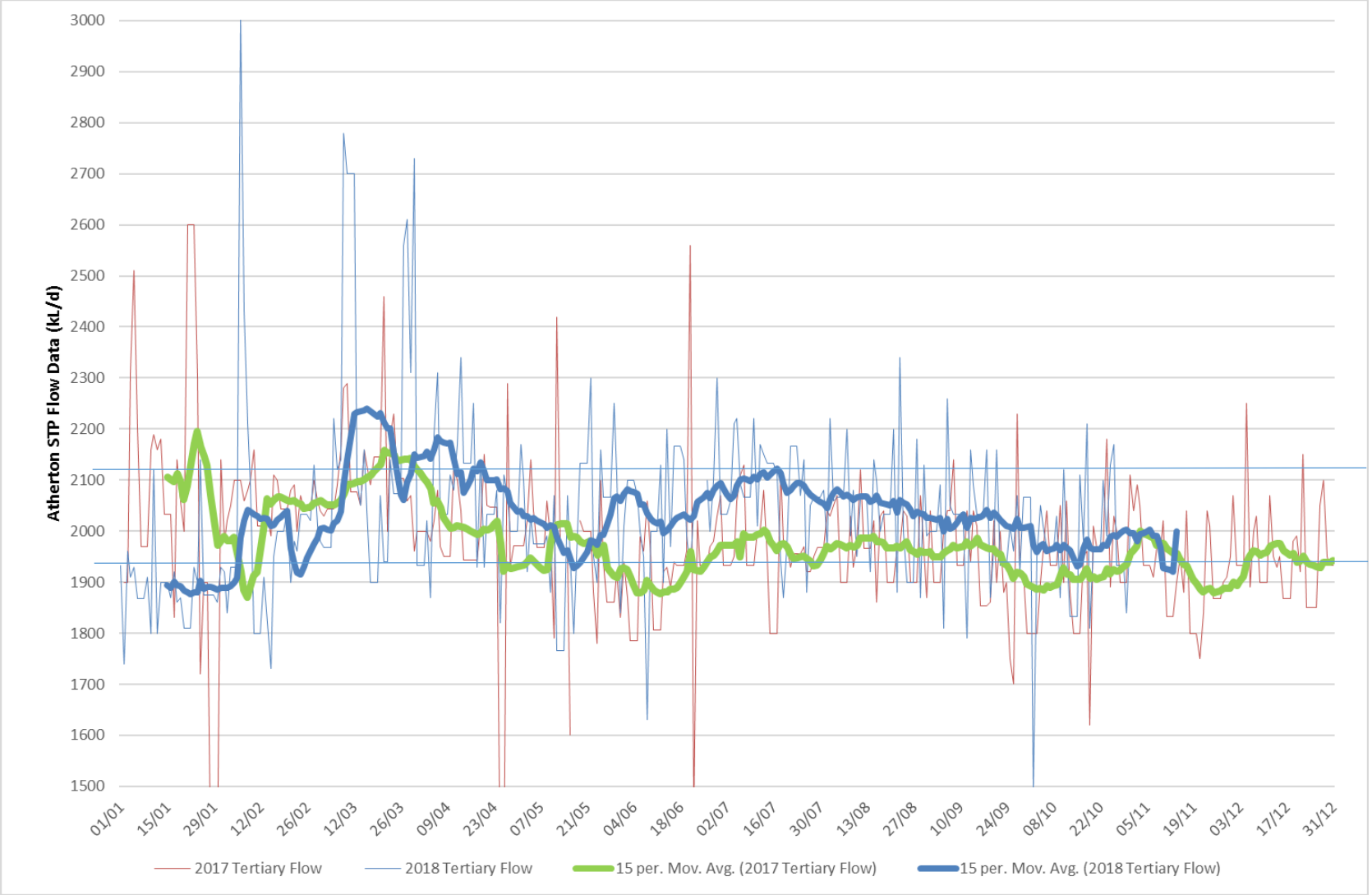


Figure 22 Atherton STP effluent flow meter data

Appendix G – Equipment List and Condition Summary

Atherton STP P&ID Reference	Area Code	Area Description	Equip No.	Motor No.	Description	No. of Duty	Fluid	Manufacturer/Supplier	Brand/model	Type	Installed (Year)	Aecom RUL (Years)	Replacement/ Remediation		VSD / DOL	kW	Size/Specification	Design Capacity	Alternative Source
	0	Septage			Existing Septage Screen (To be abandoned)						2000	0	2018	Being replaced		1 kW (Estimate)			
	0	Septage			New Septage Screen						2019	15	2033			Replaces existing			
	0	Septage	TK-		Septage Balance Tank						2018	25	2043			N/A			
	0	Septage	P		Balanced Septage Pump # 1						2018	15	2033			1.4			
	0	Septage	P		Balanced Septage Pump # 2						2018	15	2033			1.4			
	5	RV			RV Discharge Point			Dump-Ezy								N/A			
595-I-501 Rev 2	10	PTA	SE1011	M1011	Noggerath Screen	0.25	Unscreened, Raw Sewage	ConSep	1420/00/a	FSS-Screen 15x360x6	2000	5	2023	Electrical 5 years Mechanical 5 years		0.55		125 L/s (ESI Design)	
595-I-501 Rev 2	10	PTA	SCR-1016	M1016	Screw Conveyor, Washer and Press	0.25	Screenings	ConSep	1421/00/b		2000	5	2023	Electrical 5 years Mechanical 5 years		0.55			
595-I-501 Rev 2	10	PTA		M1020	Grit Paddle Drive	1	Screened sewage	ConSep	brgs-620zzz		2000	5	2023	Electrical 5 years Mechanical 5 years		0.37			
595-I-501 Rev 2	10	PTA	BL1021	M1021	Grit Air Blower #1	0.5	Air	CAPS Australia	RBLS 10/1p		2000	5	2023	Electrical 5 years Mechanical 5 years		2.2		76 m3/h	
O&M Manual	10	PTA		M1022	Grit Air Blower #1 - Cooling Fan	0.5	Air	CAPS Australia			2000	5	2023	Electrical 5 years Mechanical 5 years		0.09			
595-I-501 Rev 2	10	PTA	BL1022	M1022	Grit Air Blower #2	0.5	Air	CAPS Australia	RBLS 10/1p		2000	5	2023	Electrical 5 years Mechanical 5 years		2.2		76 m3/h	
O&M Manual	10	PTA		M1022	Grit Air Blower #2 - Cooling Fan	0.5	Air	CAPS Australia			2000	5	2023	Electrical 5 years Mechanical 5 years		0.09			
595-I-501 Rev 2	10	PTA	GC1501	M1024	Grit Classifier	1	Grit	ConSep	1421/00/c	SD 190/1.25	2000	5	2023	Electrical 5 years Mechanical 5 years		? SEW SA52 DT63L4			
	10	PTA	TK-		Inlet channel						2000	6	2024	Internal Coating 6 years External concrete 25 years		N/A	1000mm TD x 500mm wide		
	10	PTA	TK-		By-pass channel						2000	6	2024	Internal Coating 6 years External concrete 25 years		N/A	750mm TD x 500mm wide		
	10	PTA	TK-1020		Grit Vortex				2.44m dia	Reinforced concrete	2000	6	2024	Internal Coating 6 years External concrete 25 years		N/A	2.44m Ø		
	10	PTA	TK-1501		Grit Classifier					Stainless steel	2000	5	2023	Electrical 5 years Mechanical 5 years		N/A			
	10	PTA			Manual screen					30No. 75d x 5w bars with 25mm clear opening	2000	5	2023	Mechanical 5 years		N/A			
595-P-620 Rev 1	10			Pipe A	Plant Inlet					DN450 PVC-CIOD Class 12						N/A			
595-P-620 Rev 1	10			Pipe J	Inlet Rising Main Relocation					DN110 Polyethylene						N/A	1.91	15 L/s typical SCADA max (1.9m/s)	
595-I-501 Rev 2	12	ODR	FN1025	M1025	Odour Control Fan	1	Foul air	Fantech	015 CW 180							1.5			
	12	ODR	TK-1025		Odour control system											N/A			
595-P-620 Rev 1	14		Pipe B		SBR Basins inlet					DN450 DI Class 12						N/A			
	15	Splitter	TK-		SBR Flow Splitter						2000	8	2026	External concrete 25 years Internal Coating 8 Years		N/A	3m(W)x1.1m(L)x3.5m TD	Working volume = **5.3 kL**	Volume to underside of feed pipe
595-P-620 Rev 1	15		L001	Pipe C	SBR Basins overflow inlet					DN375 DI						N/A			
595-I-502 Rev 2	20	SBR	P2101	M2101	SBR 1 - RAS pump	0.5	MLSS	KSB Ajax	F80-200		2000	5	2023	Electrical 5 years Mechanical 10 years		1.8		Theoretical 14 L/s from pump curve, actual 0.6 L/s	
595-I-502 Rev 2	20	SBR	P2103	M2103	SBR 1 - WAS Pump	0.5	MLSS	KSB Ajax	F80-200		2000	5	2023	Electrical 5 years Mechanical 10 years		1.8		5 L/s @ 9m head duty	
595-I-502 Rev 2	20	SBR	C2104	M2104	SBR Compressor	0.1	Air	Compak	EM22WS3		2000	5	2023	Electrical 5 years Mechanical 10 years		3			
595-I-502 Rev 2	20	SBR	SK2111	M2111	SBR 1 - Decanter	0.5	Secondary Effluent				2000	5	2023	Electrical 5 years Mechanical 10 years		Looks air actuated	4m long decanter		
595-I-502 Rev 2	20	SBR	P2201	M2201	SBR 2 - RAS Pump	0.5	MLSS	KSB Ajax	F80-200		2000	5	2023	Electrical 5 years Mechanical 10 years		1.8		Theoretical 14 L/s from pump curve, and actual flow measured on site	
595-I-502 Rev 2	20	SBR	P2203	M2203	SBR 2 - WAS Pump	0.5	MLSS				2000	5	2023	Electrical 5 years Mechanical 10 years		1.8		5 L/s @ 9m head duty	
595-I-502 Rev 2	20	SBR	SK2211	M2211	SBR 2 - Decanter	0.5	Secondary Effluent				2000	5	2023	Electrical 5 years Mechanical 10 years		Looks air actuated	4m long decanter		
595-I-502 Rev 2	20	SBR	BL2501	M2501	SBR - Duty Blower	1	Air		Robuschi Robox Evolution, ES 66-3P		2009	5	2023	Electrical 5 years Mechanical 10 years		55		1,950m3/h	
O&M Manual	20	SBR			SBR Blower #1 - Cooling Fan	0.5	Air	CAPS Australia			2000	5	2023	Electrical 5 years Mechanical 5 years		0.35			
595-I-502 Rev 2	20	SBR	BL2502	M2502	SBR - Standby Blower	1	Air	CAPS Australia	Robuschi Robox Evolution, ES 66-3P		2009	5	2023	Electrical 5 years Mechanical 10 years		55		1,950m3/h	
O&M Manual	20	SBR			SBR Blower #2 - Cooling Fan	0.5	Air	CAPS Australia			2000	5	2023	Electrical 5 years Mechanical 5 years		0.35			
	20	SBR	L010		SBR 1 Air Blower Pipework Manifold	1	Air			DN200 - Mild Steel						N/A	32.63	2 x blowers in parallel (32.67 m/s)	
	20	SBR	L011		SBR 2 Air Blower Pipework Manifold	1	Air			DN200 - Mild Steel						N/A	16.31	1 x blower (16.3 m/s)	
	20	SBR			SBR 1 - Diffusers					EDI mini panel	2000	3	2021	Metallic 3 years		N/A			2 off Type 1 DN100 with 13 duplex Mini Panels on each (total 26 duplexes or 52 individual tubes); 2 off Type 2 DN150 with 14 duplex Mini Panels on each (total 28 duplexes or 56 individual tubes); 2 off Type 3 DN150 with 13 duplex Mini Panels on each (total 26 duplexes or 52 individual tubes);
	20	SBR			SBR 2 - Diffusers						2000	3	2021	Metallic 3 years		N/A			Included in SBR 1 diffuser details
	20	SBR	TK-3001		SBR Basin #1						2000	2	2020	Sealants < 2yrs External concrete 25 years 5 Years Blockwork		N/A			
	20	SBR	TK-3002		SBR Basin #2						2000	2	2020	Sealants < 2yrs External concrete 25 years Blockwork 5 years		N/A			
595-P-620 Rev 1	20		Pipe E1		SBR 1 WAS					DN63 Polyethylene						N/A	1.60	5 L/s ESI Duty point (1.6 m/s)	
595-P-620 Rev 1	20		Pipe E2		SBR 2 WAS					DN63 Polyethylene						N/A	1.60	5 L/s ESI Duty point (1.6 m/s)	
595-P-620 Rev 1	20		Pipe F1		SBR 1 RAS					DN63 Polyethylene						N/A	0.21	0.6 L/s measured on site (0.21 m/s)	

Atherton STP P&ID Reference	Area Code	Area Description	Equip No.	Motor No.	Description	No. of Duty	Fluid	Manufacturer/Supplier	Brand/model	Type	Installed (Year)	Aecom RUL (Years)	Replacement/ Remediation		VSD / DOL	kW	Size/Specification	Design Capacity	Alternative Source
595-P-620 Rev 1	20		Pipe F2		SBR 2 RAS					DN63 Polyethylene						N/A	3.69	11.5 L/s from pump curve (3.7 m/s)	
595-P-620 Rev 1	25		Pipe D		SBR Outlet					DN450 PVC-CIOD Class 12						N/A			
595-I-503 Rev 2	30	EBT	P3001	M3001	SBR Effluent / Equalisation Pump 1 (D/A/S)	0.5	Secondary Effluent	KSB Ajax	E100-280	Submersible	2000	3	2021	Interior metallic 8 years Mechanical 3 years Electrical 5 years	VSD	11		40 L/s@15m	595-P-607; Google search on model for kW
595-I-503 Rev 2	30	EBT	P3002	M3002	SBR Effluent / Equalisation Pump 2 (D/A/S)	0.5	Secondary Effluent	KSB Ajax	E100-280	Submersible	2000	3	2021	Interior metallic 8 years Mechanical 3 years Electrical 5 years	DOL	11		40 L/s@15m	595-P-607; Google search on model for kW
595-I-503 Rev 2	30	EBT	P3003	M3003	SBR Effluent / Equalisation Pump 3 (D/A/S)	0	Secondary Effluent	KSB Ajax	E100-280	Submersible	2000	3	2021	Interior metallic 8 years Mechanical 3 years Electrical 5 years	DOL	11		40 L/s@15m	595-P-607; Google search on model for kW
	30	EBT			Secondary clarifier scraper (Equalisation Tank)						1994	3	2021	Interior metallic 8 years Mechanical 3 years Electrical 5 years		0.5			Assumed kW
	30	EBT	TK-4001		Effluent Balance Tank						1994	10	2028	Interior concrete 10 years Internal coating < 2 years		N/A	2.73m TD of wall	**200 kL** reported by ESI Design	
595-P-620 Rev 1	32		Pipe S		EBT Drain					DN150 DI						N/A			
	32		Pipe L1		EBT Overflow Pipe					DN100 PVC						N/A		Required capacity is 45 L/s, not possible with current overflow	
595-P-620 Rev 1	35		Pipe L		Filter by-pass					DN300 AC						N/A			
595-P-620 Rev 1	35		Pipe M		Filter Inlet					DN250 DI						N/A			
595-I-506 Rev 2	40	FIL	C3018	M3018	Sand Filter Compressor		Air				2000	5	2023	Electrical 5 years		3		Not accessible, assume same as SBR compressor	
	40	FIL	SF-7001		Sand Filter Unit						2000	10	2028	Tank 10 years Electrical 5 years		N/A	Total filter area of 16.8m2 from ESI design	Normal operation 40-65 L/s, up to peak of 80 L/s	Average filtration rat e<10m/h adopted in ESI Design, with <20 m/h at peak
	40	FIL			Filter backwash: Air scour blower											?		Site photo	
595-P-620 Rev 1	45	FIL	Pipe N		Filter Outlet					DN250 DI						N/A	1.63	80 L/s peak from ESI (1.63 m/s)	Normal operation 40-65 L/s, up to peak of 80 L/s
595-P-620 Rev 1	46	FIL	Pipe P		Filter Backwash					DN250 DI						N/A	0.81	40 L/s from ESI (0.8 m/s)	7.2kL per backwash (40L/s for 3 min)
	50	FEBT			Secondary clarifier scraper (Filtered Water Tank)						1994	5	2023	Mechanical 10 years Electrical 5 years Interior metallic 5 years		0.5			Assumed kW
	50	FEBT	TK-4002		Chlorine Contact Tank (FEBT)						1994	6	2024	Concrete 25 years Coating 6 years		N/A			
	55		Pipe N1		FEBT Outlet					DN??						N/A			
	60	Hypo			Chlorine Race						1994	15	2033	Interior concrete 15 years		N/A			
595-P-620 Rev 1	60		Pipe Q		CCT Drain					DN150 DI						N/A			
	80	Irr			Irrigation Dam						1994	50	2068			N/A			
	80	Irr			Irrigation Dam Feed Pump #1 / Maize Pump 1											15			
	80	Irr			Irrigation Dam Feed Pump #2											18.5			
	90	Irr			Irrigation Pump (to Golf Course / Farm)											55			Assumed kW (nameplate not legible) but it is a very large motor
595-I-504 Rev 2	100	Thicken	GD6000	M6000	Gravity Drainage Deck	1	Thickened WAS	TEMA	Series 500	GDD	2000	5	2023	Electrical 5 years Mechanical 6 years		0.55	86 kg/hr of thickened sludge (3-4% DS) ESI Design. Operated 4 hours per day, 5 days per week.		6L/s pumped from Reactor @0.8% DS. Thicken to 3-4% DS
595-I-504 Rev 2	100	Poly	TK6008	M6009	GDD Flocculant Mixing Tank		WAS									0.37			
595-P-620 Rev 1	100		Pipe G		Dewatered WAS (What is this pipe?)					DN63 Polyethylene						N/A			
595-I-504 Rev 2	105	Poly	TK6005	M6005	Polymer Make Up and Dosing Tank Mixer		Polymer	Sardik	SSP75							?			
595-I-504 Rev 2	105	Poly	P6006	M6006	GDD & BFP Dosing Pump - Shared Standby		Polymer	MONO	CB021AC1 J8/G							?			
595-I-504 Rev 2	105	Poly	P6007	M6007	GDD Polymer Dosing Pump - Duty		Polymer	MONO	CB021AC1 J8/G							?			
595-I-504 Rev 2	105	Poly	P6008	M6009	BFP Poly Dosing Pump (Duty)		Polymer	MONO	CB021AC1 J8/G							?			
	105	Poly	TK-6001		Polymer Tank											N/A			
595-I-502 Rev 2	110	DIG	BL5501	M5501	Digester Blower #1	0.5	Air	CAPS Australia	SRB 40/2P		2000	2	2020	Mechanical < 2 years	VSD	11			
O&M Manual	110	DIG			Digester Blower #1 - Cooling Fan	0.5	Air	CAPS Australia			2000	5	2023	Electrical 5 years Mechanical 5 years		0.12			
595-I-502 Rev 2	110	DIG	BL5502	M5502	Digester Blower #2	0.5	Air	CAPS Australia	SRB 40/2P		2000	2	2020	Mechanical < 2 years	VSD	11			
O&M Manual	110	DIG			Digester Blower #1 - Cooling Fan	0.5	Air	CAPS Australia			2000	5	2023	Electrical 5 years Mechanical 5 years		0.12			
	110	DIG	L014		Digester Air Blower Pipework Manifold					DN150						N/A			
	110	DIG	TK-5001		Aerobic Digester						1994	5	2023	Internal coating 5 years Internal concrete 15 years		N/A	9.75m Ø x 2.13m wall depth, 600mm foor slope, 1.224m deep sludge sump	200 kL working volume in ESI. But 164 m3 in SOP.	595-C-113; Original design was for 16 day SRT. Design capacity 432 kg/d @3.5% DS
	110	DIG			Aerobic Digester Diffusers						2000	2	2020	Mechanical < 2 Years		N/A	16 No. Diffusers shown on drawing, 10 EDI Maxi Coarse diffusers in ESI design, and 12 in photos		595-C-113
595-I-502 Rev 2	115	Dewater	P5103	M5103	BFP Feed Pump	1	Digested, thickened sludge	MONO	CB061AC1 R8/G							3			
595-I-504 Rev 2	120	Dewater	AC6010	M6010	BFP Air Compressor	0.1	Air	Compak	EM22WS3		2000	5	2023	Mechanical 10 years Electrical 5 years		3		Not accessible, assume same as SBR compressor	
595-I-504 Rev 2	120	Dewater	BP6013	M6013	Belt Press	1	Dewatered sludge	TEMA	Series 500	BFP	2000	5	2023	Mechanical 10 years Electrical 5 years		0.75	Dewatered sludge designed for 13-15m3/week @16-18% DS		BFP designed for 3 L/s @ 3% DS (324kg/h)
595-I-504 Rev 2	120	Dewater	CN6016	M6016	Dewatered Solids Inclined Conveyor		Dewatered sludge	Enmin	MR45-7	Belt Conveyor	2000	5	2023	Mechanical 10 years Electrical 5 years		1.1		Motor size from motorised drum	
595-I-504 Rev 2	120	Dewater		M6020	BFP Flocculator Mixer		Digested, thickened sludge				2000	5	2023	Mechanical 10 years Electrical 5 years		0.37			
	120	Dewater			Biosolids Bunker		Digested, thickened sludge				1994	15	2033			N/A			30m3 storage volume

Atherton STP P&ID Reference	Area Code	Area Description	Equip No.	Motor No.	Description	No. of Duty	Fluid	Manufacturer/Supplier	Brand/model	Type	Installed (Year)	Aecom RUL (Years)	Replacement/ Remediation		VSD / DOL	kW	Size/Specification	Design Capacity	Alternative Source
595-P-620 Rev 1	120		Pipe R		Sludge Bunker Filtrate Drain					DN150 DI						N/A	0.68	12 L/s from ESI (0.7 m/s)	12L/s total from GDD+BFP
595-I-505 Rev 2	200	Alum	P4001	M4001	Alum Dosing Pump -Duty SBR		Alum	Ionics Watertec	M221-50							?			
595-I-505 Rev 2	200	Alum	P4002	M4002	Alum Dosing Pump - Shared Standby - SBR - Pre Sand Filter		Alum	Ionics Watertec	M221-50							?			
595-I-505 Rev 2	200	Alum	P4003	M4003	Alum Dosing Pump - Pre-Sand Filter		Alum	Ionics Watertec	M221-50							?			
	200	Alum	TK-6101		Alum Tank											N/A		22,000 litre	595-C-106
595-P-620 Rev 1	200		Pipe T		Chemical Storage Drain					DN100 DI						N/A			
595-P-620 Rev 1	200		Pipe U		Slab Stormwater Drain					DN150 DI						N/A			
595-I-505 Rev 2	300	Hypo	P4041	M4041	Sodium Hypochlorite Dosing Pump - Duty		Hypo	Ionics Watertec	M221-16							?			
595-I-505 Rev 2	300	Hypo	P4042	M4042	Sodium Hypochlorite Dosing Pump - Standby		Hyo	Ionics Watertec	M221-16							?			
	300	Hypo	TK-6202		Hypochlorite Tank											N/A		9,000 litre	595-C-106
595-I-504 Rev 2	500	GPPS	P6018	M6018	GPPS - Abandoned		Site drainage	KSB Ajax	ELS 100	Submersible				Abandoned, but still installed		N/A			
595-I-504 Rev 2	500	GPPS	P6019	M6019	GPPS - Abandoned		Site drainage	KSB Ajax	ELS 100	Submersible				Abandoned, but still installed		N/A			
	500	GPPS			GPPS Pump #1		Site drainage	Gorman Rupp	T-Series	Self priming dry mounted						11		20 L/s ESI Design; 18 L/s adopted for the modelling	15 L/s (typical SCADA peak)
	500	GPPS			GPPS Pump #2		Site drainage	Gorman Rupp	T-Series	Self priming dry mounted						11		20 L/s ESI Design; 18 L/s adopted for the modelling	15 L/s (typical SCADA peak)
	500	GPPS	TK-1001		General Purpose Pump Station											N/A	Internal: 2.7m (L) x 1.2m(W) x 5.7m (TD)	Working volume = **18 kL**	ESI Design, 12L/s from GDD+BFP and 40L/s from Filter Backwash, (8,000 Septage Discharge redundant)
595-P-620 Rev 1	500			Pipe H	GPPS Rising Main					DN150 PVC-CIOD						N/A	1.13	20 L/s (ESI), 1.13 m/s	
	600	Sludge			Sludge Drying Beds						1994	25	2043			N/A			
595-P-620 Rev 1	600		Pipe K		Sludge Drying Beds Inlet					DN63 Polyethylene						N/A			
				GEN	Generator						2000	3	2021			N/A			
595-I-503 Rev 2		SVW	P3041	M3041	GDD & BFP Wash Water - Duty Pump	0.5	Tertiary Effluent	Grundfos								3			Assumed kw, In confined space
595-I-503 Rev 2		SVW	P3042	M3042	GDD & BFP Wash Water - Standby Pump	0.5	Tertiary Effluent	Pumps n Pipes	SV160775tpu							3			In confined space
595-I-503 Rev 2		SVW	P3043	M3043	Onsite Irrigation Pump			Fixed Pump Submersible								?			

Appendix H – Biological Model Build & Calibration

The objective of this component of this study was to develop a BioWin model and calibrate to the operational data from the onsite sampling completed between 20th November and 26th November 2018.

The process modelling utilises the proprietary software package BioWin™ (version 5.3) supplied by Envirosim (Canada). This software includes architecture to simulate wastewater treatment processes, however does not include modelling for the following processes relevant to Atherton STP:

- Screenings removal,
- Odour control,
- Specific dewatering and filtration processes (i.e. separate model units for the different dewatering and filtration processes, rather a common 'dewatering unit' is used to simulate solids removal and flow split),
- Disinfection (hypochlorite dosing), and
- Water balance and irrigation modelling.

The above restrictions have limited impact on the model functionality for the purposes of this project.

E.1 Assumptions

The design basis for the model calibration has been based on existing plant design data and the results of the sampling program completed by TRC in November 2018. The design basis is summarised in Section 2.

A number of assumptions were made when undertaking this study. The assumptions with respect to the model parameters are referred to throughout the report. In addition, the key underlying assumptions include the following:

- Disinfection unit processes (specifically the hypochlorite dosing system) lay outside the scope of the Biowin modelling.
- Unless specified it is assumed that all model parameters (including kinetic, stoichiometric, physical, chemical and switching functions) are based on the BioWin default values.
- Users of this document are familiar with and have a fundamental working knowledge of the BioWin™ simulation software. This document does not include detailed instructions on how to use the BioWin™ software. Refer to the BioWin™ Help files for further details not covered by this report.

E.2 Overview of treatment process

The key process unit details are summarised in Table 30. These values were adopted as the basis for the model unless otherwise stated.

Table 30 Atherton STP unit summary

Process Unit	Details
Inlet works	
Inlet works	6 mm mechanical step screen, equipped with a screw conveyor, washing system and press zone to dewater and transfer the screenings. The inlet bypass channel contains manual screens. *Not included in BioWin™ model*
Grit removal	Vortex grit separator with duty/standby blowers for air lift grit removal. Shaft-less screw grit classifier. *Not included in BioWin™ model*
Odour control	Single fan for odour extraction from inlet works screens and grit removal *Not included in BioWin™ model*
Secondary treatment – Sequencing batch reactors	
Distribution zone	6.8 kL *Splitter element used in BioWin™ model*
Selector zone (anaerobic)	2 No. 0.22 ML tank (forms part of overall SBR structure) 2.5 to 4.8 m operating depth *SBR pre-zone 1 in BioWin™ model*
Aeration pre-zone	2 No. 0.21 ML tank (forms part of overall SBR structure) *SBR pre-zone 2 in BioWin™ model*
SBR main zone	2 No. 0.7 ML tank; 4.8 m top water level (TWL) 4 hour cycles (2 hrs fill and aerate, 1 hr settle, 1 hr decant); Decant to minimum decant level of 3 m (bottom water level BWL) Design sludge age 20 days MLSS 3,700 mg/L (design) Diffused aeration with 2 No. 55 kW blower (duty / standby); 102 diffusers per SBR (76 in main zone, 26 in aeration-pre-zone). RAS flow is continuous during the aeration phase WAS flow started 30 minutes into the settle phase and runs for 85 minutes and 70 minutes for SBR 1 and SBR 2, respectively *SBR main zone in BioWin™ model*
Tertiary treatment	
Equalisation tank	0.21 ML *Equalisation tank element used in BioWin™ model*
Sand filter	*Dewatering unit element used in BioWin™ model*
Chemical dosing systems	
Alum dosing	Alum is dosed to distribution chamber, SBR main zone and equalisation tank
Hypochlorite dosing	*Not included in BioWin™ model*
Sludge treatment and dewatering	

Process Unit	Details
Gravity drainage deck	*Dewatering unit element used in BioWin™ model*
Aerobic digester	0.16 ML 4 hour cycle; aerated for 230 minutes with 10 minutes air off
Belt filter press	*Dewatering unit element used in BioWin™ model*
Miscellaneous	
General purpose pump station	0.02 ML *Equalisation tank element used in BioWin™ model*

E.3 BioWin model set up and tuning

The process model was developed and calibrated using the proprietary software package BioWin™ (version 5.3) supplied by Envirosim. Figure 23 provides an overview of the BioWin™ model settings.

The adopted values for all key input parameters for the BioWin™ model are summarised in Table 31. Values in bold are preliminary assumptions where no data was available and were altered throughout the calibration process.

Table 31 Adopted values for key parameters in BioWin™ model

Process Unit	Value	Units	Comments
Sequencing batch reactor			
Flow split to SBRs	2	hr	Set up as flow routing rotates between the two SBRs; SBR 2 offset by 2 hrs
Selector zone (Prezone 1)			
Volume	0.22	ML	Per SBR
Area	46.8	m^2	Per SBR
Depth	2.5 - 4.8	m	Depth varies during operation
Width	4	m	Semi-circular tank; width varies.
Alpha F	0.5	-	Assumed
Beta	0.95	-	Assumed
Aeration zone (Prezone 2)			
Volume	0.21	m^3	Per SBR
Area	43.2	m^2	Per SBR
Depth	2.5 - 4.8	m	Depth varies during operation
Width	5	m	Semi-circular tank; width varies.
Alpha F	0.5	-	Assumed
Beta	0.95	-	Assumed
DO set point	1.8	mg/L	Set as constant DO setpoint
No. diffusers	26	No. per SBR	Diffusers are fine pore, EDI Mini Panel diffusers (102 total across SBR main zone and aeration zone; one quarter in aeration zone)
SBR basin			
Area	160	m^2	Per SBR
Depth	4.8	m	Full operating level
Width	6	m	Semi-circular tank; width varies. Value input - 6m
Minimum decant level	62.5	% of full	

Process Unit	Value	Units	Comments
Alpha F	0.5	-	Assumed
Beta	0.95	-	Assumed
Settling model	Reactive	-	
DO set point	Cycled as per SCADA data	mg/L	
No. diffusers	76	No. per SBR	Diffusers are fine pore, EDI Mini Panel diffusers (102 total across SBR main zone and aeration zone; one quarter in aeration zone)
Maximum airflow	1,950	Nm^3/hr	Per blower/SBR system (Robuschi Robox Evolution ES 66)
Decant flowrate setting	Set as decant to minimum decant level	-	
Cycle length or duration	Fill/aerate: 120 mins Settle: 60 mins Decant: 60 mins	d, h, m	
Offset cycle by	SBR 1: 0 SBR 2: 2	hrs	Calculated based on knowledge SBR 1 starts at 8am, SBR 2 starts at 10am
SBR underflow	1st hour: 0.71 2nd hour: 0.43 3rd & 4th hour: 0	ML/d	Combined WAS & RAS flow
SBR splitter main flow	1st hour: 0.28 2nd hour: 0 3rd & 4th hour: 0	ML/d	WAS flow
Equilization chamber			
Volume	1.00	ML	Actual volume 0.21 ML; set as 1 ML to prevent Biowin model errors with chamber running dry
Depth	2.5	m	
Diameter	10.3	m	
Outflow	1.9	ML/d	
Initial liquid hold up	80	%	Nominal value
Tertiary sand filter (TK3010)			
Percentage solids removal	**80**	**%**	**Preliminary estimate**
Flow split	0.02	-	Based on measured daily tertiary flowrates and mass balance (influent = effluent)
Gravity drainage deck (upstream of Aerobic Digester)			
Percentage removal	97	%	Solids capture efficiency; Assumed based on typical GDD operation
Flow split	0.11	-	Calculated based on solids capture efficiency and GDD dewatered solids %TS from sampling period
Aerobic digester (AeD)			
Volume	0.16	ML	
Depth	2.1	m	
Width	9.75	m	Diameter
Alpha F	0.5	-	Assumed

Process Unit	Value	Units	Comments
Beta	0.95	-	Assumed
DO set point	2	mg/L	Assumed Operates 24 hrs; 240 mins (230 mins aerated, 10 mins non-aeration)
Diffuser density	8	%	Assumed
Belt filter press (downstream of AeD)			
Percentage removal	92	%	Solids capture efficiency; Assumed based on typical BFP operation
Flow split	0.18	-	Calculated based on solids capture efficiency and BFP dewatered solids %TS from sampling period
GPPS			
Volume	1.00	ML	Actual volume 0.02 ML; set as 1 ML to prevent Biowin model errors with chamber running dry
Depth	4.25	m	
Width	1.75	m	
Length	2.7	m	
Outflow	0.45	ML/d	Average daily flow from the sampling days was 450 kL/d; averages out to 5.3 L/s
Initial liquid hold up	80	%	Nominal value
Alum dosing			
SBR1 dose rate	1.0	L/min	
SBR2 dose rate	1.0	L/min	
Concentration of alum	19.5	%w/w	Safety data sheet provided by TRC
SBR1 dosing details	96	L/d	Dosed each cycle for 16 min from start of second hour of aeration
SBR2 dosing details	108	L/d	Dosed each cycle for 18 min from start of second hour of aeration
Distribution chamber dosing details	**0**	**L/d**	
Equalisation chamber dosing details	**0**	**L/d**	

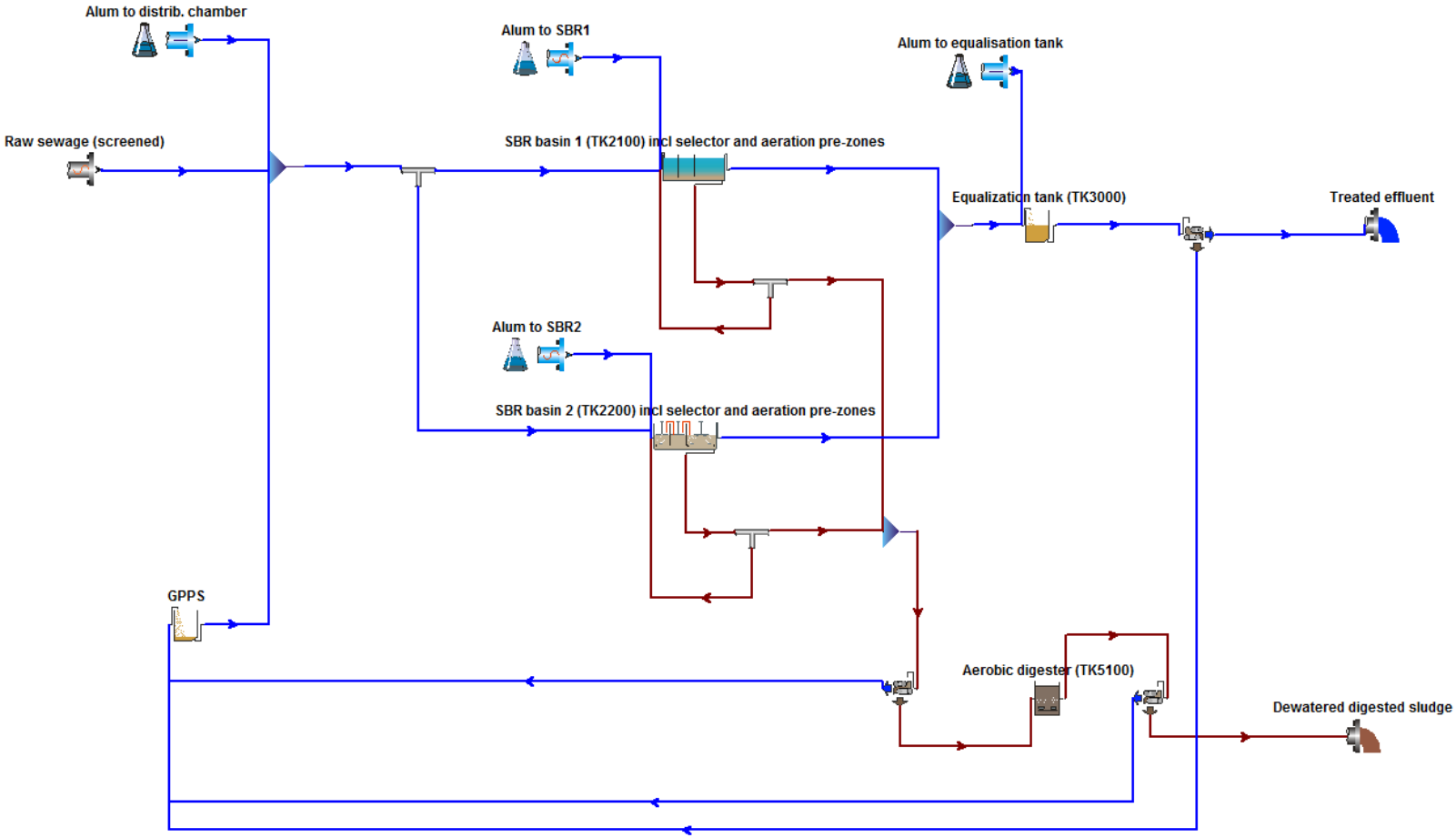


Figure 23 BioWin™ configuration

The following assumptions were made when establishing the model:

- **Grit and screening units** were not included in the model. BioWin™ does not have a process unit for screening and grit removal only accounts for removal of a small fraction of organic or inorganic material in the raw wastewater. For the purposes of this model, the small fraction (<1%) of the influent solids mass load likely to be removed was assumed to be negligible and within the sampling error.
- A generic dewatering unit simulated the **GDD, BFP and the tertiary sand filter**. The BioWin™ simulator does not have process elements specifically for the filter process. No reactions occur in simulated dewatering units other than solids separation.
- **Bioreactor temperature.** No temperature data was available for the Atherton STP process streams. A temperature of 23 °C was adopted based on long term average temperature in Atherton during November (when the sampling program was completed).
- **Internal recycle.** The internal recycle flow was set at 0.43 ML/d (or 5 L/s). This value was calculated assuming a maximum velocity in the RAS main of 1.5 m/s. This is significantly lower than the typical RAS flow observed for similar plants of at least 1x inflow. To improve the model functionality it is recommended that TRC confirm the RAS flow rate or pump sizing.

When modelling the plant the following operational changes were made:

1. **Wasting changed to occur during fully mixed phase of SBR cycle**. Initial model runs were completed with wasting occurring 30 minutes into the settle phase (for 85 minutes and 70 minutes for SBR 1 and SBR 2, respectively) as per existing plant operation. During these runs, the MLSS concentration wasted was high and the mass wasted resulted in a very low sludge age (the SBR MLSS dropped below 1,000 mg/L, which is significantly lower than the actual operating MLSS of ~4,000 mg/L).

   When the wasting time within the cycle was changed to the fully mixed phase and the amount wasted increased to 150 kL/d (from the actual observed value of 120 kL/d) the expected MLSS concentrations and mass of solids wasted were observed. This likely indicates that rat-holing is occurring; initially thicker (settled) sludge is withdrawn, following which water is pulled off rather than sludge, thereby balancing the total solids removed from the reactor compared with constantly withdrawing mixed liquor.

   Monitoring the WAS stream and the quantity of solids throughout a wasting cycle would confirm this hypothesis.

2. **Alum dosing.** The alum dose for the SBRs was provided by TRC as 1 L/min for 16 minutes each cycle for SBR 1 and 18 minutes each cycle for SBR 2 (starting 1 hour into the fill/aerate phase). A 46% w/w solution was adopted for the purposes of the modelling.

   In addition to the alum dose to the bioreactor, it is understood that alum is also dosed to the upstream distribution chamber and the downstream equalisation chamber. No data was provided on the dose rate to these units. The alum dose to both the distribution chamber and equalisation chamber was assumed to be 0 L/d. This was set to provide a reasonable match between the modelled and measured effluent phosphorus concentration.

E.3.1 Wastewater fractionation review

The proposed wastewater fractionation and BioWin™ default fractionation are summarised in Table 32. The proposed fractionation was developed using the BioWin™ influent specifier using the influent characteristics summarised in Section 2.2.2.

Table 32 Design wastewater fractionation

Parameter	Unit	Atherton	BioWin Default
F_{us}	mg COD_{us}/mg COD_{total}	0.026[12]	0.05
F_{up}	mg COD_{up}/mg COD_{total}	0.18[13]	0.13
F_{bs}	mg RBCOD/mg COD_{total}	0.179[14]	0.16
F_{ac}	mg COD as VFA/mg rbCOD	0.68	0.15
F_{xsp}	mg part,SBCOD/mg sbCOD	0.75	0.75
F_{nus}	mg N_{us}/mgN TKN	0.02	0.02
F_{na}	mg N_a/mgN TKN	0.70	0.66
F_{nox}	mg particulate OrgN/mg Org N	0.5	0.5

ac: acetate
bs: biodegradable soluble
us: unbiodegradable soluble
up: unbiodegradable particulate
Nus: unbiodegradable soluble nitrogen
xsp: particulate biodegradable (non-colloidal)
VFA: volatile fatty acids
na: Ammonia
nox: particulate organic nitrogen
F: fraction
RB: readily biodegradable
COD: Chemical Oxygen Demand
VSS: Volatile Suspended Solids
TKN: Total Kjeldahl Nitrogen

E.3.2 Steady state model

Given the treatment process at Atherton STP is a SBR (i.e. a dynamic process), a steady state BioWin™ model could not be produced. The dynamic model was run for two sludge ages until steady mixed liquor concentrations were observed.

E.3.3 Dynamic model

To simulate the predicted performance of the process under variable conditions, long-term dynamic process model (BioWin™) simulations were carried out using projected influent quality. The influent data set for BioWin™ was based on the actual measured feed to Atherton STP over the sampling program (20th through 26th November 2018). The parameters for which dynamic variability was included using available data were:

- Influent Flow
- Influent COD
- Influent TKN
- Influent TP
- Influent Alkalinity
- Influent inert suspended solids (ISS)

All other influent data (including fractions) were held constant in the dynamic simulations at the adopted design average values.

[12] Derived from the average of the 17 samples for effluent un-biodegradable soluble COD of ~18 mg/L

[13] Adjusted to match influent BOD, TSS and VSS value

[14] Derived from the average of the 16 samples for influent flocculated and filtered COD of 153 mg/L

The normalised concentration profiles adopted for the variable parameters are presented in Figure 24. These profiles were developed using the results of the sampling program.

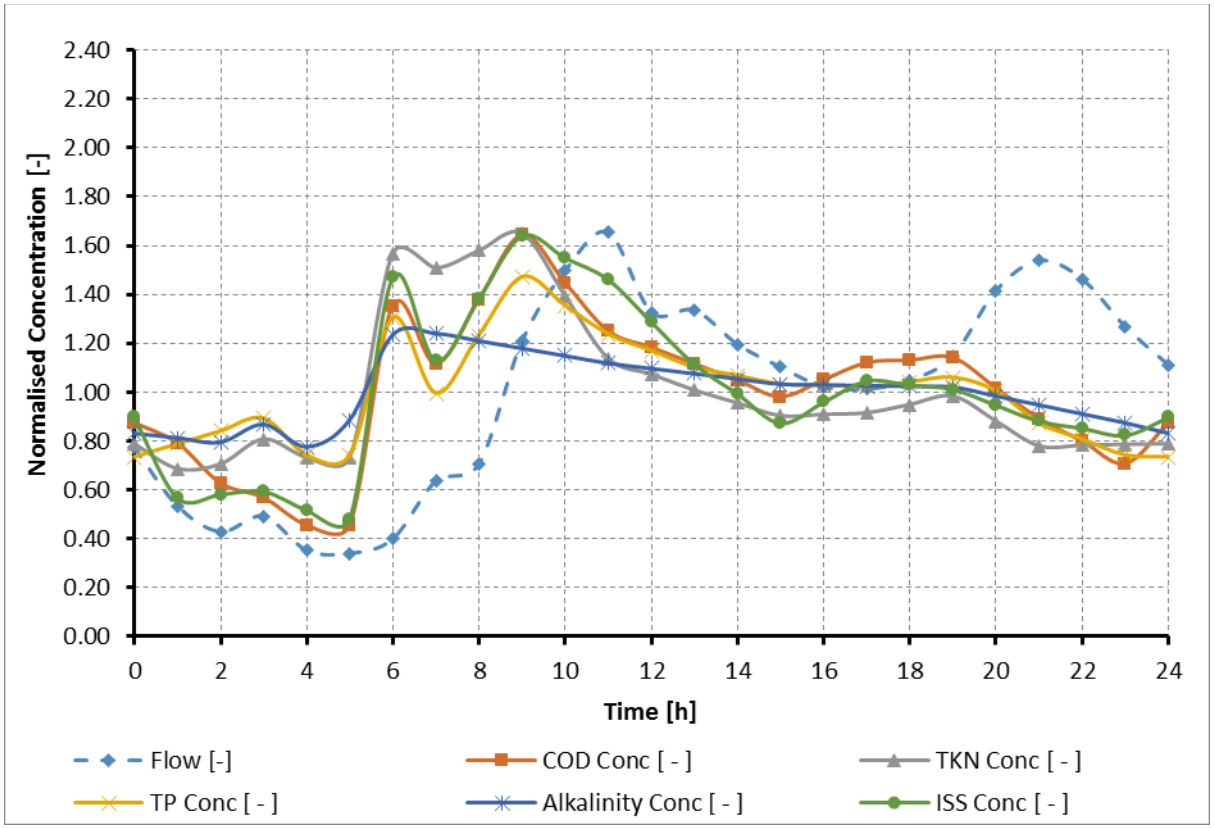


Figure 24 Normalised concentration profiles

E.3.4 Model options

The following model options in BioWin were included (i.e. model processes turned 'On') for this Study:

- BioWin integrated activated sludge dynamic model
- Oxygen modelling (i.e. DO transfer and transport between reactors)
- Model Ammonia stripping
- Model pH calculations
- Applied pH limitation in activated sludge kinetic equations
- Included metal precipitation for metal (Aluminium) phosphates and hydroxides
- Settling model: Modified Vesilind (with maximum compactability and clarification switch)
- The other model options not included in this study were:
- Nitrous oxide (N_2O) production
- Chemical precipitation reactions for magnesium and calcium:
    - Struvite (magnesium-ammonium-phosphate, $MgNH_4PO_4 . 6H_2O$)
    - Hydroxy-dicalcium-phosphate (HDP, $Ca_2HPO_4(OH)_2$)
    - Hydroxy-apatite (HAP)
    - These were not included in the model as they are not critical to the calibration, will further slow simulation time, and no data for N_2O, Mg and Ca were available.

E.4 Model simulations

E.4.1 Overview

Dynamic simulations of the model were ran until steady state conditions were observed. Given the only influent quality data available for model calibration was that from the sampling program, long term variation in influent quality and the ability of the system to cope with peak loading could not be investigated at this stage.

The model was run for 60 days to confirm steady state conditions were achieved.

E.4.2 Outcomes

The following outcomes were evident from the modelling:

- The overall plant solids inventory shows a reasonable match between the predicted and measured values:
    - Monthly dewatered sludge volume of approximately 90 tonnes wet solids per month (equal to observed volume for 2018 period)
    - Total solids concentration of GDD dewatered solids to aerobic digester of 3.5 – 4% total solids compared with actual observed concentration of 3%
    - Volatile solids destruction (VSD) in aerobic digester modelled as 14.8% compared with actual observed VSD of 8%. The low VSD in the aerobic digester could be due to aeration limitations in the digester or inhibition due to low alkalinity. As discussed below, additional alkalinity was added to the digester during the model runs to prevent low pH inhibition impacting the model.
    - Total solids concentration of BFP dewatered solids (final dewatered sludge) of 12.8% total solids compared with actual observed concentration of 15%[15]
- The overall sludge age in the system is estimated to be 18 days (based on BioWin™ modelling). This is lower than the plant design sludge age of 20 days.
- Reasonably good agreement was achieved between the median model predictions and observed effluent quality for most parameters.
- Model predictions were similar to plant monitoring and only limited adjustment of the model parameters was made from default values. The key model parameters that required adjustment were:
    - The OHO dissolved oxygen half saturation switching function was increased to 0.3 mg/L (from the default of 0.15 mg/L) to increase the simultaneous nitrification / denitrification occurring in the model and obtain a closer match the effluent nitrate/nitrate observed.
    - The aeration set point controller gain was increased to 10 (from the default of 1) to increase the response time for an aeration set point change, allow the DO set points to be met and reflect the actual operation of the plant.
    - Initial runs of the model saw the aerobic digester failing to acidic conditions. As it is understood this is not observed onsite, a low flow stream with high alkalinity concentration was added to the model to maintain the pH in the digester at an expected level. By adopting a low flow stream, the overall mass balance within the model is not effective.

[15] Note only one sample was available for %TS of dewatered sludge

- Plants with alum dosed for chemical phosphorus removal often have caustic, lime or magnesium hydroxide liquid dosing to provide the alkalinity consumed by the alum. It is understood this is not occurring at Atherton STP. It is recommended TRC monitor the pH levels in the bioreactor and aerobic digester. Low pH may be contributing to poor nitrification and the low volatile solids destruction in the digester.
- The tertiary sand filter solids capture efficiency was adjusted to provide a reasonable match with the measured effluent TSS concentration.
- The timing of the wasting of activated sludge from the SBRs was changed to occur during fully mixed phase of SBR cycle
- Initial model runs were completed with the full aeration pattern (i.e. daily DO set points) however this was simplified to a two hour pattern (i.e. each cycle has the same aeration set points) to improve the run speed of the model.

Given the DO set points are similar across each cycle and the timing of the air on vs. air off is consistent, this is not expected to have a significant impact on the modelled outputs.

E.4.3 Predicted Effluent Quality

A summary of the dynamic BioWin™ model predictions compared with actual effluent quality is summarised in Table 33.

Table 33 Predicted and actual median effluent quality (from sampling period)

Parameter	Actual Effluent Quality During Sampling Period			Modelled Effluent Quality	
	50%ile	80%ile	Number of samples	50%ile	80%ile
Total Nitrogen	4.2	7.5	9	5.1	5.6
Ammonia (NH_3)	0.8	2.1	7	2.1	2.4
Nitrate + Nitrite	2	2.6	9	0.9	1.1
Total phosphorus (TP)	1.5	2.4	7	1.1	1.1
Total suspended solids (TSS)	7	10	8	7.1	7.1
Biological Oxygen Demand (BOD)	5.4	8.1	9	3.7	3.9

The predicted results from the BioWin™ model outlined in Table 33 are comparable with the actual effluent quality measured at the plant during the sampling period. The variability of predicted effluent quality compared to actual plant performance is illustrated in Figure 25 through Figure 29. Only 5 days of data has been presented in the graphs out of the full 60 day run completed.

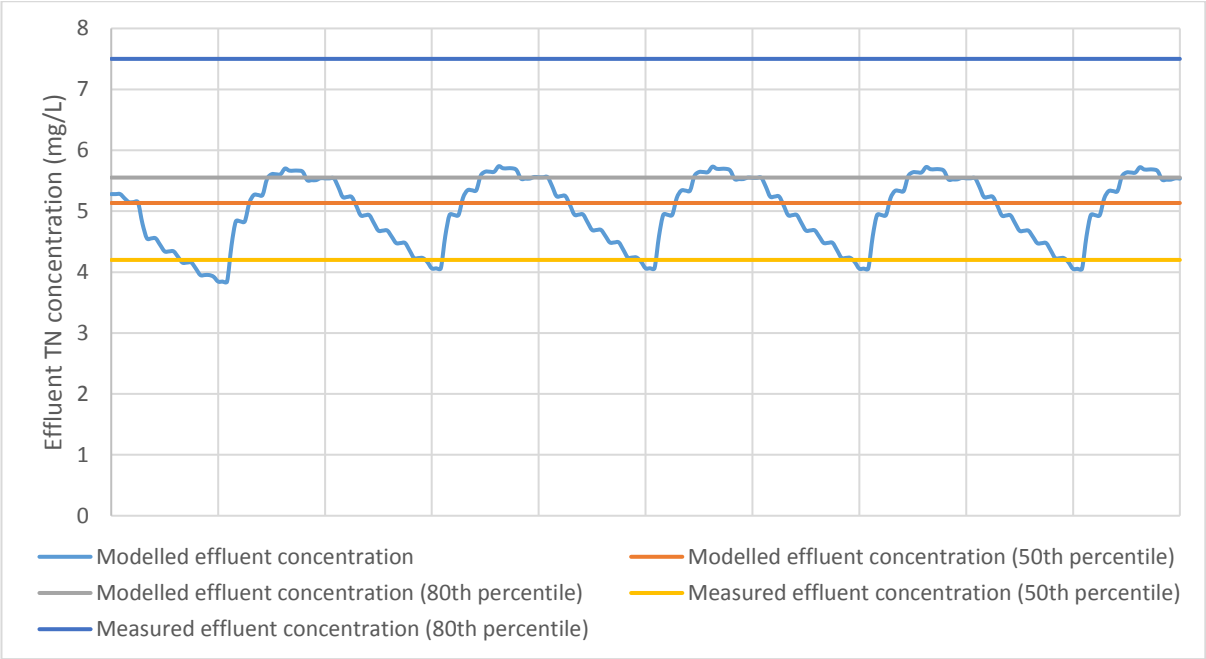


Figure 25 Effluent total nitrogen actual and predicted

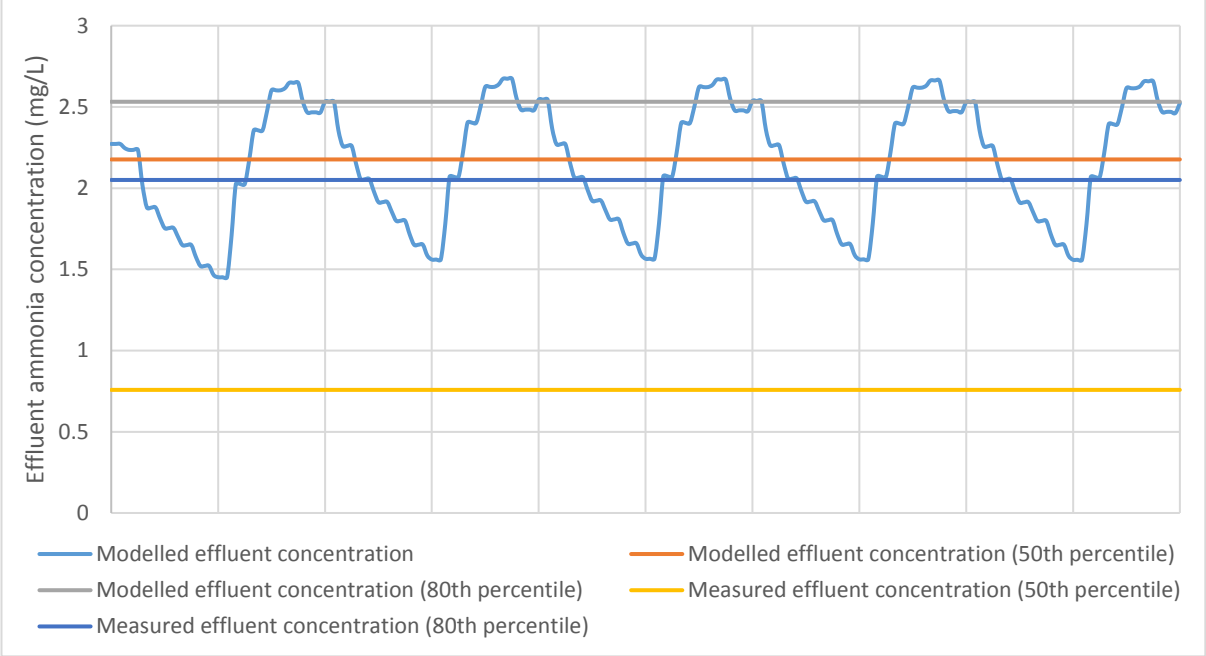


Figure 26 Effluent ammonia actual and predicted

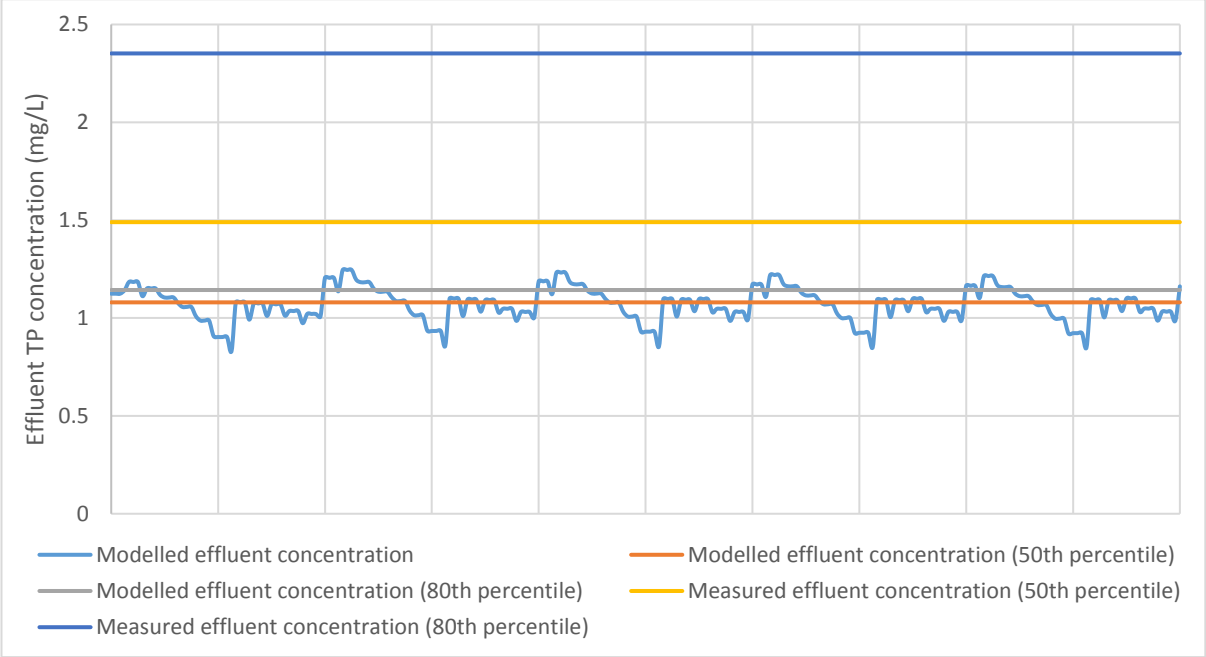


Figure 27 Effluent total phosphorus actual and predicted

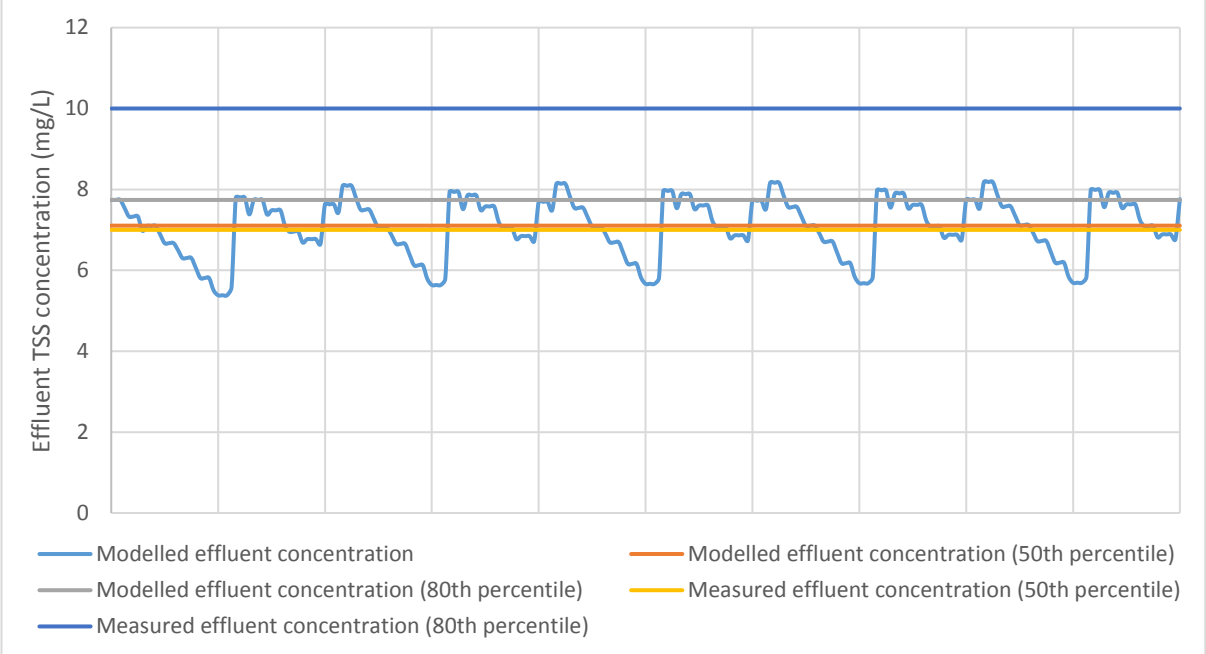


Figure 28 Effluent total suspended solids actual and predicted

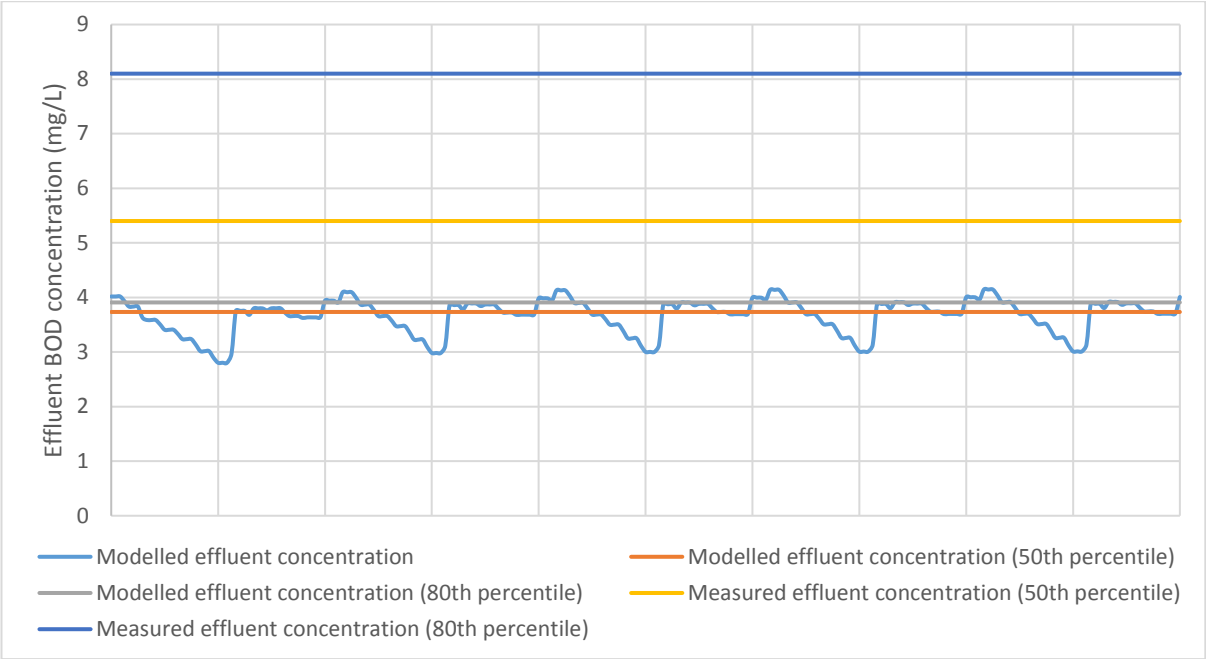


Figure 29 Effluent BOD actual and predicted

The following was noted when reviewing the actual and predicted data:

- **Effluent nitrogen –** Figure 25 and Figure 26 illustrate that the predicted median effluent total nitrogen and ammonia align reasonably well with the actual sampling results. The biggest discrepancy is in the modelled ammonia peaks, with variability the predicted data is greater than the actual effluent results. This could be due to the sampling results not capturing the intermittent peaks or the plant may be increasing aeration to nitrify these peaks. Further consideration of the actual air flow to the bioreactors would be required to allow the modelling to consider the actual air flow rather alongside the DO set points.
- **Total phosphorus –** A good match was achieved between the BioWin™ predicted and actual effluent total phosphorus concentrations. The small difference between the actual and predicted could possibly be improved if alum dose rate and frequency to the distribution chamber and equalisation tank is confirmed.
- **Solids inventory –** The BioWin™ modelling aligned well with the plant operating data with respect to the sludge age, mixed liquor suspended solids and the total biomass generated.

E.5 Summary of biological modelling

This study developed a BioWin™ model for the Atherton STP.

The modelling used measured influent flow and influent concentration data over the sampling period from 20th through 26th November 2018. The remainder of the modelling inputs were as advised by TRC for normal operation unless otherwise discussed. For practical modelling purposes some inputs were simplified such as the daily aeration cycles simplified to 2 hour cycles only.

The following outcomes were evident from the modelling:

- The overall plant solids inventory shows a reasonable match between the predicted and measured values.
- The overall sludge age in the system is estimated to be 18 days (based on BioWin™ modelling). This is lower than the plant design sludge age detailed in the initial design concept report prepared by ESI in 1999.

- Reasonably good agreement was achieved between the median model predictions and observed effluent quality for most parameters.
- Model predictions were good, requiring only limited adjustment of model parameters from default values.
- Further alignment of the effluent ammonia could be undertaken if the plant airflow rates were known and matched to the model.

Appendix I – Process Capacity

Inlet Works

Equipment	6 mm mechanical step screen, screw conveyor and discharge chute; Manually raked coarse bar screen Auto-sampler Grit removal system, grit vortex with mixer paddle and air lift blower Odour Control Unit Ultrasonic flow meter installed upstream of the mechanical screen			
Design Capacity	Estimated mechanical screen capacity: 100 L/s (refer Section 2.1) Inlet works design capacity (with manual screen operating (125 L/s[16])			
Redundancy	Duty mechanical screen and screenings conveyor Manually screened by-pass channel Duty only grit vortex			
Capacity Assessment	**Current (2018)**		**Future (2041) incl. tourist peak**	
	ADF = 23 L/s	✓	ADF = 33 L/s	✓
	ADF tourist season = 25 L/s	✓	ADF tourist season = 35 L/s	✓
	PDF tourist season = 41 L/s	✓	PDF tourist season =57 L/s	✓
	Peak wet weather flow = 5x ADF = 115 L/s	✓	Peak wet weather flow = 5x ADF = 165 L/s	x
Operational Concerns & Upgrade Triggers	– Poor screenings capture, resulting in downstream pump blockages and process interruptions; – Flow metering upstream of screen does not detect peak flows; – Mechanical screen required to run ~ continuously to minimise overtopping to the manual screen channel. Step screens screenings capture is most efficient when a screenings mat is allowed to develop – not possible with the structure limitations at Atherton.			

[16] Original Basis of Design

Bioreactor

SBR capacity

Equipment	Total SBR volume (at TWL): 2,250 m^3 SBR top water level (TWL): 4.5 m SBR bottom water level (BWL): 3 m (original BWL was 2.8m)			
Design Capacity	Design MLSS concentration: 3,700 mg/L Design SRT: 20 days Normal decant loading rate: 120 L/s Peak decant loading rate: 150 L/s			
Redundancy	2 SBR tanks in rotating duty (round tank split down middle)			
Capacity Assessment	**Current (2018)**		**Future (2041) incl. tourist peak**	
	Sludge age = 18.5 days	✓	Sludge age = 13.5 days (13 days for tourist load)	x
	TWL to achieve required decant volume at ADF = 3.7 m[17]	✓	TWL to achieve required decant volume at ADF = 4.1 m[17]	✓
	TWL to achieve required decant volume at PDF = 4.1 m[17]	✓	TWL to achieve required decant volume at PDF = 4.6 m[17]	x
Operational Concerns & Upgrade Triggers	– The existing decanters are suitably sized handle the ADF through to 2041 (incl. the tourist load). The existing decanters are only capable of handling the PDF through to 2031. – Peak wet weather flow can only be processed in storm mode, with decanters docked.			

SBR aeration capacity

Equipment	Fine Bubble Diffused Aeration; EDI Mini Panel diffusers (102 total across SBR main zone and aeration zone) 2 No. Robuschi Robox Evolution ES 66 blowers		
Design Capacity	Maximum air flow: 3,900 Nm^3/hr (total) with duty/assist blowers Single blower capacity: 1,950 Nm^3/hr Design SOR: 1,931 kg O_2/d at 25°C (80 kg O_2/h)		
Redundancy	No stand-by blower capacity during peak demand		
Capacity Assessment	**Current (2018)**		**Future (2031)[18] incl. tourist peak**
	ADF maximum airflow (BioWin) = 1,625 m^3/h[19]	✓	Effluent quality requirements cannot be met in 2031 under ADF with tourist peak loading.
	ADF 90%ile SOTR (BioWin) = 110 kg O_2/h[19]	x	

[17] Conservative estimate of sludge settlability was adopted given there was no SVI data available. SVI Assumes SVI of sludge is 200 mL/g (moderate-poor settling sludge)

[18] Given the SBR will be hydraulically limited after 2031, the organic capacity has not been considered past this time.

[19] Alpha value of 0.5 adopted.

	ADF 50%ile SOTR (BioWin) = 90 kg O_2/h[19]	✘	
Operational Concerns & Upgrade Triggers	– 90th percentile (peak month) loads were not available and therefore have been unable to be considered in the capacity assessment – The actual air flow rates may vary from theoretical capacity. Air flow metering should be installed to enable the capacity to be assessed, and the aeration efficiency (diffusers) investigated. – Based on the site testing and BioWin modelling completed, the SBR is organically overloaded and struggling to meet its effluent TN and ammonia limit. Improvements to the aeration required in the short term.		

Tertiary Treatment

Sand filter

Equipment	Retained clarifier repurposed as Effluent Balance Tank upstream of sand filter 1 no. tertiary pressure sand filter with 5 parallel cells Backwash blower Tertiary flow metering Hypo dosed immediately downstream of filters			
Design Capacity	Effluent Balance Tank: 200 m^3 holding capacity to balance flow to downstream tertiary filters **Sand filter loading:** Normal operation (10 m/hr filter loading rate): 37 L/s (assuming 1 cell in backwash) Peak operation (20 m/hr filter loading rate): 74 L/s (assuming 1 cell in backwash) Sustained peak flows > 75 L/s by-pass the filters (once the EBT is full); *Note – loading rates are as stated in ESI Design Report. Actual loading rates have not been verified.*			
Redundancy	Feed pumps: Duty/duty/standby Filters: 5 independent Cells			
Capacity Assessment	**Current (2018)**		**Future (2041) incl. tourist peak**	
	Holding capacity required under ADF tourist season = 47 m^3 [20]	✓	Holding capacity required under ADF tourist season = 116 m^3 [20]	✓
	Holding capacity required under PDF tourist season = 164 m^3 [20]	✓	Holding capacity required under PDF tourist season = 278 m^3 [20]	✘
	Holding capacity required under PWWF = 434 m^3 [21]	✘	Holding capacity required under PWWF = 693 m^3 [21]	✘
Operational Concerns & Upgrade Triggers	– Effluent Balancing Tank is currently undersized for managing inflow greater than 4 ML/d (i.e. current extreme PWWF or PDF after 2021).			

[20] Calculated based on normal filter loading rate (10 m/hr) and 60 minute decant

[21] Calculated based on peak filter loading rate (20 m/hr) and 45 minute decant

Disinfection

Equipment	Dual tank hypochlorite system 2 No. dosing pumps Hypochlorite solution: 10% Cl_2	
Design Capacity	Chlorine contact tank volume[22] at TWL: 175 m^3 Chlorine contact tank volume[22] at BWL: 125 m^3 Target CT: 29 mg.min/L[23]	
Redundancy	Dosing pumps: Duty / Standby	
Capacity Assessment	**Minimum CT achieved[24]**	
	CCT TWL tertiary filtration typical flow (40 L/s) = 52.0 mg.min/L	✓
	CCT TWL tertiary filtration peak flow (80 L/s) = 25.5 mg.min/L	✗
	CCT BWL tertiary filtration typical flow (40 L/s) = 36.0 mg.min/L	✓
	CCT BWL tertiary filtration peak flow (80 L/s) = 18.0 mg.min/L	✗
Operational Concerns & Upgrade Triggers	– The required capacity of the disinfection system is limited by the capacity of the upstream tertiary filtration system. If the capacity of the upstream filters is increased, the required capacity for the hypo dosing system should be reviewed. – The required CT is not achieved during peak filter loading and therefore required disinfection may not be achieved. This has been determined based on conservative assumptions of the required log reduction value (4 log) and pH (between 8.5 and 9 following hypo dose). – No details on the capacity of the existing dosing pumps was available.	

Sludge handling

Gravity drainage deck

Equipment	TEMA Series 500			
Design Capacity	Hydraulic loading rate: 30 m^3/hr Design operating hours: 4 hr/day, 5 days/week (20 hrs/week total)			
Redundancy	Duty only Sludge can be store in SBR Tanks for days, whilst repairs undertaken.			
Capacity Assessment	**Current (2018)**		**Future (2041) incl. tourist peak**	
	Hours operating =28 hrs/week	✓	Hours operating = 38 hrs/week	✓

[22] Note the CCT volume includes the volume of the outlet pipe from the tertiary filters to the filtered effluent balance tank (downstream of the hypo dose point), the volume in the filtered effluent balance tank, the discharge pipe to the CCT manhole and the discharge pipe from the CCT manhole to the CCT inlet channel.

[23] Conservative estimate of target CT based on 4 log reduction target and 'Guidelines for validating treatment processes for pathogen reduction - Supporting Class A recycled water schemes in Victoria'

[24] Based on required maximum chlorine residual of 0.7 mg/L

Operational Concerns & Upgrade Triggers	– GDD has sufficient capacity

Aerobic digester

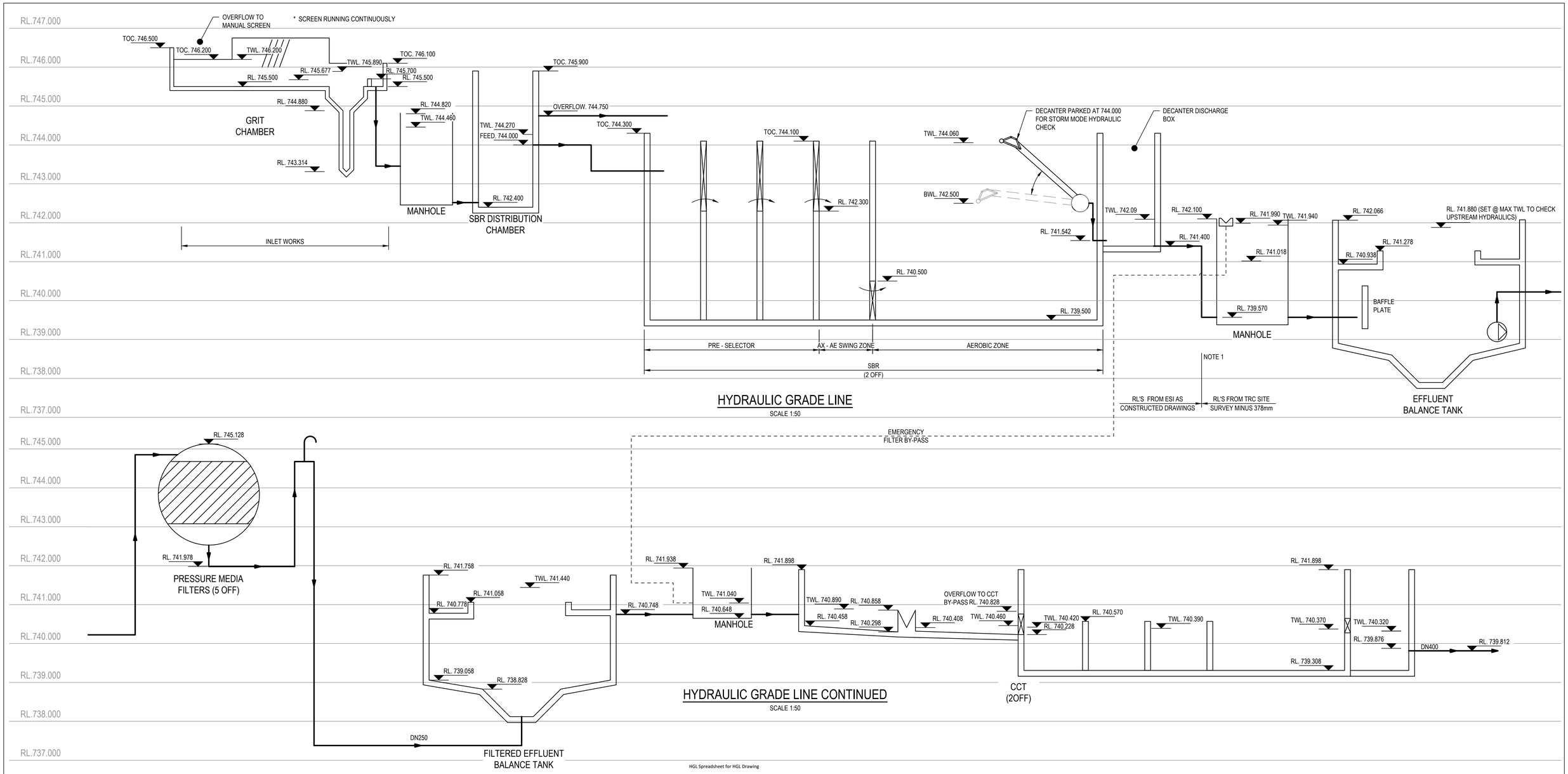
Equipment	Aerobic Digester: 0.157 ML, 2.1 m depth, 9.75 m diameter 2 No. 11 kW blowers. Model number SRB 40/2P.(Upgraded by TRC in April 2019)			
Design Capacity	**Hydraulic** Design sludge age: 16 days Solids loading rate: 432 kg/d at 3.5% TS **Organic** No details of the blower capacity could be determined from O&M or Supplier			
Redundancy	Digester tank: Duty only Blowers: Duty / Standby			
Capacity Assessment	**Current (2018)**		**Future (2041) incl. tourist peak**	
	Sludge age / HRT = 9.1 days	✘	Sludge age / HRT = 6.7 days	✘
	Solids loading rate = 519 kg/d	✘	Solids loading rate = 698 kg/d	✘
	Maximum airflow to achieve 38% VS destruction = 10,670 m^3/hr	?	Maximum airflow to achieve 38% VS destruction = 14,360 m^3/hr	?
Operational Concerns & Upgrade Triggers	– The sludge age and hydraulic retention time in the aerobic digester are equivalent given there is a single outlet. The current (2018) sludge age is significantly lower than the design sludge age of 16 days. Typical aerobic digestion HRT are in the range of 40 days at 20°C if biosolids are to be beneficially reused (MOP8). – Given TRC are considering importing additional sludge from nearby satellite STPs thereby further increasing the solids load on the digester, additional capacity is required immediately – Whilst the maximum airflow for the blowers was not able to be confirmed, based on the blower motor size it is unlikely the blowers will be able to meet the required airflow for the VS destruction required for Grade B stabilisation and beneficial reuse of biosolids			

Belt filter press

Equipment	TEMA Series 500			
Design Capacity	Solids loading rate: 324 kg/h at 3% TS[25] Hydraulic loading rate: 3 L/s Design operating hours: 5 hr/day, 2 days/week (10 hrs/week total) Target dewatered sludge concentration: 16 – 18 %DS			
Redundancy	Duty only			
Capacity Assessment	**Current (2018)**		**Future (2041) incl. tourist peak**	
	Hours operating =11 hrs/week	✓	Hours operating = 14 hrs/week	✓
Operational Concerns & Upgrade Triggers	– BFP has sufficient capacity.			

[25] TEMA advised in an email from Michael Caripis to Garth Gademan on 20/03/19 that the BFP can dewater up to 16 m^3/hr at 1% DS. The BFP is currently dewatering approx. 10.8 m^3/hr at 3% DS

Appendix J – Existing STP HGL



HGL Spreadsheet for HGL Drawing

		Influent	GPPS	U/S Mech Screen		Q/F to Manual Channel	Grit Tank		Influent Manhole		SBR Distribution Box			SBR Duty (Shared or Alternating)	RAS Pumps (Off or 15 L/s)	SBR Tank		F/ Decanter	Decant Rate	Decanter Outlet Box		Effluent Manhole		F/ Filter By-Pass	Effluent Balance Tank	
	Scenario Description			RL (m)	F/B (mm)	RL (m)	RL (m)	F/B (mm)	RL (m)	F/B (mm)	RL (m)	F/B (mm)				RL (m)	F/B (mm)	RL	(L/s)	RL (m)	F/B (mm)	RL (m)	F/B (mm)	RL	RL (m)	F/B (mm)
Top of Structure				**746.50**		**746.20**	**746.10**		**744.82**		**745.90**					**744.30**				**744.30**		**741.99**		741.018	**742.07**	
PWWF	Maximum flow and all Tanks at TWL	125 L/s	18 L/s	746.20	*305*	Lapping over	745.89	*207*	744.46	*363*	744.26	*1,639*	A/B	Shared	Off	744.05	*248*	744.000	125	742.09	*2,208*	741.94	-56	Filter By-Pass Active	741.88	-106
PDWF	Normal Operation	52 L/s	18 L/s	746.16	*338*		745.86	*239*	744.30	*521*	744.20	*1,697*	A/B	Alternating	15 L/s	744.05	*248*	744.000	125	740.87	*3,429*	740.64	*1,351*		740.57	*1,491*
ADWF	Normal Operation	24 L/s	18 L/s	746.13	*371*		745.83	*272*	744.20	*615*	744.17	*1,730*	A/B	Alternating	15 L/s	744.05	*248*	744.000	125	740.87	*3,429*	740.64	*1,351*		740.57	*1,491*

		Filtered Flow	By-Pass Flow	F/ Filter Outlet Pipe	CCT 1 and CCT 2		Filtered Effluent Balance Tank		Filtered Water Outlet MH		CCT Entrance Channel			V-Notch Weir	CCT1&2 Bypass Weir		CCT1 U/S		CCT1 @ Low Baffles	Below Baffle Level (mm)	CCT 1 Outlet Weir	Outlet Sump		Priors Creek Discharge
	Scenario Description			RL (m)			RL (m)	F/B (mm)	RL (m)	F/B (mm)	RL (m)	F/B (mm)			RL (m)	RL (m)	F/B (mm)	RL (m)		RL (m)		RL (m)	RL (m)	F/B (mm)	RL (m)
Top of Structure							**741.76**		**741.94**		**741.90**				**740.41**	**740.81**		**741.88**		**740.57**		**740.18**	**741.88**		
PWWF	Maximum flow and all Tanks at TWL	80 L/s	63 L/s	742.83	50:50		741.44	*316*	741.04	*902*	740.90	*1,001*		740.89	740.46	*350*	740.42	*1,463*	740.39	174	740.37	740.32	*1,561*	740.00	
PDWF	Normal Operation	52 L/s	0 L/s	741.66	50:50		741.07	*689*	740.79	*1,147*	740.73	*1,166*		740.73	740.33	*483*	740.30	*1,581*	740.29	*275*	740.29	740.04	*1,836*	740.00	
ADWF	Normal Operation	24 L/s	0 L/s	741.19	50:50		741.06	*694*	740.75	*1,187*	740.65	*1,253*		740.64	740.27	*533*	740.26	*1,623*	740.25	*314*	740.25	740.01	*1,873*	740.00	

Fail Scenario Freeboard < 200 mm A/B = Atmospheric Break F/B = Freeboard U/S = Upstream D/S = Downstream O/F = Overflow M/S = Manual Screen

NOTES:

1. COMPLETE SITE SURVEY OF ALL STRUCTURES AND LEVELS TO CONFIRM ACCURACY TO BE UNDERTAKEN FOR DETAILED DESIGN.

PRELIMINARY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
A	PRELIMINARY ISSUE		EDJ	GG*	TMB*	28.05.19

0 0.5 1.0 1.5 2.0 2.5m
SCALE 1:50 AT ORIGINAL SIZE

TABLELANDS REGIONAL COUNCIL

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Drawn	E.JOHNSON	Designer	G.GADEMAN
Drafting Check		Design Check	
Approved (Project Director)			
Date			
Scale	AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	

Client TABLELANDS REGIONAL COUNCIL
Project ATHERTON STP PLANNING AND EVALUATION
Title HYDRAULIC GRADE LINE

Original Size **A1** Drawing No: **42-20841-W001** Rev: **A**

Plot Date: 28 May 2019 - 2:00 PM Plotted by: Evan Johnson Cad File No: G:\42\20841\CADD\Drawings\42-20841-W001.dwg

Appendix K – Cost Estimates

Option 1a
New 4.5 ML SBR

Project:	Atherton STP Planning Report
Client:	Tablelands Regional Council
Job No.:	42/20841
Prepared By:	GHD Pty Ltd
Date Prepared:	Jun-2019

CAPEX

	ITEM	Qty	Unit	Rate	Direct cost	Civil cost	M&E cost	Total cost	Comments	Timing
1	Preliminaries	15%	%	$ 14,100,000	$ 2,115,000	$ -	$ -	$ 3,161,925	10% of direct cost	2026
2	New inlet works	1	No.	$ 750,000	$ 750,000	$ 375,000	$ 375,000	$ 1,121,250	Allowance	2026
3	New SBR tank	1	No.	$ 5,100,000	$ 5,100,000	$ 5,100,000	$ -	$ 7,624,500	New 4.8 ML tank (2.25 ML per tank) 4.8 m depth 2 No. 12.5 m by 40 m tanks Cost based on GHD previous project experience ($4m excl. blowers, diffusers and contingency for 5 ML aeration tanks in 2009). Cost scaled down for 4.8 ML and inflated to 2019 costs. Additional allowance included for decanter ($170k, based on GHD cost database).	2026
4	SBR aeration (blowers + diffusers)	1	No.	$ 1,010,000	$ 1,010,000	$ -	$ 1,010,000	$ 1,509,950	3 No. 100 kW (nominal) blowers operating duty / duty / common standby (1 duty per SBR tank) Costed using GHD cost database 2,950 Nm3/hr diffusers ($530k) and 3 No. 100 kW (nominal) blowers ($160k each). Costs exclude civil and electrical.	2026
5	Civils associated with SBR blowers	1	Allowance	$ 500,000	$ 500,000	$ 500,000	$ -	$ 747,500	Allowance	2026
6	New WAS and RAS pump stations	1	No.	$ 260,000	$ 260,000	$ 100,000	$ 160,000	$ 388,700	WAS: Sized for 10 L/s (4 No. pumps, duty / standby for each SBR) Costed using GHD cost database $100k allowance for pump station, 4 No. 2.4 kW (nominal) pumps ($7.5k each) RAS: Sized for 35 L/s (4 No. pumps, duty / standby for each SBR) Costed using GHD cost database $100k allowance for pump station, 4 No. 2.4 kW (nominal) pumps ($7.5k each)	2026
7	Pipework modifications	1	Allowance	$ 900,000	$ 900,000	$ -	$ 900,000	$ 1,345,500	Allowance approximated as 10% of total cost. Allowance includes: Secondary plant feed pipework from distribution chamber to SBR Secondary plant effluent pipework from SBR to new tertiary filtration balance tank (TFBT) RAS pipework WAS pipework to GDD Thickened sludge pipework from GDD to Aerobic Digester Digested sludge pipework from Aerobic Digester to BFP Pipework connect new TFBT to existing TFBT	2026
8	Additional storage tank for tertiary filtration balance tank	1	No.	$ 250,000	$ 250,000	$ 250,000	$ -	$ 373,750	New 0.3 ML tank Depth: 3 m 6 m diameter Costed using GHD cost database, 0.3 ML concrete tank	2026
9	New sand filters (duplicate capacity)	1	No.	$ 1,000,000	$ 1,000,000	$ -	$ 1,000,000	$ 1,495,000	Double existing sand filter capacity (i.e. total capacity approximately 80 L/s normal, 160 L/s peak) New unit 40 L/s normal, 80 L/s peak Costed using GHD cost database based on peak flow	2026
10	New dewatering facility	1	No.		$ -	$ -	$ -	$ -	Allowance	2026
11	Odour management	1	No.	$ 400,000	$ 400,000	$ -	$ 400,000	$ 598,000	Allowance	2026
12	Aerobic digester aeration (blowers + diffusers)	1	No.	$ 630,000	$ 630,000	$ -	$ 630,000	$ 941,850	3 No. 55 kW (nominal) blowers operating duty / duty / standby Costed using GHD cost database 2,850 Nm3/hr diffusers ($520k) and 3 No. 55 kW (nominal) blowers ($70k each). Costs exclude civil and electrical.	2026
13	Civils associated with aerobic digester blowers	1	Allowance	$ 300,000	$ 300,000	$ 300,000	$ -	$ 448,500	Allowance	2026
14	New sludge import facility	1	Allowance	$ 25,000	$ 25,000	$ 12,500	$ 12,500	$ 37,375	Allowance	2026
15	New (increased capacity) alum storage and dosing	1	No.	$ 300,000	$ 300,000	$ -	$ 300,000	$ 448,500	Cost based on GHD previous project experience ($260k in 2016 for complete storage and dosing system for 550 L/d alum system). Cost scaled down up for 600 L/d and inflated to 2019 costs.	2026
16	New alkalinity storage and dosing	1	Allowance	$ 500,000	$ 500,000	$ -	$ -	$ 747,500	Allowance	2026
17	Modifications to recycled water draw off location	1	Allowance	$ 100,000	$ 100,000	$ -	$ 100,000	$ 149,500	Allowance	2026
18	Electrical, instrumentation and control allowance	15%	%	$ 12,030,000	$ 1,804,500	$ -	$ 1,804,500	$ 2,697,728	15% of direct costs	2026
19	Commissioning	1	Allowance	$ 200,000	$ 200,000	$ -	$ -	$ 299,000		2026
20					$ -	$ -	$ -	$ -		2026
21					$ -	$ -	$ -	$ -		2026
22					$ -	$ -	$ -	$ -		2026
23					$ -	$ -	$ -	$ -		2026
24					$ -	$ -	$ -	$ -		2026
25					$ -	$ -	$ -	$ -		2026
	Add new items above this line									
	TOTAL			2019 AUD	**$ 16,144,500**	**$ 6,637,500**	**$ 6,692,000**	**$ 24,136,028**		
				Incl engineering	$ 18,566,175					
					$ 18.6					

OPEX

	ITEM	Value	Start year	Comments
1	Operation and maintenance of new facilities, civils	$ 70,000	2027	Based on 1% (civils) of direct civil capital costs
2	Operation and maintenance of new facilities, M&E	$ 210,000	2027	Based on 3% (M&E) of direct M&E capital costs
3	Electricity	$ 290,000	2027	SBR aeration: 1 No. 100 kW (nominal) blower operating 24 hrs per day (cycles between 2 reactors) = 876 MWh/yr WAS pump: 2 No. 2.4 kW (nominal) pump each operating 6 hrs per day = 10.5 MWh/yr RAS pump: 2 No. 2.4 kW (nominal) pump each operating 12 hrs per day = 21 MWh/yr Aerobic digester aeration: 2 No. 55 kW (nominal) blower operating 24 hrs per day = 964 MWh/yr
4	Biosolids disposal	$ -	2027	Consistent across all sites
5	Chemical usage	$ -	2027	Consistent across all sites
6	Additional labour	$ -	2027	No additional labour required
7				
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	Add new items above this line			

Option 2b

4 stage Bardenpho in new tank (with clarifiers)

Project:	Atherton STP Planning Report
Client:	Tablelands Regional Council
Job No.:	42/20841
Prepared By:	GHD Pty Ltd
Date Prepared:	Jun-2019

CAPEX

	ITEM	Qty	Unit	Rate	Direct cost	Civil cost	M&E cost	Total cost	Comments	Timing
1	Preliminaries	15%	%	$ 14,600,000	$ 2,190,000	$ -	$ -	$ 3,274,050	10% of direct cost	2026
2	New inlet works	1	No.	$ 750,000	$ 750,000	$ 375,000	$ 375,000	$ 1,121,250	Allowance	2026
3	New bioreactor tank	1	No.	$ 4,400,000	$ 4,400,000	$ 4,400,000	$ -	$ 6,578,000	New 4 ML tank (1.4 ML Anoxic Zone 1, 2 ML Aerobic Zone 1, 0.2 ML Anoxic Zone 2, 0.4 ML Aerobic Zone 2) 4.5 m depth, 18 m by 50 m tank Cost based on GHD previous project experience ($4m excl. blowers, diffusers and contingency for 5 ML aeration tanks in 2009). Cost scaled down for 4 ML and inflated to 2019 costs.	2026
4	Bioreactor aerobic zone 1 (blowers + diffusers)	1	No.	$ 710,000	$ 710,000	$ -	$ 710,000	$ 1,061,450	3 No. 55 kW (nominal) blowers operating duty / duty / standby Costed using GHD cost database 2,200 Nm3/hr diffusers ($500k) and 3 No. 55 kW (nominal) blowers ($70k each). Costs exclude civil and electrical.	2026
5	Bioreactor aerobic zone 2 (blowers + diffusers)	0	No.	$ -	$ -	$ -	$ -	$ -	Included in above	2026
6	Civils associated with bioreactor blowers	1	Allowance	$ 500,000	$ 500,000	$ 500,000	$ -	$ 747,500	Allowance	2026
7	New WAS pumps	1	No.	$ 115,000	$ 115,000	$ 100,000	$ 15,000	$ 171,925	Sized for 10 L/s (2 No. pumps, duty / standby) Costed using GHD cost database $100k allowance for pump station, 2 No. 2.4 kW (nominal) pumps ($7.5k each)	2026
8	New RAS pumps	1	No.	$ 130,000	$ 130,000	$ 100,000	$ 30,000	$ 194,350	Sized for 35 L/s (4 No. pumps, duty / standby) Costed using GHD cost database $100k allowance for pump station, 4 No. 2.4 kW (nominal) pumps ($7.5k each)	2026
9	New a-recycle pumps	1	No.	$ 160,000	$ 160,000	$ 100,000	$ 60,000	$ 239,200	Sized for 200 L/s (2 No. pumps, duty / standby) Costed using GHD cost database $100k allowance for pump station, 2 No. 11 kW (nominal) pumps ($30k each)	2026
10	Clarifiers	2	No.	$ 750,000	$ 1,500,000	$ 520,000	$ 230,000	$ 2,242,500	2 No. 20 m diameter clarifiers, 4.5 m depth Sized for duty / standby in ADWF and duty / duty in PWWF Costed using GHD cost database (includes $520k civil and $230k mech)	2026
11	Pipework modifications	1	Allowance	$ 900,000	$ 900,000	$ -	$ 900,000	$ 1,345,500	Allowance approximated as 10% of total cost. Allowance includes: Secondary plant feed pipework from distribution chamber to bioreactor Intermediate pipework from bioreactor to clarifier Secondary plant effluent pipework from clarifier to tertiary filtration RAS pipework A-recycle pipework WAS pipework to GDD Thickened sludge pipework from GDD to Aerobic Digester Digested sludge pipework from Aerobic Digester to BFP	2026
12	New sand filters (duplicate capacity)	1	No.	$ 1,000,000	$ 1,000,000	$ -	$ 1,000,000	$ 1,495,000	Double existing sand filter capacity (i.e. total capacity approximately 80 L/s normal, 160 L/s peak) New unit 40 L/s normal, 80 L/s peak Costed using GHD cost database based on peak flow	2026
13	New dewatering facility	1	No.		$ -	$ -	$ -	$ -	Allowance	2026
14	Odour management	1	No.	$ 400,000	$ 400,000	$ -	$ 400,000	$ 598,000	Allowance	2026
15	Aerobic digester aeration (blowers + diffusers)	1	No.	$ 630,000	$ 630,000	$ -	$ 630,000	$ 941,850	3 No. 55 kW (nominal) blowers operating duty / duty / standby Costed using GHD cost database 2,850 Nm3/hr diffusers ($520k) and 3 No. 55 kW (nominal) blowers ($70k each). Costs exclude civil and electrical.	2026
16	Civils associated with aerobic digester blowers	1	Allowance	$ 300,000	$ 300,000	$ 300,000	$ -	$ 448,500	Allowance	2026
17	New sludge import facility	1	Allowance	$ 25,000	$ 25,000	$ 12,500	$ 12,500	$ 37,375	Allowance	2026
18	New (increased capacity) alum storage and dosing	1	No.	$ 300,000	$ 300,000	$ -	$ 300,000	$ 448,500	Cost based on GHD previous project experience ($260k in 2016 for complete storage and dosing system for 550 L/d alum system). Cost scaled down up for 600 L/d and inflated to 2019 costs.	2026
19	New alkalinity storage and dosing	1	Allowance	$ 500,000	$ 500,000	$ -	$ -	$ 747,500	Allowance	2026
20	Modifications to recycled water draw off location	1	Allowance	$ 100,000	$ 100,000	$ -	$ 100,000	$ 149,500	Allowance	2026
21	Electrical, instrumentation and control allowance	15%	%	$ 12,420,000	$ 1,863,000	$ -	$ 1,863,000	$ 2,785,185	15% of direct costs	2026
22	Decomissioning of infrastructure	1	Allowance	$ 100,000	$ 100,000	$ -	$ -	$ 149,500	Decommission existing tertiary filtration balance tank	2026
23	Relocation of sludge drying beds	1	Allowance	$ -	$ -	$ -	$ -	$ -		2026
24	Commissioning	1	Allowance	$ 200,000	$ 200,000	$ -	$ -	$ 299,000		2026
25					$ -	$ -	$ -	$ -		
	Add new items above this line									
	TOTAL	2019 AUD			**$ 16,773,000**	**$ 6,407,500**	**$ 6,625,500**	**$ 25,075,635**		
		Incl engineering			$ 19,288,950					
					$ 19.3					

OPEX

	ITEM	Value	Start year	Comments
1	Operation and maintenance of new facilities, civils	$ 70,000	2027	Based on 1% (civils) of direct civil capital costs
2	Operation and maintenance of new facilities, M&E	$ 200,000	2027	Based on 3% (M&E) of direct M&E capital costs
3	Electricity	$ 320,000	2027	Bioreactor aeration: 2 No. 55 kW (nominal) blower operating 24 hrs per day = 964 MWh/yr WAS pump: 2 No. 2.4 kW (nominal) pump operating 6 hrs per day = 10.5 MWh/yr RAS pump: 2 No. 2.4 kW (nominal) pump operating 24 hrs per day = 42 MWh/yr a-recycle pump: 1 No. 11 kW (nominal) pump operating 24 hrs per day = 96.4 MWh/yr Aerobic digester aeration: 2 No. 55 kW (nominal) blower operating 24 hrs per day = 964 MWh/yr
4	Biosolids disposal	$ -	2027	Consistent across all sites
5	Chemical usage	$ -	2027	Consistent across all sites
6	Additional labour	$ -	2027	No additional labour required
7				
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	Add new items above this line			

Option 3b

4 stage Bardenpho in new tank (with MBR)

Project:	Atherton STP Planning Report
Client:	Tablelands Regional Council
Job No.:	42/20841
Prepared By:	GHD Pty Ltd
Date Prepared:	Jun-2019

CAPEX

	ITEM	Qty	Unit	Rate	Direct cost	Civil cost	M&E cost	Total cost	Comments	Timing
1	Preliminaries	10%	%	$ 13,200,000	$ 1,320,000	$ -	$ -	$ 1,973,400	10% of direct cost	2026
2	Inlet works (common costs)	1	Allowance	$ 750,000	$ 750,000	$ 375,000	$ 375,000	$ 1,121,250	Allowance	2026
3	Allowance for higher stringent screening (i.e. fine screens for MBR)	1	Allowance	$ 400,000	$ 400,000	$ -	$ 400,000	$ 598,000	Allowance	2026
4	New bioreactor tank	1	No.	$ 3,300,000	$ 3,300,000	$ 3,300,000	$ -	$ 4,933,500	New 2.5 ML tank (0.8 ML Anoxic Zone 1, 1 ML Aerobic Zone 1, 0.4 ML Anoxic Zone 2, 0.3 ML MBR Zone) 4.5 m depth, 14 m by 40 m tank Cost based on GHD previous project experience ($4m excl. blowers, diffusers and contingency for 5 ML aeration tanks in 2009). Cost scaled down for 2.5 ML and inflated to 2019 costs.	2026
5	Bioreactor aerobic zone (blowers + diffusers)	1	No.	$ 570,000	$ 570,000	$ -	$ 570,000	$ 852,150	3 No. 30 kW (nominal) blowers operating duty / duty / standby Costed using GHD cost database 1,900 Nm3/hr diffusers ($420k) and 3 No. 30 kW (nominal) blowers ($50k each). Costs exclude civil and electrical.	2026
6	MBR aeration (blowers)	1	No.	$ 140,000	$ 140,000	$ -	$ 140,000	$ 209,300	2 No. 55 kW (nominal) blowers operating duty / standby Costed using GHD cost database 2 No. 55 kW (nominal) blowers ($70k each). Costs exclude civil and electrical.	2026
7	Civils associated with bioreactor and MBR blowers	1	Allowance	$ 400,000	$ 400,000	$ 400,000	$ -	$ 598,000	Allowance	2026
8	New WAS pumps	1	No.	$ 110,000	$ 110,000	$ 100,000	$ 10,000	$ 164,450	Sized for 5 L/s (2 No. pumps, duty / standby) Costed using GHD cost database $100k allowance for pump station, 2 No. 1.8 kW (nominal) pumps ($5k each)	2026
9	New RAS pumps	1	No.	$ 115,000	$ 115,000	$ 100,000	$ 15,000	$ 171,925	Sized for 35 L/s (2 No. pumps, duty / standby) Costed using GHD cost database $100k allowance for pump station, 2 No. 2.4 kW (nominal) pumps ($7.5k each)	2026
10	New a-recycle pumps	1	No.	$ 160,000	$ 160,000	$ 100,000	$ 60,000	$ 239,200	Sized for 200 L/s (2 No. pumps, duty / standby) Costed using GHD cost database $100k allowance for pump station, 2 No. 11 kW (nominal) pumps ($30k each)	2026
11	Supply of membranes and ancillary equipment (permeate pumps, CIP, backwash pumps and tank)	1	No.	$ 2,200,000	$ 2,200,000	$ -	$ 2,200,000	$ 3,289,000	Sized for ADWF 3 ML/d and PWWF of 14.3 ML/d Cost based on GHD previous project experience ($1.8m for 2.7 ML/d in 2014). Cost scaled up for 3 ML and inflated to 2019 costs. Cost includes membranes, instrumetnation, CIP and backwash equipment.	2026
12	Pipework modifications	1	Allowance	$ 750,000	$ 750,000	$ -	$ 750,000	$ 1,121,250	Allowance approximated as 10% of total cost. Allowance includes: Secondary plant feed pipework from distribution chamber to bioreactor Secondary plant effluent pipework from MBR to effluent balance tank (upstream of CCT) RAS pipework A-recycle pipework WAS pipework to Aerobic Digester Thickened sludge pipework from GDD to Aerobic Digester Digested sludge pipework from Aerobic Digester to BFP	2026
13	New dewatering facility	1	No.		$ -	$ -	$ -	$ -	Allowance	2026
14	Odour management	1	No.	$ 400,000	$ 400,000	$ -	$ 400,000	$ 598,000	Allowance	2026
15	Aerobic digester aeration (blowers + diffusers)	1	No.	$ 630,000	$ 630,000	$ -	$ 630,000	$ 941,850	3 No. 55 kW (nominal) blowers operating duty / duty / standby Costed using GHD cost database 2,850 Nm3/hr diffusers ($520k) and 3 No. 55 kW (nominal) blowers ($70k each). Costs exclude civil and electrical.	2026
16	Civils associated with aerobic digester blowers	1	Allowance	$ 300,000	$ 300,000	$ 300,000	$ -	$ 448,500	Allowance	2026
17	New sludge import facility	1	Allowance	$ 25,000	$ 25,000	$ 12,500	$ 12,500	$ 37,375	Allowance	2026
18	New (increased capacity) alum storage and dosing	1	No.	$ 300,000	$ 300,000	$ -	$ 300,000	$ 448,500	Cost based on GHD previous project experience ($260k in 2016 for complete storage and dosing system for 550 L/d alum system). Cost scaled up for 600 L/d and inflated to 2019 costs.	2026
19	New alkalinity storage and dosing	1	Allowance	$ 500,000	$ 500,000	$ -	$ -	$ 747,500	Allowance	2026
20	Modifications to recycled water draw off location	1	Allowance	$ 100,000	$ 100,000	$ -	$ 100,000	$ 149,500	Allowance	2026
21	Electrical, instrumentation and control allowance	15%	%	$ 11,150,000	$ 1,672,500	$ -	$ 1,672,500	$ 2,500,388	15% of direct costs	2026
22	Decomissioning of infrastructure	1	Allowance	$ 100,000	$ 100,000	$ -	$ -	$ 149,500	Decommission existing tertiary filtration balance tank, sand filter feed pumps, sand filters and GDD	2026
23	Commissioning	1	Allowance	$ 200,000	$ 200,000	$ -	$ -	$ 299,000		2026
24					$ -	$ -	$ -	$ -		2033
25					$ -	$ -	$ -	$ -		2026
	Add new items above this line									
	TOTAL	2019 AUD			**$ 14,442,500**	**$ 4,687,500**	**$ 7,635,000**	**$ 21,591,538**		
		Incl engineering			$ 16,608,875					
					$ 16.6					

OPEX

	ITEM	Value	Start year	Comments
1	Operation and maintenance of new facilities, civils	$ 50,000	2027	Based on 1% (civils) of direct civil capital costs
2	Operation and maintenance of new facilities, M&E	$ 230,000	2027	Based on 3% (M&E) of direct M&E capital costs
3	Electricity	$ 350,000	2027	Bioreactor aeration: 2 No. 30 kW (nominal) blower operating 24 hrs per day = 525 MWh/yr MBR aeration: 1 No. 55 kW (nominal) blower operating 24 hrs per day = 482 MWh/yr MBR permeate, CIP and backwash infrastructure: allowance of 220 MWh/yr ($200 kWh/ML, conservative estimate from membrane supplier advice on previous GHD project) WAS pump: 1 No. 1.1 kW (nominal) pump operating 6 hrs per day = 2.4 MWh/yr RAS pump: 1 No. 2.4 kW (nominal) pump operating 24 hrs per day = 21 MWh/yr a-recycle pump: 1 No. 11 kW (nominal) pump operating 24 hrs per day = 96.4 MWh/yr Aerobic digester aeration: 2 No. 55 kW (nominal) blower operating 24 hrs per day = 964 MWh/yr
4	Biosolids disposal	$ -	2027	Consistent across all sites
5	Chemical usage	$ -	2027	Consistent across all sites
6	Additional labour	$ -	2027	No additional labour required
7	Savings from sand filter, sand filter feed pumps and GDD decomissioning (operation and maintenance)	-$ 31,600	2027	Reduced operation and maintenance of sand filter ($650k capex for 40 L/s average capacity unit), sand filter feed pumps (3 No. 11 kW (nominal) pumps, estimated capex $30k each), GDD (capex approximately $50k)
8	Replacement of membranes - 1st time	$ 500,000	2033	Once off cost
9	Replacement of membranes - 2nd time	$ 500,000	2040	Once off cost
10				
11				
12				
13				
14				
15				
	Add new items above this line			

Option 1a

New 4.5 ML SBR

Project:	Atherton STP Planning Report
Client:	Tablelands Regional Council
Job No.:	42/20841
Prepared By:	GHD Pty Ltd
Date Prepared:	Jun-2019

	Year ending	0 2019	1 2020	2 2021	3 2022	4 2023	5 2024	6 2025	7 2026	8 2027	9 2028	10 2029	11 2030	12 2031	13 2032	14 2033	15 2034	16 2035	17 2036	18 2037	19 2038	20 2039	21 2040	22 2041
	CAPEX	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 31,761,366	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
1	Preliminaries	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 4,160,878	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2	New inlet works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,475,489	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3	New SBR tank	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,033,322	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
4	SBR aeration (blowers + diffusers)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,986,991	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
5	Civils associated with SBR blowers	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 983,659	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
6	New WAS and RAS pump stations	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 511,503	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
7	Pipework modifications	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,770,586	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
8	Additional storage tank for tertiary filtration balance tank	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 491,830	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
9	New sand filters (duplicate capacity)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,967,318	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
10	New dewatering facility	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
11	Odour management	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 786,927	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
12	Aerobic digester aeration (blowers + diffusers)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,239,410	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
13	Civils associated with aerobic digester blowers	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 590,195	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
14	New sludge import facility	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 49,183	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
15	New (increased capacity) alum storage and dosing	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 590,195	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
16	New alkalinity storage and dosing	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 983,659	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
17	Modifications to recycled water draw off location	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 196,732	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
18	Electrical, instrumentation and control allowance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,550,025	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
19	Commissioning	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 393,464	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
20		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
21		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
22		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
23		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
24		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
25		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Add new items above this line																							

	OPEX	Scale for Growth?	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 780,084	$ 817,282	$ 856,206	$ 896,937	$ 939,557	$ 983,928	$ 1,030,345	$ 1,078,902	$ 1,129,694	$ 1,182,824	$ 1,237,684	$ 1,295,039	$ 1,355,004	$ 1,417,693	$ 1,483,229
1	Operation and maintenance of new facilities, civils	No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 95,800	$ 99,632	$ 103,617	$ 107,762	$ 112,072	$ 116,555	$ 121,217	$ 126,066	$ 131,109	$ 136,353	$ 141,807	$ 147,479	$ 153,379	$ 159,514	$ 165,894
2	Operation and maintenance of new facilities, M&E	No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 287,400	$ 298,895	$ 310,851	$ 323,285	$ 336,217	$ 349,665	$ 363,652	$ 378,198	$ 393,326	$ 409,059	$ 425,421	$ 442,438	$ 460,136	$ 478,541	$ 497,683
3	Electricity	Yes	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 396,885	$ 418,754	$ 441,738	$ 465,890	$ 491,268	$ 517,708	$ 545,476	$ 574,638	$ 605,260	$ 637,412	$ 670,455	$ 705,122	$ 741,489	$ 779,638	$ 819,652
4	Biosolids disposal	Yes	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
5	Chemical usage	Yes	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
6	Additional labour	No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
7		No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
8		No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
9		No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
10		No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
11		No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
12		Yes	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
13		Yes	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
14			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
15			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Add new items above this line																								

NPV		$ 48,245,775

Option 2b

4 stage Bardenpho in new tank (with clarifiers)

Project:	Atherton STP Planning Report
Client:	Tablelands Regional Council
Job No.:	42/20841
Prepared By:	GHD Pty Ltd
Date Prepared:	Jun-2019

	Year ending	0 2019	1 2020	2 2021	3 2022	4 2023	5 2024	6 2025	7 2026	8 2027	9 2028	10 2029	11 2030	12 2031	13 2032	14 2033	15 2034	16 2035	17 2036	18 2037	19 2038	20 2039	21 2040	22 2041
	CAPEX	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 32,997,325	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
1	Preliminaries	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 4,308,426	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2	New inlet works	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,475,489	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3	New bioreactor tank	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8,656,199	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
4	Bioreactor aerobic zone 1 (blowers + diffusers)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,396,796	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
5	Bioreactor aerobic zone 2 (blowers + diffusers)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
6	Civils associated with bioreactor blowers	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 983,659	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
7	New WAS pumps	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 226,242	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
8	New RAS pumps	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 255,751	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
9	New a-recycle pumps	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 314,771	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
10	Clarifiers	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,950,977	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
11	Pipework modifications	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,770,586	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
12	New sand filters (duplicate capacity)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,967,318	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
13	New dewatering facility	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
14	Odour management	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 786,927	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
15	Aerobic digester aeration (blowers + diffusers)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,239,410	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
16	Civils associated with aerobic digester blowers	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 590,195	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
17	New sludge import facility	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 49,183	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
18	New (increased capacity) alum storage and dosing	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 590,195	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
19	New alkalinity storage and dosing	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 983,659	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
20	Modifications to recycled water draw off location	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 196,732	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
21	Electrical, instrumentation and control allowance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,665,113	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
22	Decomissioning of infrastructure	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 196,732	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
23	Relocation of sludge drying beds	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
24	Commissioning	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 393,464	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
25		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Add new items above this line																							

	OPEX	Scale for Growth?	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 807,456	$ 846,368	$ 887,101	$ 929,738	$ 974,368	$ 1,020,833	$ 1,069,457	$ 1,120,338	$ 1,173,578	$ 1,229,284	$ 1,286,783	$ 1,346,915	$ 1,409,798	$ 1,475,557	$ 1,544,321
1	Operation and maintenance of new facilities, civils	No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 95,800	$ 99,632	$ 103,617	$ 107,762	$ 112,072	$ 116,555	$ 121,217	$ 126,066	$ 131,109	$ 136,353	$ 141,807	$ 147,479	$ 153,379	$ 159,514	$ 165,894
2	Operation and maintenance of new facilities, M&E	No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 273,714	$ 284,662	$ 296,049	$ 307,891	$ 320,206	$ 333,015	$ 346,335	$ 360,189	$ 374,596	$ 389,580	$ 405,163	$ 421,370	$ 438,225	$ 455,754	$ 473,984
3	Electricity	Yes	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 437,942	$ 462,074	$ 487,435	$ 514,086	$ 542,089	$ 571,263	$ 601,905	$ 634,083	$ 667,873	$ 703,351	$ 739,812	$ 778,065	$ 818,195	$ 860,290	$ 904,443
4	Biosolids disposal	Yes	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
5	Chemical usage	Yes	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
6	Additional labour	No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
7		No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
8		No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
9		No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
10		No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
11		No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
12		Yes	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
13		Yes	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
14			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
15			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Add new items above this line																								

NPV		$ 50,119,720

Option 3b

4 stage Bardenpho in new tank (with MBR)

Project:	Atherton STP Planning Report
Client:	Tablelands Regional Council
Job No.:	42/20841
Prepared By:	GHD Pty Ltd
Date Prepared:	Jun-2019

	Year ending	0 2019	1 2020	2 2021	3 2022	4 2023	5 2024	6 2025	7 2026	8 2027	9 2028	10 2029	11 2030	12 2031	13 2032	14 2033	15 2034	16 2035	17 2036	18 2037	19 2038	20 2039	21 2040	22 2041
	CAPEX	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 28,412,990	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
1	Preliminaries	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,596,860	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2	Inlet works (common costs)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,475,489	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3	Allowance for higher stringent screening (i.e. fine screens for	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 786,927	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
4	New bioreactor tank	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 6,492,149	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
5	Bioreactor aerobic zone (blowers + diffusers)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,121,371	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
6	MBR aeration (blowers)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 275,425	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
7	Civils associated with bioreactor and MBR blowers	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 786,927	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
8	New WAS pumps	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 216,405	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
9	New RAS pumps	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 226,242	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
10	New a-recycle pumps	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 314,771	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
11	Supply of membranes and ancillary equipment (permeate	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 4,328,100	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
12	Pipework modifications	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,475,489	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
13	New dewatering facility	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
14	Odour management	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 786,927	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
15	Aerobic digester aeration (blowers + diffusers)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,239,410	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
16	Civils associated with aerobic digester blowers	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 590,195	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
17	New sludge import facility	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 49,183	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
18	New (increased capacity) alum storage and dosing	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 590,195	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
19	New alkalinity storage and dosing	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 983,659	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
20	Modifications to recycled water draw off location	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 196,732	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
21	Electrical, instrumentation and control allowance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,290,339	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
22	Decomissioning of infrastructure	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 196,732	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
23	Commissioning	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 393,464	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
24		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
25		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Add new items above this line																							

	OPEX	Scale for Growth?	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 818,952	$ 858,944	$ 900,825	$ 944,682	$ 990,606	$ 1,038,424	$ 1,954,320	$ 1,140,883	$ 1,195,734	$ 1,253,149	$ 1,312,383	$ 1,374,350	$ 1,439,176	$ 2,646,372	$ 1,577,923
1	Operation and maintenance of new facilities, civils	No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 68,428	$ 71,166	$ 74,012	$ 76,973	$ 80,052	$ 83,254	$ 86,584	$ 90,047	$ 93,649	$ 97,395	$ 101,291	$ 105,342	$ 109,556	$ 113,938	$ 118,496
2	Operation and maintenance of new facilities, M&E	No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 314,771	$ 327,362	$ 340,456	$ 354,074	$ 368,237	$ 382,967	$ 398,286	$ 414,217	$ 430,786	$ 448,017	$ 465,938	$ 484,575	$ 503,958	$ 524,117	$ 545,081
3	Electricity	Yes	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 478,999	$ 505,393	$ 533,132	$ 562,281	$ 592,910	$ 624,819	$ 658,333	$ 693,528	$ 730,486	$ 769,290	$ 809,170	$ 851,009	$ 894,901	$ 940,942	$ 989,235
4	Biosolids disposal	Yes	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
5	Chemical usage	Yes	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
6	Additional labour	No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
7	Savings from sand filter, sand filter feed pumps and GDD decomissioning (operation and maintenance)	No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-$ 43,247	-$ 44,977	-$ 46,776	-$ 48,647	-$ 50,593	-$ 52,616	-$ 54,721	-$ 56,910	-$ 59,186	-$ 61,554	-$ 64,016	-$ 66,576	-$ 69,239	-$ 72,009	-$ 74,889	
8	Replacement of membranes - 1st time	No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 865,838								
9	Replacement of membranes - 2nd time	No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,139,384	
10		No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
11		No	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
12		Yes	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
13		Yes	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
14			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
15			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Add new items above this line																								

NPV		$ 47,859,711

Appendix L – Major Upgrade General Arrangement

N

PEAK WET WEATHER BY-PASS, IF PERMITTED IN NEW LICENSE

AREA 80 - IRRIGATION DAM FEED PUMPS

AREA 60 - CHLORINE CONTACT TANK (CCT)

AREA 500 - GENERAL PURPOSE PUMP STATION (GPPS)

AREA 50 - FILTERED EFFLUENT BALANCE TANK (FEBT)

PROPOSED NEW MBR EFFLUENT DISCHARGE

EXISTING CHLORINE CONTACT TANK

AREA 300 - CHEMICAL STORAGE

AREA 30 - EFFLUENT BALANCE TANK (EBT)

CHEMICAL STORAGE

EXISTING PUMP STATION

FILTER

PROPOSED NEW 4-STAGE BARDENPHO MBR (30m x 18.6)

PIPE D

FUTURE CHEMICAL - STORAGE / DOSING

AREA 40 MEDIA - FILTRATION

SLUDGE BUNKER

AREA 120 - SLUDGE DEWATERING

AREA 00 - SEPTAGE BALANCING

GENERATOR

WAS

PROPOSED NEW RAW SEWAGE FEED PIPE

AREA 20 SEQUENTIAL BATCH REACTORS (SBR)

ABANDONED TRICKLING FILTER

PIPE G

PIPE J

PIPE E2

PIPE C

RETROFIT TO AEROBIC DIGESTER

AREA 15 - FLOW SPLITTER

PIPE D

MAIN SWITCHROOM

AREA 100 PRE - THICKENING

PIPE E1

PIPE K

ABANDONED

GDD BUILDING

AEROBIC DIGESTER

AREA 110 AEROBIC DIGESTER

PIPE E1

PIPE G

AREA 600 SLUDGE DRYING BEDS

PIPE J

PIPE B

RM

EXISTING PLANT CONTROL BUILDING

EXISTING SLUDGE DRYING BEDS

EXISTING DRYING BEDS

ABANDONED

PIPE G

PIPE K

PROPOSED NEW INLET WORKS WITH FINE SCREEN 12m x 8m

PIPE J

PIPE H

EXISTING SLUDGE DRYING BEDS

INLET STRUCTURE

PIPE B

PIPE A

PIPE H

PIPE J

AREA 10 INLET WORKS

AREA 05 RV DISCHARGE

AREA 00 SEPTAGE RECEIVAL

LEGEND

- MAIN TREATMENT FLOW PATH
- TO BE RETAINED
- TO BE ABANDONED
- UPGRADED FLOW PATH

TREATMENT PLANT GENERAL ARRANGEMENT

SCALE 1:250

PRELIMINARY

No	Revision	Drawn	Job Manager	Project Director	Date
A	PRELIMINARY ISSUE	EDJ	GG*	TMB*	28.05.19

Note: * indicates signatures on original issue of drawing or last revision of drawing

0 2.5 5 7.5 10 12.5m

SCALE 1:250 AT ORIGINAL SIZE

TRC TABLELANDS REGIONAL COUNCIL

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DO NOT SCALE

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Drawn	E.JOHNSON	Designer	G.GADEMAN
Drafting Check		Design Check	
Approved (Project Director)			
Date			
Scale	AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	

Client: TABLELANDS REGIONAL COUNCIL

Project: ATHERTON STP PLANNING AND EVALUATION

Title: PROPOSED LONG-TERM UPGRADE GENERAL ARRANGEMENT

Original Size: A1

Drawing No: 42-20841-G003

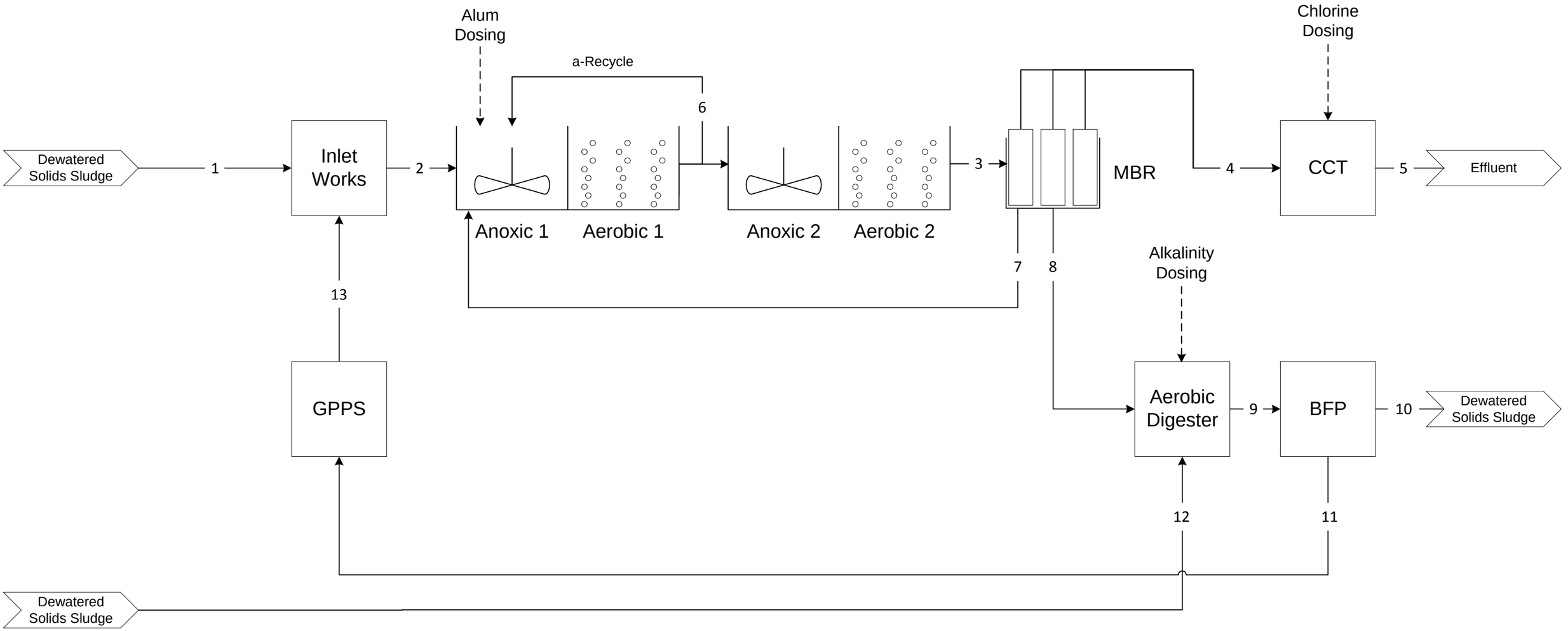
Rev: A

Plot Date: 28 May 2019 - 3:27 PM

Plotted by: Evan Johnson

Cad File No: G:\42\20841\CADD\Drawings\42-20841-G003.dwg

Appendix M – Major Upgrade PFD



Stream	Description	Typical Flowrate (L/s)	PDWF (L/s)	PWWF (L/s)
1	Influent	35	60	165
2	Bioreactor Feed	39.5		
3	MBR Feed	79.5		
4	Filtered Effluent	35		
5	Final Effluent	35		
6	a-Recycle	200		
7	Return Activated Sludge (RAS)	35		
8	Waste Activated Sludge (WAS)	5		
9	Digested Sludge	5		
10	Dewatered Biosolids	0.5		
11	BFP Filtrate	4.5		
12	Sludge Import	0.1		
13	BFP Filtrate	4.5		

GHD

Atherton STP Planning Study

Option 3: 4 Stage Bardenpho in new tank (with MBR)

Drawn By: R.Thomson

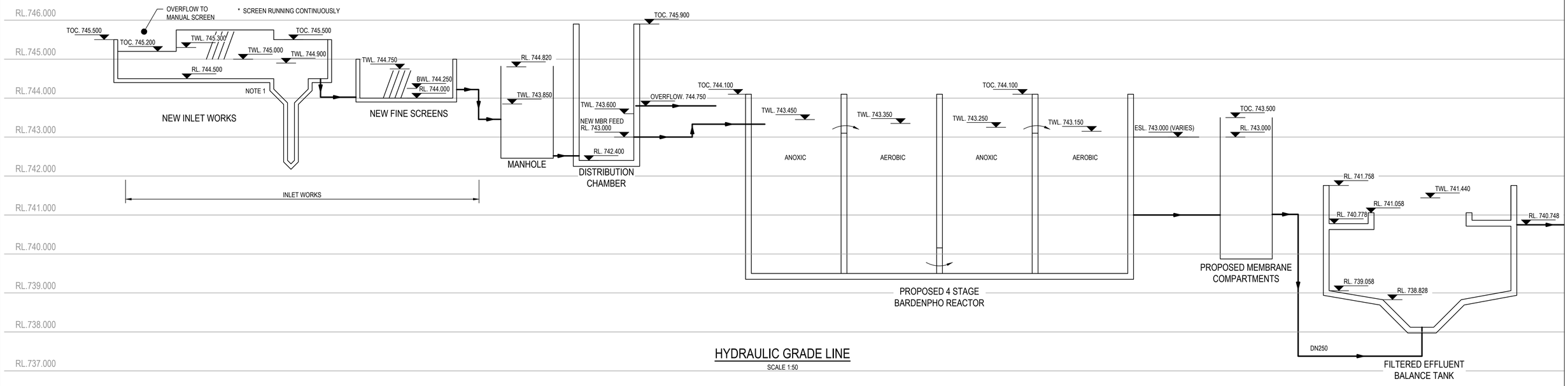
Checked By: J.Gallo

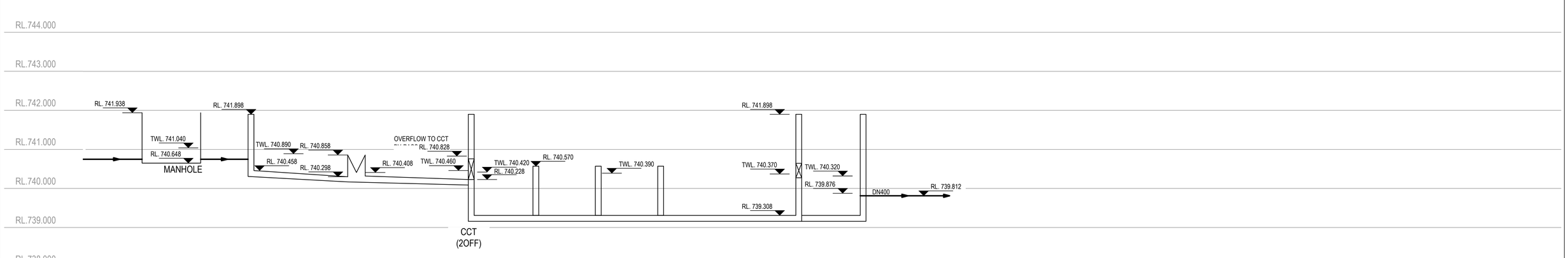
SIZE	DATE	DWG NO	REV
A3	22/05/2019	-	B

SCALE NTS

SHEET 1 OF 1

Appendix N – Major Upgrade Concept HGL





NOTE:

1. PROPOSE TO LOWER NEW INLET WORKS BY 1m TO PROVIDE MORE GRADE TO NEW GRAVITY PIPELINES.

CONCEPT GRADE LINE FOR PLANNING PURPOSES ONLY

PRELIMINARY

No	Revision	Drawn	Job Manager	Project Director	Date
A	PRELIMINARY ISSUE	EDJ	GG*	TMB*	28.05.19

Note: * indicates signatures on original issue of drawing or last revision of drawing

0 0.5 1.0 1.5 2.0 2.5m
SCALE 1:50 AT ORIGINAL SIZE

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Drawn	E.JOHNSON	Designer	G.GADEMAN
Drafting Check		Design Check	
Approved (Project Director)			
Date			
Scale	AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	

Client TABLELANDS REGIONAL COUNCIL
Project ATHERTON STP PLANNING AND EVALUATION
Title HYDRAULIC GRADE LINE - MBR ALTERNATIVE

Original Size **A1** Drawing No: **42-20841-W002** Rev: **A**

Plot Date: 28 May 2019 - 2:00 PM Plotted by: Evan Johnson Cad File No: G:\42\20841\CADD\Drawings\42-20841-W002.dwg

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4220841-53427/https://projects.ghd.com/oc/nqoc1/athertonstpplanningr/Delivery/Documents/4220841_REP_EE Planning Report.docx

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	G.Gademan K.Smalley	T.Boland J.Gallo	**T.Boland* **J.Gallo*	T.Boland	**T.Boland*	26/06/19

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