

**Report**

**Thrumster Wastewater  
Scheme**

Thrumster WWTP Concept  
Design Report

**Port Macquarie Hastings  
Council**

July 2024

Beca HunterH2O | ABN 16 602 201 552

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# Executive Summary

## Background

The Port Macquarie Hastings Council (PMHC) local government area is experiencing high population growth and the existing Port Macquarie Wastewater Treatment Plant does not have capacity to receive additional loads from the forecast growth.

PMHC has developed the Thrumster Wastewater Scheme to treat wastewater from the Port Macquarie area using two separate treatment plants which include a refurbished Port Macquarie WWTP and a new Thrumster WWTP.

## Purpose of this Report

This report and the accompanying drawings describe the concept design of the Thrumster WWTP. This concept design has been prepared to assist to PMHC and key stakeholders to review the proposed treatment plant design including a review of safety in design prior to PMHC inviting tenders for design development and construction of the works.

The concept design will inform the preparation of an Environmental Impact Statement for the project and will support PMHC in applying for approval for the works under Section 60 of the *Local Government Act 1993* by providing a description of the works.

## Basis of Design

The concept design for Thrumster WWTP has been developed following earlier project development and stakeholder consultation including Water Quality Objectives Modelling, Discharge Options Assessment and Treatment Plant Options Assessment.

Thrumster WWTP will provide treatment capacity for an equivalent population of 40,000 EP. The plant will treat flows from the Thrumster and Sancrox areas as well as a number of catchments currently serviced by the Port Macquarie WWTP. Provision is provided in the site arrangement and some aspects of the process design for the future expansion of the facility to treat the ultimate population of the catchment of 80,000 EP. The plant will include a facility for receiving tanker deliveries of septic effluent from septic tanks and treated leachate from the PMHC Waste Management Facility.

The Thrumster WWTP will be a modern treatment facility that will provide nutrient removal and membrane filtration prior to transferring treated water for discharge at the existing Port Macquarie WWTP discharge point to Kooloonbung Creek. Recycled Water treated with UV and chlorine disinfection and produced by the treatment plant will be supplied to the existing Thrumster Area 13 dual reticulation system.

Biosolids produced by the treatment process will be dewatered and transported for further treatment at the Cairncross organics recycling facility, owned by PMHC and operated by Remondis.

## Concept Overview

The treatment process at Thrumster WWTP includes:

- Inlet screening using 5mm band screens.
- Grit removal in a vortex style grit chamber.
- Fine screening using 2mm drum screens.
- Biological nutrient removal in an oxidation ditch bioreactor.
- Filtration using five membrane bioreactor (MBR) membrane trains.
- Treated effluent storage and discharge pumps to transfer treated effluent to Kooloonbung Creek.

The main treatment process provides full treatment for flows of up to 4 x ADWF. During significant wet weather events, storm flows greater than 4 x ADWF are diverted and contained in a 25 ML storm storage pond. These flows are returned to treatment when inlet flows subside. Controlled overflows from the storm storage pond are rare; modelling for the 40,000 EP design predicted four overflow events during the 12 year period modelled.

Filtered permeate from the MBR is further disinfected using UV and chlorine disinfection to produce recycled water that is supplied to Thrumster Area 13 and used on site for process water, hose reels and toilet flushing in the amenities building.

Waste activated sludge produced by the treatment process is dewatered using centrifuges and transferred to trucks for further treatment offsite.

A summary of the upgrade process units is provided in the table below.

*Table A – Overview of the Unit Operations of the Design*

Category	Design equipment
Inlet screening	Band screens – 5 mm 2 dimensional. Screening washing.
Storm storage pond	25 ML storm storage pond downstream of the inlet screens
Grit removal	Vortex grit trap. Grit classifier.
Fine screens	Inclined rotating drum screens – 2 mm.
Bioreactor	Biological phosphorus removal configured reactor. Anaerobic zones followed by an oxidation ditch.
Membrane filtration	Five MBR trains fitted with Memcor B50N submerged membranes
Treated water tank	Storage and discharge pumps to Kooloonbung Creek discharge point
Disinfection for Recycled Water	Activated Sludge Treatment + MBR filtration + UV + chlorination
Biosolids dewatering and handling	Two centrifuges that are to be out-loaded directly into truck for transport off-site
Chemical systems	<ul style="list-style-type: none"> <li>▪ Alum – for chemical phosphorus removal</li> <li>▪ Sodium hydroxide – for pH adjustment and odour management</li> <li>▪ Citric acid - for membrane recovery</li> <li>▪ Sodium hypochlorite – for membrane recovery and maintenance</li> <li>▪ Chlorine gas – for recycled water disinfection</li> <li>▪ Polymer – for sludge dewatering</li> </ul>

## Site Arrangement and Civil Works

The Thrumster WWTP will be constructed on an existing site owned by PMHC located adjacent to Partridge Creek in Thrumster. The treatment plant will be constructed on a raised earthen pad formed with imported fill to meet PMHC's flood protection requirements. The treatment facility has been located on the site with consideration to minimising the impact of construction on the surrounding wetland environment.

The site will be accessed via Fernbank Creek Road. A secondary access will also be established for use during flood conditions.



*Figure B – Overview of the Thrumster WWTP*

The site arrangement for the Thrumster WWTP has been developed based on experience with similar facilities. The site arrangement considerations include:

- Operator amenities building located at the entrance to the site to provide operators with good visibility of people accessing the site.
- Road design of the treatment plant separates heavy vehicle traffic from other operational areas. The heavy vehicle traffic route onsite provides access for chemical delivery, septage delivery, dewatered sludge removal and removal of screening and grit skips from the site.
- Providing a space allowance for a future expansion for construction of a future bioreactor, membrane tanks and additional treated water tank.
- Construction sequence considerations including space allowances for the construction batters required for excavation of the bioreactor.
- Multiple switch rooms located close to equipment with large power demands.
- Space allowances for pipe plant work, electrical conduits and other services.

## Electrical and Control

A new power supply to the plant will be established consisting of a new 11kV underground supply from the Essential Energy Distribution Network terminating at an Essential Energy switching station at the boundary of the site. PMHC will be supplied via a LV supply incomer, terminating on the Main Switch Board.

Backup onsite diesel generators are provided to automatically start and transfer power on loss of transformer supply.

Due to the size of the site, three switch rooms have been located on the site to service the power and control needs of local equipment. The switchrooms use a similar design and house the MCCs, VSDs, distribution boards and ancillary equipment.

## Cost Estimate

A risk-based engineering cost estimate for the project has been prepared and will be issued separately to this report.

# Glossary of Terms

Abbreviation	Definition
ADWF	Average Dry Weather Flow
AEP	Annual Exceedance Probability
AGWR	Australian Guidelines for Water Recycling
AHD	Australian Height Datum
AMF	Aerobic Mass Fraction
AUD	Australian Dollar
BNR	Biological Nutrient Removal
BOD	Biochemical Oxygen Demand
CFD	Computational Fluid Dynamics
CIP	Clean-In-Place
COD	Chemical Oxygen Demand
CSTR	Continuous Stirred Tank Reactor
DO	Dissolved Oxygen
DPE	Department of Planning and Environment
DPI	Department of Primary Industries
DS	Dry Solids
EP	Equivalent Person
EPA	Environmental Protection Authority
EPL	Environmental Protection Licence
FTE	Full-Time Equivalent
GIS	Geographical Information System
GWI	Groundwater Infiltration
HRT	Hydraulic Retention Time
IDEA	Intermittent Decanted Extended Aeration
LRV	Log Reduction Value
MBR	Membrane Bioreactor
MCA	Multi Criteria Analysis
ML	Mega Litre
ML/d	Mega Litre Per Day
MLSS	Mixed Liquor Suspended Solids
NH <sub>3</sub>	Ammonia
NPV	Net Present Value
NSW	New South Wales
NTU	Nephelometric Turbidity Unit
O <sub>2</sub>	Oxygen
OD	Oxidation Ditch
OLS	Obstacle Limitation Surfaces
ORP	Oxidation-Reduction Potential
OTR	Oxygen Transfer Rate
PDT	Pressure Decay Test
PDWF	Peak Dry Weather Flow
PFD	Process Flow Diagram
PFTF	Peak Full Treatment Flow
PIF	Peak Instantaneous Flow

PLC	Programmable Logic Controller
PMF	Probable Maximum Flood
PMHC	Port Macquarie Hastings Council
PM WWTP	Port Macquarie Wastewater Treatment Plant
PWA	Public Works Advisory
PWWF	Peak Wet Weather Flow
RAS	Return Activated Sludge
REF	Review of Environmental Factors
RFI	Request For Information
RII	Rainfall Intensity Increase
SAE	Standard Aeration Efficiency
SBR	Sequencing Batch Reactor
SCADA	Supervisory Control and Data Acquisition
SLR	Sea Level Rise
SOER	Specific Odour Emission Rate
SOTE	Standard Oxygen Transfer Efficiency
SOTR	Standard Oxygen Transfer Rate
SPS	Sewage Pumping Station
SRT	Sludge Residence Time
STEL	Short Term Exposure Limit
STP	Sewage Treatment Plant
SVI	Sludge Volume Index
TKN	Total Kjeldahl Nitrogen
TMP	Transmembrane Pressure
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
TWA	Time Weighted Average
TWL	Top Water Level
UV	Ultraviolet
VSS	Volatile Suspended Solids
WAS	Waste Activated Sludge
WHS	Work Health and Safety
WWTP	Wastewater Treatment Plant

# 1 Introduction

## 1.1 Background

The Port Macquarie region is experiencing high population growth. As a result, the Port Macquarie Wastewater Treatment Plant (PMWWTP) is nearing capacity and additional treatment capacity is required.

Port Macquarie Hastings Council (PMHC) has been developing the provision to construct the Thrumster Wastewater Treatment Plant (TWWTP) since the early 2000s to service this additional growth. An overview of the Thrumster Wastewater Scheme is shown below. The proposed Thrumster Wastewater Treatment Plant provides a treatment facility that serves the areas of greater Sancrox, Fernbank Creek, Thrumster as well as a number of existing catchments areas currently serviced by the PMWWTP.

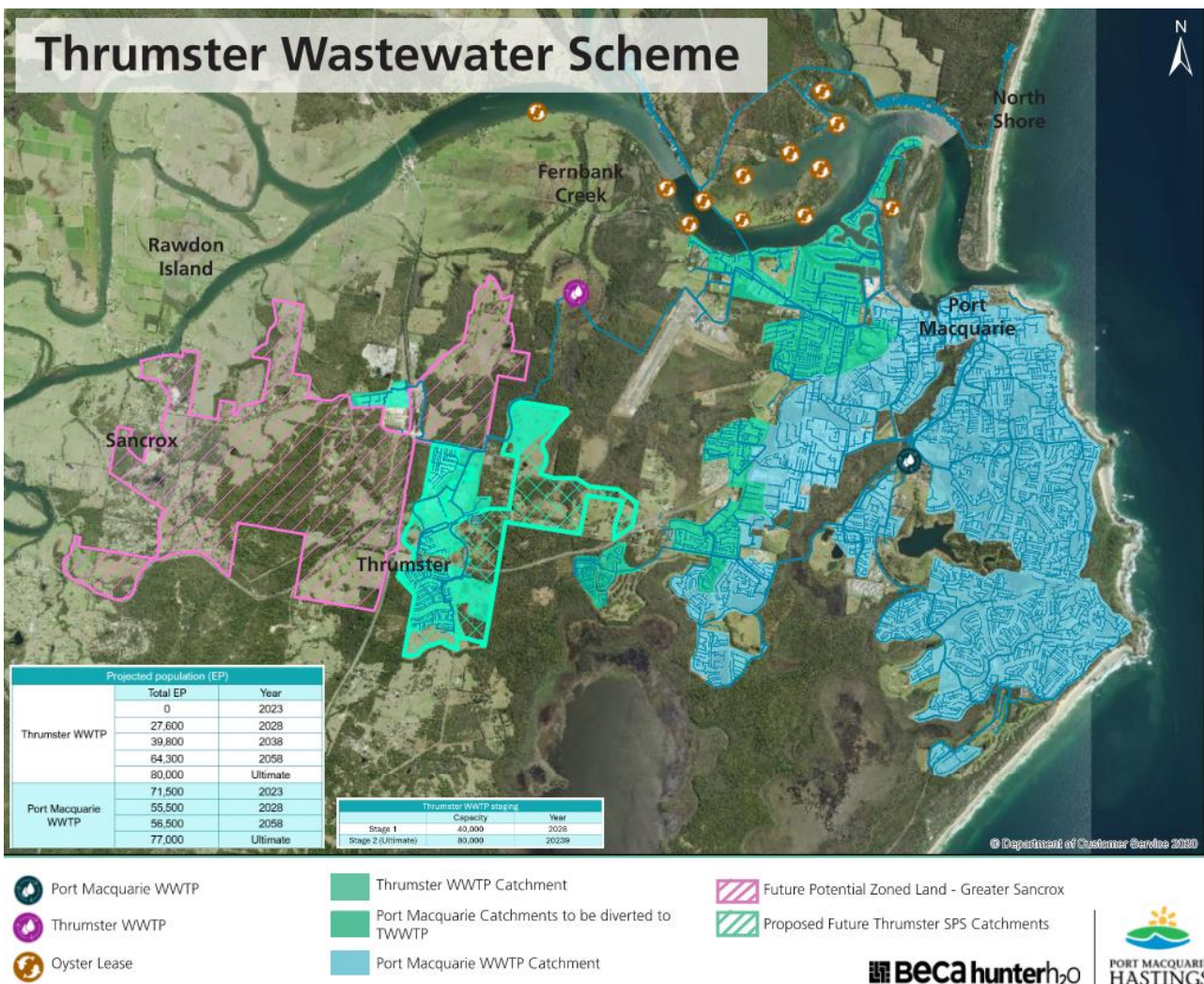


Figure 1-1: Overview of the Thrumster Wastewater Scheme

## 1.2 Previous Studies

Key previous studies which influence development of this report are presented in Table 1-1.

Table 1-1: Population Projections for Thrumster WWTP

	Author	Report Title	Key Outcome
1	CH2M Hill	Thrumster WWTP Concept Design, 2005	30,000 EP MBR Selected as the preferred upgrade strategy. Discharge nominated to Kooloonbung Creek.
2	Beca HunterH2O	Peer Review Report, 2023	Stage 1 Capacity of 52,000 EP and ultimate of 78,000 EP. Redirections of west sections of PM WWTP catchment.
3	Intrawater	Water Quality Objectives Modelling, 2023	Water quality associated with discharges to Hastings River provide only slight increase in nutrients. Total nitrogen and total phosphorous adopted was equal to 6 and 1 mg/L respectively.
4	Ramboll	Ecological Risk Assessment, 2023	Several risks were identified: <ul style="list-style-type: none"> <li>▪ Flood.</li> <li>▪ Vegetation: 18 Plant Community Types associated with threatened ecological communities.</li> <li>▪ Fauna: 7 threatened species within the project area.</li> <li>▪ Other habitat, coastal wetland, heritage, social, community and regulatory risks identified.</li> </ul>
5	Beca HunterH2O	Port Macquarie WWTP Capacity Assessment, 2022	PM WWTP is currently at capacity and has a high amount of groundwater infiltration. Short term upgrades are required to manage growth until 2027.
6	Port Macquarie Hastings Council	Site Location Option Evaluation Report, 2022	The Sand Plains site in Fernbank Creek was selected as the preferred site. It has three key risks being; flood prone area, poor access and exposure of acid sulphate soils.
7	The Water and Carbon Group	Option 1 Discharge to Partridge Creek via Wetland – Environmental Reuse Feasibility and Concept Design Report	Proposed that a 46 Ha modified natural wetland, constructed adjacent to the WWTP could provide polishing to an average TN of 1.7 mg/L at 12 ML/d flow and 3 days retention time. Further optimisation of the wetland design will be required to pursue this option.
8	Beca HunterH2O	Discharge Options Assessment, 2022	Considered alternative locations for the discharge of treated effluent from TWWTP. Two key options were considered in detail Partridge Creek via a polishing wetland, or Kooloonbung Creek were the most viable options. Pumped discharge of treated effluent to Kooloonbung Creek has been adopted as the preferred discharge location. The Storm storage pond at Thrumster WWTP will also include an emergency discharge release.
9	Beca HunterH2O	Treatment Plant Options Assessment, 2022	Considered a range of treatment plant processes for construction of Thrumster Wastewater Treatment Plant. Three configurations were developed: <ul style="list-style-type: none"> <li>▪ Intermittent plant with tertiary filtration and chlorine disinfection</li> <li>▪ Continuous plant with clarifiers, tertiary filtration and chlorine disinfection</li> <li>▪ Continuous plant with submerged membranes (MBR) and chlorine disinfection</li> </ul> Based on the multi-criteria analysis of options, a continuous plant with submerged membranes (MBR) was selected as the preferred option.

The current Thrumster Wastewater Scheme is being progressed to achieve completion by the end of 2027. The concept design for TWWTP has been developed based on the following key decisions:

- The treatment plant options assessment confirmed that the preferred treatment process is a continuous bioreactor with submerged membrane separation (MBR) and chlorine disinfection.
- The discharge options assessment and series of stakeholder workshops confirmed Kooloonbung Creek to be the discharge location for effluent produced at TWWTP.

Figure 1-2 provides context of where this report sits in the overall project.

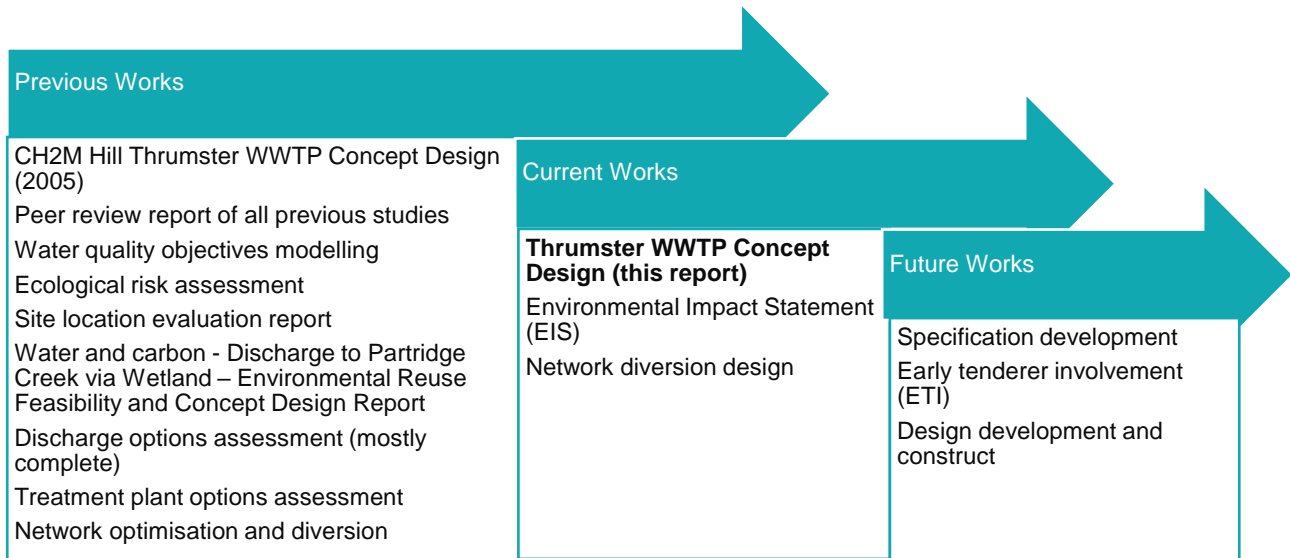


Figure 1-2: Previous, Current and Future Works for the Thrumster Wastewater Scheme

### 1.3 Consultation and Approval Requirements

In April 2023, the Thrumster Wastewater Scheme was nominated state significant infrastructure (SSI), which requires the project to be assessed under the SSI framework, by the planning section of the NSW Department of Planning, Housing and Infrastructure (formally part of the Department of Planning and Environment (DPE)).

The project also requires approval for development under section 60 of the *Local Government Act*.

Final determination of the SSI application will be provided by the Minister of Planning and section 60 approval will be provided by the Minister of Water (or their delegate).

### 1.4 Project Objectives

The key objectives for the Thrumster Wastewater Scheme are:

1. To construct and commission the Thrumster Wastewater Scheme upgrade by early 2028 to address the existing capacity constraints and operational risk faced by PMHC.
2. To provide treatment capacity to allow for future growth and reduce the load on the PMWWTP to minimise loss of sewage network containment, environmental contamination and allow important preventative maintenance to occur.
3. To promote PMHC as a regional leader through the project delivery and improve the standard of community and environmental outcomes in areas including:
  - Network odour and loss of containment events in the sewerage network impacting the community.
  - Energy efficiency and power usage associated with sewer collection, transfer and treatment.

- Providing high quality recycled water for third pipe scheme including potential future industrial users.
- Enable PMHC to implement biosolids resource recovery processes and manage biosolids stabilisation offsite as part of PMHC's broader centralised organics recycling strategy.

4. To provide a reliable and resilient sewage scheme.

## 1.5 Purpose of this Report

This report and the accompanying drawings describe the concept design of the Thrumster WWTP. This report has been prepared to assist to PMHC and key stakeholders to review the proposed treatment plant design and support the review of safety in design prior to PMHC inviting tenders for design development and construction of the works.

The concept design will inform the preparation of an Environmental Impact Statement for the project and will support PMHC in applying for approval for the works under Section 60 of the *Local Government Act 1993* by providing a description of the works.

## 2 Basis of Design

This section documents the key parameters used to develop the design of the Thrumster WWTP. The criteria have been developed during the project as summarised in the following reports:

- Peer Review Report (Beca HunterH2O, 2023).
- Port Macquarie Wastewater Treatment Plant Capacity Assessment (Beca HunterH2O, 2023).
- Thrumster WWTP Treatment Options Assessment (Beca HunterH2O, 2023).

### 2.1 Population and Growth Projections

Beca HunterH2O undertook a review of the equivalent population (EP) projections for the Port Macquarie and Thrumster development areas in 2022 and subsequently a review of the diversion areas in the network optimisation strategy in 2023. The review included consideration of current land zonings, development areas and historical population growth.

Thrumster WWTP will service the areas of Sancrox, Thrumster and catchment diversions from the Port Macquarie Wastewater Scheme (Beca HunterH2O, 2023). Thrumster WWTP is planned to be commissioned in 2027. The initial connection loads are shown in the table below.

The ultimate EP for the catchments to be serviced by the Thrumster WWTP is projected to grow to an ultimate population of approximately 80,700 by 2071 assuming complete development of the nominated areas. This is an increase from the 78,000 adopted during the options assessment phase due to further refinements in the Port Macquarie Sewer Network Optimisation Diversion Strategy (Beca HunterH2O, 2024).

In reviewing the projections for catchment growth, it is noted that approximately 30,000 of the 80,000 EP ultimate loading is from non-residential development. The allowance for non-residential developments has been estimated based on WSAA guidelines and is considered to be conservative. For this catchment, PMHC anticipate that non-residential development is likely to be light industrial developments such as warehouses that will contribute lower loads to sewer than the non-residential allowances in Table 2-1. This lower contribution from non-residential development extends the design horizon of the wastewater treatment plant capacity as the lower non-residential contribution provides headspace that can be used by residential population growth. The total catchment growth rate is therefore expected to be lower than shown in Table 2-1 and it will take longer to reach the total EP projects than the years shown in the table.

*Table 2-1: EP Projections and Development Area Loads for Thrumster WWTP*

Development Area	Existing	2027	2039	2049	Ultimate	Source
Thrumster Residential	3,700	5,700	12,000	16,300	16,300	Based on peer review study (Beca HunterH2O, 2022)
Thrumster Non-Residential	2,800	5,400	5,400	5,400	5,400	
Sancrox Residential	0	0	0	1,000	13,000	
Sancrox Non-Residential	0	700	7,300	13,000	25,700	
Port Macquarie WWTP Diversions	13,100	14,500	16,100	17,900	20,300	Updated based on sewer network optimisation study.
<i>Total Residential</i>	<i>16,800</i>	<i>20,200</i>	<i>28,100</i>	<i>35,200</i>	<i>49,600</i>	
<i>Total Non-Residential</i>	<i>2,800</i>	<i>6,100</i>	<i>12,700</i>	<i>18,400</i>	<i>31,100</i>	
<b>Total</b>	<b>19,600</b>	<b>26,300</b>	<b>40,800</b>	<b>53,600</b>	<b>80,700</b>	

## 2.2 Design Population and Staging

Thrumster WWTP will provide treatment capacity for an equivalent population of 40,000 EP. Based on the EP projections in Table 2-1 the 40,000 EP capacity may be reached at some time beyond 2039 depending on residential population growth and the type of non-residential development that occurs in the catchment.

Thrumster WWTP has been designed to be expandable in the future to an ultimate capacity of 80,000 EP. Development of the site arrangement considers the space requirements upgrade. Consideration for this future upgrade has also been given as part of the hydraulic design, site layout and process sizing of some treatment units that would be difficult to upgrade at a later date, such as the civil structures for the inlet works screening and grit removal facilities. Further detail on the staging allowances can be found in Appendix B.

Table 2-2: Design Population and Staging

Stage	Plant Design Capacity	Plant Design Flow	Completion Year	Design Horizon
Thrumster WWTP Stage 1 (This Design)	40,000 EP	9.2 ML/d 106 L/s	2027	Beyond 2039
Stage 2 (Ultimate)	80,000 EP	18.4 ML/d 213 L/s	2039 or later	2071

## 2.3 Design Flows

This section summarises design flows for the following parameters that are used for sizing wastewater infrastructure:

- Average Dry Weather Flow (ADWF).
- Peak Dry Weather Flow (PDWF).
- Peak Full Treatment Flow (PFTF).
- Peak Instantaneous Flow (PIF).

### 2.3.1 Hydraulic Contribution and Average Dry Weather Flow

The hydraulic contribution has been discussed in several reports to date:

- The Peer Review and Gap Analysis Report (Beca HunterH2O, 2023).
- The Port Macquarie WWTP Capacity Assessment (Beca HunterH2O, 2023).
- The Thrumster Wastewater Scheme Network Diversions Optimisation Strategy (Beca HunterH2O, 2024).

The outcomes of the peer review and capacity assessment both identified that the current domestic flow loading was approximately 230 L/EP/d but due to acceptance of low flow-high strength leachate an actual flow loading of 200 L/EP/d was identified. This does not apply to Thrumster WWTP and leachate will be pre-treated at the Cairncross facility (which is an offsite facility away from Thrumster).

Both assessments calculated the flow loading using 24-hour flow weighted composite data between 2012 and 2016. Data between 2016 and 2022 was not measured. Twenty-five sewage samples were collected between 9 November 2022 and 1 May 2023. Most samples were rainfall affected; however analysis indicates that the flow loading could be between 220 and 250 L/EP/d, most likely on the lower end of this, which correlates to the previous flow loading calculation. Further raw sewage sampling during non-rainfall periods is recommended.

Recent assessment of the individual pump catchments for the network diversion optimisation study identified a ADWF flow loading of approximately 210 L/EP/d. Which aligns with the SEQ methodology for “baseline” calculations for existing conventional sewer (SEQ, 2020).

To align with the data reviewed during the peer review and Port Macquarie WWTP capacity assessment, a flow loading of 230 L/EP/d has been adopted as basis of design. This provides PMHC with some flexibility within the network upgrades. For the design population of 40,000 EP, this equates to and ADWF of 9 ML/day.

### 2.3.2 Peak Dry Weather Flow

PDWF is usually displayed as a PDWF to ADWF ratio. It tends to decrease as the population and area of the catchment increases. NSW Public Works developed a formula which considers this aspect and uses it to estimate the dry weather peaking factors. The NSW Public Works formula is provided in Equation ( 1 ):

$$r = (1.74 + \frac{56}{ET^{0.4}})^{0.5} \text{ for } ET > 30 \quad (1)$$

Where:

- r = PDWF / ADWF.
- ET = Equivalent Tenement.
- Adopted EP per ET is 3.34 (Beca HunterH2O, 2023).

For the design population of 40,000 EP, Equation (1) estimates the PDWF = 1.75 ADWF.

Additional assessment of the flows into the Port Macquarie WWTP were undertaken during the Port Macquarie WWTP Capacity Assessment (Beca HunterH2O, 2023). The data indicates a current peak dry weather flow is between 1.75 and 2x ADWF.

A PDWF factor based on 2x ADWF and will be adopted as the basis of design.

### 2.3.3 Peak Full Treatment Flow

PFTF is the maximum flow that receives treatment through the bioreactor process without significantly compromising effluent quality. The basis of design adopts a PFTF of 4x ADWF. This was agreed during the options assessment phase to reduce the storm storage pond size and reduce emergency overflow frequency.

### 2.3.4 Peak Instantaneous Flow

PIF is the highest instantaneous flow that can arrive at the treatment plant and is often higher than PWWF expressed as an instantaneous value. For Thrumster WWTP, all inflow will be pumped and therefore, this is set by the addition of all maximum pumped flowrates.

Based on the network optimisation strategy, a PIF of 8x ADWF has been adopted.

### 2.3.5 Flow Summary

A summary of flows used as the basis for design are presented in Table 2-3.

Table 2-3: Flow Summary.

Parameters	Units	Flow Factor (x ADWF)	Commissioning Flows	Stage 1 Forecasted Flows	Stage 2 Forecasted Flows
Projected EP	EP	-	26,300	40,000	80,000
Flow Loading	L/EP/d		230	230	230
ADWF	ML/d		6.0	9.2	18.4
PDWF	ML/d	2x	12.0	18.4	36.8
PFTF	ML/d	4x	24.2	36.8	73.6
PFTF	L/s	4x	280	426	852
PIF	L/s	8x	560	852	1704

## 2.4 Storm Storage Pond

Flows above PFTF will be stored in a storm storage pond and returned to the process for full treatment through the MBR during periods of lower inflow.

The storm storage pond has been sized using historical inflows from the Port Macquarie WWTP scaled to the ultimate design population of Thrumster WWTP of 80,000 EP. A very limited data set of 12 years has been used in daily time step spill and draw model, mimicking the operation of the storm storage pond.

This assessment was undertaken using daily total flow data only as long-term instantaneous sewage flow was not available. Therefore, the predictions will not be conservative and are subject to some error. It is possible this analysis may mask short term peak flows associated with intense storm events.

Table 2-4 presents the modelled emergency overflow events over the 12 years of data.

*Table 2-4: Thrumster WWTP Storm Pond Size and Predicted Events*

Event Date	Stage 1	Ultimate
Population	40,000 EP	80,000 EP
Storm Storage Pond Volume	25 ML	25 ML
Number of Events in 12 years (Limited by Data)	4	6

## 2.5 Organic and Nutrient Loading

Raw sewage loadings are key for sizing a wastewater treatment plant. TWWTP is expected to have a mostly domestic catchment with a small industrial load contribution (mainly from warehouses). If heavy industry occurs in the catchment (i.e. food processing, etc) then the impact of this additional load and onsite treatment at the industry will need to be adopted following PMHC's trade waste requirements.

### 2.5.1 Raw Sewage Concentrations

The raw sewage concentrations presented below considers sampling data collected from Port Macquarie WWTP:

- January 2012 to December 2016,
- November 2022 to May 2023, as well as
- Typical domestic quality adopted for similar catchments.

#### *Sewage Sampling Results (January 2012 to December 2016)*

Sewage quality has been historically measured at Port Macquarie WWTP from 2012 to 2016 at a weekly frequency. There were a total 256 samples collected with 107 twenty-four composite samples. Presented in Table 2-5 is a summary of dry weather sewage data only. Wet weather impacted data was removed if rainfall was greater than 2 mm on a day or 7-day rolling total was greater than 10mm.

*Table 2-5: Influent Sewage Monitoring Data (Dry Weather) (January 2012 to December 2016)*

Parameter	Units	Data points	Median Concentration
Chemical Oxygen Demand (COD)	mg/L	16	676*
Biochemical Oxygen Demand (BOD)	mg/L	132	270
Total Nitrogen (TN) as N	mg/L	132	57
Ammonia as N	mg/L	132	41
Total Phosphorus (TP) as P	mg/L	132	10
Total Suspended Solids (TSS)	mg/L	132	282
pH	pH Units	132	7.5
Alkalinity	mg CaCO <sub>3</sub> /L	132	253

\*Data is limited to 16 samples and not considered representative of the incoming catchment. A value of 600 mgCOD/L is typical for this type of catchment based on COD/BOD ratio of 2.2. All other data is based on 132 samples and is considered sufficient.

In general, the raw sewage results are considered typical domestic sewage concentrations consistent with other regional NSW catchments.

### *Sewage Sampling Results (November 2022 to May 2023)*

Twenty-five samples were collected from the inlet works at Port Macquarie WWTP between 9 November 2022 and 1 May 2023. This period was impacted by higher than average rainfall (leading to elevated inflows) and return streams from sludge lagoon dewatering. The collected samples were analysed for a range of analytes, with a summary of key parameters presented in Table 2-6.

*Table 2-6: Influent Sewage Monitoring Data (All Weather) (November 2022 to May 2023)*

Parameter	Units	Data points	Median Concentration	Median Concentration (Rainfall Adjusted)
Chemical Oxygen Demand (COD)	mg/L	25	500	575
Total Nitrogen (TN) as N	mg/L	25	48	55
Total Suspended Solids (TSS)	mg/L	25	260	299

The average inflow for the testing period equates to 19 ML/day, whilst the effluent flow for the same period is in the order of 16 ML/day. Although evaporation could account for some of the discrepancy, it cannot explain it in full (especially given the quantity of rainfall that would contribute to outflows during the period).

Considering the effluent flows and 15% reduction to allow for dry weather, the raw sewage concentrations can be considered domestic, aligning with the 2012 to 2016 data and typical domestic sewage quality.

Given the heavy influence of rainfall and dewatering recycle streams on the sampling, further sampling during non-rainfall effected periods avoiding sludge lagoon dewatering is recommended.

### *Adopted Raw Sewage Concentrations*

Typical domestic loadings (g/EP/d) can be applied to the population projections as the basis of design. These are shown in Table 2-7. The calculated concentrations adopt the 230 L/EP/d flow loading. The calculated concentration values align with data assessed above and therefore have been adopted for the basis of design.

*Table 2-7: Typical Domestic Raw Sewage Loading Summary.*

Pollutant	Typical Domestic Loading (g/EP/day)	Median Loading (g/EP/d)	Concentration at 230 L/EP/d (mg/L)
Chemical Oxygen Demand (COD)	120-130	130	565
Biochemical Oxygen Demand (BOD)	60-70	65	283
Total Suspended Solids (TSS)	60-70	65	283
Total Kjeldahl Nitrogen (TKN)	12-14	13	57
Total Phosphorus (TP)	1.8-2.5	2.2	9.6
Alkalinity	60-70	65	283

For the design of key process units such as the bioreactor aeration, a maximum and minimum nutrient and organic peaking factor is required. Maximum and minimum peaking factors of 1.8 and 0.6 have been adopted. These values align to other similar plant designs.

## 2.5.2 Raw Sewage Loadings

Table 2-8 provides the raw sewage loadings associated with commissioning, this design (Stage 1) and the ultimate loading for the catchment (Stage 2). These were calculated by multiplying the domestic loadings in Table 2-7 by the population. These are the yearly daily average loads.

*Table 2-8: Average Daily Raw Sewage Loading Summary at Key Design Stages*

Pollutant	2027 Commissioning Load (kg/d)	2039 Stage 1 Design Load (kg/d)	2071 Stage 2 Design Load (kg/d)
Chemical Oxygen Demand (COD)	3,400	5200	10,400
Biochemical Oxygen Demand (BOD)	1,700	2600	5,200
Total Suspended Solids (TSS)	1,700	2600	5,200
Total Kjeldahl Nitrogen (TKN)	340	520	1,040
Total Phosphorus (TP)	60	90	180
Alkalinity	1,700	2600	5,200

## 2.5.3 Raw Sewage Fractions

Modern design practices and process modelling requires sewage characteristics to be broken into fractions and ratios. Some of these can be measured, others cannot. Since domestic sewage fractions are well known typical values for similar catchments can be adopted when no data is available.

Table 2-9 presents the raw sewage fractions for similar catchments and are adopted for the design.

*Table 2-9: Adopted Raw Sewage Fractions*

Characteristic	Known As	Similar Catchments
<b>Solids Ratios</b>		
Particulate Non-Biodegradable COD: COD	fup	0.20
Volatile SS: Total SS(1)	fxv	0.90
<b>Soluble Ratios</b>		
Soluble Non-Biodegradable COD: COD	fus	0.07
Soluble Biodegradable COD: Biodegradable COD	fbs	0.20
Soluble Non-Biodegradable TKN: TKN	fnus	0.02
Ammonia Nitrogen: TKN	fna	0.667

## 2.6 Leachate Volume and Quality

The Port Macquarie WWTP receives several leachate deliveries per day from the PMHC Waste Management Facility (Leachate PMHC) and Remondis (Leachate Remondis). Eleven weeks of leachate influent flow between February and August 2022 was analysed and is summarised in Table 2-10. The maximum leachate influent flow shown in Table 2-10 has been adopted for the TWWTP concept design.

*Table 2-10: Leachate Influent Flow Analysis*

Percentile	Units	Leachate PMHC	Leachate Remondis
Median	kL/d	32	44
90%ile	kL/d	64	56
Max	kL/d	87	56

The PMHC tip and Remondis leachate water quality from 10 samples taken during the same time period were analysed. The testing results indicate that the leachate concentrations from both streams are reasonably stable. However, PMHC tip contributes more to the Total Kjeldahl Nitrogen (TKN) load.

PMHC are in the process of implementing a leachate treatment plant for the management of leachate from both sites. The average leachate concentrations have been taken from PMHC's trade waste policy. The treated leachate concentrations are presented with the loads in Table 2-11 and are adopted for the TWWTP concept design.

*Table 2-11: Calculated Leachate Concentrations and Loads*

Parameter	Leachate PMHC Average Concentration	Leachate Remondis Average Concentration	Treated Leachate Average Concentration (Adopted)	Combined Median Leachate Load (Adopted)
Units	(mg/L)	(mg/L)	(mg/L)	(kg/d)
TSS	26	178	300	23
Ammonia	1827	316	50	4
TKN	1937	406	100	8
COD	5466	3540	900	68
BOD	214	350	300	23

The maximum leachate influent flow shown in Table 2-10 has been adopted.

## 2.7 Septic Effluent and Septage Volume and Quality

Waste tanker receipt (septic effluent and septage) can be highly variable and difficult to predict. Due to lack of waste tanker delivery sampling data, typical septic effluent concentration values adopted in the design are provided in Table 2-12. It has been assumed that TWWTP will receive 500 kL of septic effluent and septage waste per week.

*Table 2-12: Thrumster WWTP Tanker Waste Design Basis*

Parameter	Adopted Concentrations (mg/L)	Additional Load (kg/day)
Chemical Oxygen Demand (COD)	5600	400
Biological Oxygen Demand (BOD)	1600	114
Total Suspended Solids (TSS)	2,800	200
Total Kjeldahl Nitrogen (TKN)	216	15
Total Phosphorus (TP)	43	3

## 2.8 Effluent Quality Requirements

The basis of design adopts nutrient and pathogen targets for the treatment plant.

### 2.8.1 Adopted Discharge Quality – Design Requirements

Effluent quality objectives set the level of treatment required and influences the treatment technology selection. The basis of design adopts effluent quality used in the water quality objectives modelling undertaken in 2023, which were derived from the sensitive waters guidelines and other similar plants recently built or upgraded in NSW. Based on the predicted discharge to Kooloonbung Creek, the water quality objectives modelling predicted a slight increase in nitrogen concentrations in Kooloonbung Creek and negligible impact to the Hastings River (Intrawater Pty Ltd, 14 March 2023). The target criteria are presented in Table 2-13.

Since there is not yet a licence this a guide for the treatment plant concept design, further assessment of the potential water quality impacts will be undertaken and presented as part of the EIS. Based on similar recent applications, the adoption of 100%ile limits is likely. The limits are applied to the plant PFTF only (i.e. for flows up to 4x ADWF). Suitable limits for each percentile range have been presented in Table 2-13.

*Table 2-13: Adopted Effluent Quality Objective Criteria (Apply to PFTF Only)*

Parameter*	Units	90%ile	100%ile
Biological Oxygen Demand (BOD)	mg/L	10	15
Total Suspended Solids (TSS)	mg/L	15	20
Ammonia (NH <sub>4</sub> )	mg/L	1.2*	5
Total Nitrogen (TN)	mg/L	10	15
Total Phosphorus (TP)	mg/L	1	3
Oil and Grease	mg/L	5	10
Faecal Coliforms (FC)	cfu/100mL	200	600
pH	-	-	6.5 – 8.5

\*The 90%ile ammonia has been updated to align with the toxicity assessment as established within Table 5.6 of the Thrumster Wastewater Scheme, Environmental Impact Assessment, Water Quality Impact Assessment (Intrawater Pty Ltd, 2024).

### 2.8.2 Adopted Discharge Quality – Pathogens

The local oyster industry and the Department of Primary Industries – Biosecurity and Food Safety (DPI) have had a focus on preventing oyster contamination with viruses (specifically Norovirus).

A focus of the initial optioneering and strategy development was the adoption of a treatment processes that removed viruses to a high degree to avoid contamination issues with discharging upstream of oysters.

The adopted discharge location of Kooloonbung Creek now combines the discharges from Port Macquarie and Thrumster WWTPs downstream of the oyster leases.

- The current Port Macquarie WWTP may only remove 0.5 log LRV based on typical removal from activated sludge processes.
- The new Thrumster WWTP may remove 2.0 log LRV of virus using the MBR based on the LRVs presented in the Thrumster WWTP Options Assessment (Beca HunterH<sub>2</sub>O, 2023).

Further discussion of the fate of viruses in the receiving water will be provided in the Water Quality Impact Assessment.

## 2.9 Recycled Water Requirements

Recycled water requirements are guided by the need to manage health and environmental risks associated with the intended end use. PMHC have committed to dual reticulation supply to Thrumster (Area 13). This scheme will take treated effluent from Thrumster WWTP.

### 2.9.1 Recycled Water (Area 13) Demand

Thrumster WWTP will provide recycled water to the Thrumster Area 13 recycled water scheme. Recycled water demand has been estimated by the nominated ET for the supply area and adopted usage load. A design capacity of 4.7 ML/d will be used as the basis for design. The calculated average and peak demands are presented in Table 2-14.

Table 2-14: Recycled Water (Area 13) Demand Calculation Capacity

Parameter	Units	2023	2049	Comment
Number of Lots (Residential)	ET	1,700	4,880	EP/ET = 3.34. Thrumster Only. (Beca HunterH2O, 2023)
Residential Lot Usage	L/ET/d	390	390	Based on historical dual reticulation demand for the last 5 years for the entire Port Macquarie area. Thrumster current demand consumption is approximately 220 L/ET/d excluding contingency.
Average Demand (Residential)	ML/d	0.7	1.9	
Average Demand (Non-Residential)	ML/d	0.6	1.2	2023 demand based the entire Port Macquarie Area. Assumed to be the same for Thrumster and then doubled by 2049.
Peak Day Factor		1.5	1.5	To align with the Peak Day Factor for the water network.
Peak Day Demand	ML/d	1.9	4.7	Adopted values for the basis of design. Supplied over 22 hours. Potable water top-up available.

### 2.9.2 Recycled Water Quality

For NSW, two guidance documents outline the specific log reduction targets associated with direct human exposure to pathogens. These documents are:

- Australian Guidelines for Water Recycling (AGWR).
- NSW DPE Recycled Water Management Systems Guidance Document (largely based on the AGWR).

The log reduction requirements associated with dual reticulation are provided in Table 2-15. The most conservative approach is to adopt the most stringent guideline requirement. These have been adopted for the basis of technology selection for the design.

Table 2-15: Log Reduction Credits for Dual Reticulation

Parameter*	Virus	Protozoa	Bacteria
NSW DPE	6.4	5.0	5.1
AGWR	6.5	5.0	5.0
<b>Adopted Most Stringent Guideline Requirement</b>	<b>6.5</b>	<b>5.0</b>	<b>5.1</b>

Further consultation with NSW Health will be undertaken to confirm the disinfection requirements, adopted LRV of treatment units and draft critical control points.

## 2.10 Biosolids Requirements

When referencing biosolids handling, the requirements in NSW are often determined by the *NSW EPA Environmental Guidelines: Use and Disposal of Biosolids Products*. It is worth noting that the guidelines are currently under review and the criteria required to achieve stabilisation may change in the near future.

Currently all biosolids produced by PMHC are transferred to the Cairncross organics recycling facility, owned by PMHC and operated by Remondis. Biosolids do not require stabilisation for it to be accepted at this location. Processing by this facility enables PMHC to achieve Grade C stabilisation.

Biosolids from the Thrumster WWTP will be dewatered and transported to the Cairncross facility for further treatment. To enable efficient transport of biosolids to the Cairncross facility, the dewatering system will target a dewatered solids concentration of 18% dry solids by volume.

Grade C stabilisation has been adopted for the basis of design.

## 2.11 Gross Residual Requirements

Gross residuals refer to screenings and grit captured at the preliminary treatment stage and from waste tanker deliveries.

Captured gross residuals will be washed to reduce odour. Washed residuals will be stored onsite, before being transported offsite to PMHCs' waste management facility.

All gross solids will be collected in dedicated bins for removal offsite. The bins will be sized for a maximum of two collections per week.

## 2.12 Odour Mitigation

Odour mitigation considers sensitive receptors and onsite safety.

### 2.12.1 Sensitive Receptors

An air quality impact assessment has been completed for the Thrumster WWTP (GHD, 20 May 2024). The assessment concluded that odour capture and control is not required in order to achieve the odour criteria of 4 odour units at the nearest sensitive receptors.

The site layout has included space provision for the future installation of an odour control unit which could be used to capture and treat odour from the inlet works, septage receival pump station and dewatering facilities.

### 2.12.2 Work Health and Safety

Hydrogen sulphide exposure limits by Safe Work Australia may impact odour management system design. Proposed changes to the limits are likely to decrease the 8-hour time weighted average (TWA) and short-term exposure limit (STEL) by approximately 10-fold.

While not considered for odour mitigation around sensitive receivers, the detailed designer is to consider the safety aspects regarding hydrogen sulphide at the inlet works for staff. The inlet conditions with multiple pumpstations have a high likelihood to reduce sulphides causing gaseous H<sub>2</sub>S release. From experience this may breach the current TWA and STEL levels. To manage the safe work requirements, the detailed design should consider how and which of the following management methodologies will be applied to manage WH&S risk:

- Covered inlet works with forced airflow extraction (air changes between 12 and 20 per hour). Odour treatment is likely not required.
- Sodium hydroxide dosing on the inlet rising mains to a pH of greater than or equal to 8.2.
- Manage the risk by the wearing of portable H<sub>2</sub>S analyser and risk assessment. Note this approach may significantly limit access.

## 2.13 Noise Mitigation

A noise and vibration assessment for the Thrumster WWTP has been undertaken (GHD, 21 May 2024). Noise modelling predictions indicated no adverse impacts on surrounding sensitive receivers during operation of the treatment plant.

Noise mitigation that has been included in the concept design includes:

- Locating the blowers and centrifuges within blockwork buildings
- Blowers to be supplied with factory fitted acoustic hoods
- Centrifuges to be fitted with acoustic hoods (if applicable for WH&S of operations).

## 2.14 Bioreactor Temperature

The minimum reactor temperature is critical to ensure the ammonia limits are met in cold weather. Temperature data recorded at the Port Macquarie WWTP has a minimum of 15 degrees but has surface aeration. For our bioreactor that has diffused aeration, a 1 degree increase from the minimum value has been adopted for the basis of design equal to 16 degrees Celsius.

With regards to recycled water, 16 degrees Celsius aligns with the minimum requirements for Teir 1 LRVs for membrane operation in WaterVal Membrane Bioreactor Validation Protocol (WaterSecure, 2017). Refer section 4.16 for further details.

## 2.15 Chemical Storage

The plant will be designed to store 40 days of chemical operating at design flows.

## 2.16 Civil and Structural Requirements

### 2.16.1 Design Reference Documents

The following documents have been used as reference points for the structural design basis of the WWTP:

- Project Models developed by Beca Hunter H2O.
- Geotechnical Investigations: Geotechnical Assessment – Proposed Thrumster Wastewater Treatment Plant (RGS21503.1, June 2024)
- Circular Design Innovation and Opportunity Register.

### 2.16.2 Design Standards and Codes

The following design standards and codes have been used in forming the basis of the structural design criteria:

- National Construction Code – Building Code of Australia: Guide to Volume One.
- National Construction Code – Building Code of Australia: Volume One.
- AS/NZS 1170.0 Structural Design Actions Part 0: General Principles.
- AS/NZS 1170.1 Structural Design Actions Part 1: Permanent, Imposed and Other Actions.
- AS/NZS 1170.2 Structural Design Actions Part 2: Wind Actions.
- AS/NZS 1170.3 Structural Design Actions Part 3: Snow and Ice Actions.
- AS 1170.4 Structural Design Actions Part 4: Earthquake Actions in Australia.
- AS 1657 Fixed platforms, walkways, stairways and ladders.
- AS 2159 Piling: Design and installation.
- AS 3600 Concrete Structures.
- NZS 3106 Design of Concrete Structures for the Storage of Liquids.
- AS 3735 Concrete Structures for Retaining Liquids.

- AS 4100 Steel Structures.
- AS 4312 Atmospheric Corrosivity Zones in Australia.
- AS 4678 Earth-retaining Structures.

The following manuals and guidelines have been used to supplement the structural design basis:

- WSA 201 Manual for Selection and Application of Protective Coatings, Water Services Association of Australia.
- CIRIA Z7/06 Concrete Cracking and Crack Control.

## 2.16.3 Design Parameters

### 2.16.3.1 Importance Level, Design Life and Annual Probability of Exceedance

The site has been classed as Importance Level 3 as a wastewater treatment facility in accordance with AS/NZS 1170.0 and Section B1.2 of the *Building Code of Australia: Guide to Volume One*. The majority of structures including buildings have adopted this classification on the basis they are critical to the plant operation and water quality.

The following Annual Exceedance Probability (AEP) values presented in each table of this section have been adopted based on the importance level as per Table 3.3 of AS/NZS 1170.0 and will apply to all structural components as outlined in each table.

*Table 2-16: Design Life and Annual Probabilities of Exceedance for Non-Concrete Structural Components*

Component	Design Life	Importance Level	Serviceability	Wind	Earthquake	Snow
<b>AEP – Ultimate Limit State</b>						
Roofing - Structural	25 Years	3	1/25	1/500	1/500	1/100
Roofing - Non-Structural <sup>1</sup>	25 Years	3	1/25	1/500	1/500	1/100
Access Structures <sup>2</sup>	25 Years	3	1/25	1/500	1/500	1/100
<b>AEP – Temporary Construction Loads</b>						
All	Temporary Construction	2	-	1/100	1/100	1/50

<sup>1</sup> Non-framing components, cladding, purlins and girts.

<sup>2</sup> Stairs, walkways, handrailing and similar metalwork.

*Table 2-17: Design Life and Annual Probabilities of Exceedance for Reinforced Concrete Structures*

Design Life	Importance Level	Serviceability	Wind	Earthquake	Snow
<b>AEP – Ultimate Limit State</b>					
50 Years	3	1/25	1/1000	1/1000	1/250
<b>AEP – Temporary Construction Loads</b>					
Temporary Construction	2	-	1/100	1/100	1/50

## 2.16.4 Durability & Exposure

### 2.16.4.1 Site Atmospheric Corrosion Class

The WWTP site is located approximately 5.5km from the coast near the mouth of the Hastings River, approximately 600m from Fern Bank Creek off the Hastings River and 1.8km west of Port Macquarie Airport. The atmospheric environment for the site has been classified as C3 in accordance with AS 4312 due to the proximity to the ocean and the light industrial. It is noted that there is no industrial activity close to the site or other climatic factors that may typically increase the corrosivity of the local atmosphere.

### 2.16.4.2 Material Selection

The following materials presented in Table 2-18 are generally proposed for use across the site.

*Table 2-18: Proposed Materials*

Structure Type	Component
Liquid Retaining Concrete Structures	<ul style="list-style-type: none"> <li>▪ S40 Reinforced Concrete</li> <li>▪ Galvanised Steel or Aluminium for Roof Framing</li> </ul>
Non-Liquid Retaining Structures	<ul style="list-style-type: none"> <li>▪ N32 Concrete (slabs, footings, foundations etc.)</li> <li>▪ N20 Concrete (blinding, mass concrete etc.)</li> <li>▪ Building Roof - Galvanised Steel or Aluminium for Roof Framing</li> <li>▪ Buildings Walls – Blockwork or Pre-cast Tilt Up Panels</li> </ul>
Metalwork and Access Structures	<ul style="list-style-type: none"> <li>▪ Galvanised Steel or Aluminium framing and walkways</li> <li>▪ All platforms, walkway supports and handrailing over liquid retaining structures are to be aluminium.</li> <li>▪ Walkway gratings and stair treads are to aluminium or FRP (galvanised steel grating is accepted where galvanised access structures are used).</li> <li>▪ Any metal work that is immersed in liquid is to be 316 stainless steel.</li> </ul>
Pipework	<ul style="list-style-type: none"> <li>▪ Stainless Steel for all above ground pipework</li> <li>▪ D1CL/MSCL/HDPE for all below ground pipework</li> </ul>

It is recognised that several areas of the proposed WWTP facilities may have different micro-climatic conditions that may result in a higher exposure rating/class in accordance with AS 4312 and WSA 201.

Where these areas are identified during further design development, the detailed designer will be required to update the structural design basis to document the different micro-climatic features and briefly outline nominated mitigation measures to ensure durability of structural components in these areas to the nominated design lives.

## 2.16.5 Design Loads

### 2.16.5.1 Wind Loads

Design wind loads for the site have been determined in accordance with AS/NZS1170.2 and are documented in Table 2-19 including site specific terrain and shielding parameters.

Table 2-19: Site Wind Loading Parameters

Parameter		Value	Comment
Wind Region		A (0 to 5)	Region A2 – Port Macquarie
Annual Probability of Exceedance - SLS	AEP	1/25	As per Table 2-16.
Recurrence Interval - SLS	R (years)	25	
Annual Probability of Exceedance - ULS	AEP	1/1000	As per Table 2-16.
Recurrence Interval - ULS	R (years)	1000	
Regional Wind Speed - SLS	$V_{R\ SLS}$ (m/s)	37	
Regional Wind Speed - ULS	$V_{R\ ULS}$ (m/s)	46	
Wind Direction Multiplier	$M_D$	1	Adopted worst case.
Climate Change Multiplier	$M_C$	1	
Terrain Category		TBC	To be confirmed by detail designer following finalised pad layout.
Structure Height	(m)	TBC	To be confirmed by detail designer following finalised pad layout.
Terrain Category Multiplier	$M_{z,cat}$	TBC	May vary on individual structures based on height. Refer to AS1170.2 T4.1 for further details on sites in Region A0 if required.
Shielding Multiplier	$M_s$	1	No allowance for shielding of any structures made.
Topographic Multiplier	$M_t$	TBC	To be confirmed by detail designer following finalised pad layout.
Design Wind Speed ULS	$V_{des,\theta\ SLS}$ (m/s)	TBC	To be confirmed by detail designer following finalised pad layout.
Design Wind Speed ULS	$V_{des,\theta\ ULS}$ (m/s)	TBC	To be confirmed by detail designer following finalised pad layout.

### 2.16.5.2 Earthquake Loads

The following earthquake site parameters presented in Table 2-20 are as per the provided geotechnical report. These values may require review during further design development and reconfirmation by a geotechnical specialist once the final fill material for the pad is selected.

Table 2-20: Site Earthquake Loading Parameters

Parameter	Value	Comment
Earthquake Design Category	EDC II	
Probability Factor	k <sub>P</sub> 1.4	
Site Hazard Factor	Z 0.08	As per geotechnical investigation report.
Site Soil Subclass	For structures founded on: Controlled Fill from Cowarra Water Treatment Plant	M - H1 As per geotechnical investigation report.
	For structures founded on: Controlled Fill comprising blend of ripped rock and clay from Cowarra Water Treatment Plant	M As per geotechnical investigation report.
	For structures founded on: Uncontrolled fill >0.4m deep	P As per geotechnical investigation report.

Estimated design free surface movement ranges between 30mm and 60 mm and needs to be reconfirmed by a geotechnical specialist following selection of final fill. Subclass P soils will require a foundation system to be designed by an experienced engineer to suit the specific site conditions. Further details can be found in the geotechnical report.

## 2.17 Other Design Requirements

### 2.17.1 Flood Levels

Council's flood policy classifies essential components of a sewage treatment works as a critical service facility. Table 5 of the flood policy states "critical facilities must not be constructed on land below the level of PMF". Additionally, Section 4.5 states:

- The floor level of all Critical Facilities must be at or above (flood planning level) FPL4.
- Major infrastructure such as roads and bridges are to be constructed at or above FPL3.
- Flood proofing must be provided for all parts of the building up to FPL4.

PMHC commissioned Advisan (Worley Parsons Pty Ltd) to provide the Hastings River Flood Study Update in 2018 (Advisan, 2018). The flood planning levels from this report are provided in Table 2-21 and have been adopted as the basis of design.

Table 2-21: Key Elevation and Level Details

Flood Planning Level	Flood Modelling Conditions	Treatment Plant Location	Design Requirements
FPL3	1%AEP + 0.9m SLR + 10% RII	4.1m AHD + 0.5m Freeboard*	Minimum pad construction level.
FPL4	PMF + 0.9m SLR	6.7m AHD*	Critical infrastructure level

\*Taken from PMHC GIS at the TWWTP location.

It is recommended that the existing flood study is updated or revised to include the new treatment plant and access roads to determine if there are any impacts to surrounding areas during floods as well as informing the design requirements for embankment and road protection during flooding (velocities and water depths). This information will also inform the design of culverts within the new roadways.

### 2.17.2 Climate Data

Local rainfall and climate data will be taken from the nearest weather station. The closest weather station is the Port Macquarie Airport (060168 and 060139). If data is not available, then the nearest location will be adopted.

### 2.17.3 Design Storm Events

The design storm events will be considered across the design with respect to process hydraulics. This includes key locations such as hard stands for return pumping and bioreactors for hydraulics.

An initial allowance of BOM Intensity-Frequency-Duration (IFD) Design Rainfall Depth (mm) will be used:

- Intensity of 95 mm.
- Frequency of 1% Annual Exceedance Probability (AEP).
- Duration of 1 hour.

### 2.17.4 Maximum Structure Height Allowances

The Thrumster WWTP is located within 1.5 km north-west of the Port Macquarie Airport. Based on PMHC geographic information system (GIS) layer for airport obstacle limit surface (OLS), the maximum structure Australian Height Datum Relative Level (mAHD RL) allowable for the sand plains site is 47.5.

### 2.17.5 Inlet Works Penetrations for Feed Pump Stations

A number of penetrations are provided in the inlet works for the connection of current and future pumpstations to the works. Table 2-22 shows the penetration pipe size allowances and connection feed pump stations.

*Table 2-22: Thrumster WWTP Penetration allowances for Feed Pump Stations*

Feeder Pumping Station	Flowrate (L/s)	Pipe Size	Comment
TH01	155	DN500	Current duty 155 L/s. Ultimate duty approximately 420 L/s.
Redirected Flows	395	DN500	Assumed regional airport pumping station (PM87) arrangement will be adopted. Flows are not expected to change if an alternate arrangement is adopted.
Allocated Future		4 x DN500	

## 2.17.6 Discharge Location Hydraulic Requirements

Table 2-23 provides the discharge location hydraulic levels to be used in the plant design.

Table 2-23: Key Elevation for Discharge

Scenario	Location	Type of Transfer	Design Maximum RL
Treated effluent discharges up to 4x ADWF	Kooloonbung Creek	Pumped	28 mRL AHD – At the top of hill on Fernhill Rd
Emergency flow relief from Storm storage pond during non-PMF flood event	Adjacent to Site	Gravity	4.6 mRL AHD – local and adjacent to the storm storage pond direct.
Emergency flow relief from Storm storage pond during flood events	Adjacent to Site	Gravity	6.7 mRL AHD – At the treatment plant site.

The pumped treated effluent is discharged at the existing Port Macquarie WWTP licenced discharge point directly downstream of the Lake Road Lagoons. The terrain level at this point is approximately 3.5 mRL AHD. PMHC's flood data from the Hastings Flood Studies indicates the 1%AEP without climate change is 2.5 mRL AHD. The exact discharge location and levels are to be confirmed during detailed design as part of the treated effluent transfer facility design.

## 2.17.7 Operational Design Requirements

The Thrumster WWTP operators are expected to be on site each weekday during normal working hours. The greatest duration of non-attendance is assumed to be 4 days: during Easter and Christmas.

The design will include remote monitoring and alarm generation. The criticality of alarms will be set in the control system (at least three levels) with the most critical alarms resulting in remote notifications (e.g. text messages). Remote control will also be possible through telemetry.

The response time to critical alarms is assumed to be 1 hour from the time an alarm is generated to the time the operator arrives at site. Problem rectification is assumed to be 4 hours.

The following operational requirements are included as the basis of design:

- Works to be 'operationally practical', which is defined as being designed such that an operator can carry out routine operations without the need to shut down units, carry tools or the like.
- The need for good system operability and ease of control.
- Low noise generation and minimisation of other environmental and social impacts. Minimise noise at source and provide suitably designed acoustic enclosures where necessary to ensure working environment does not require operators to use PPE.
- Minimising vibration at the source and providing suitably designed vibration mounts/isolation to prevent the transferring of vibration to other process units, etc.
- Providing robust instrumentation in operator friendly locations as appropriate for monitoring, control, calibration and compliance purposes. All calibration and adjustment points must be safely accessible from floor / platform level.
- All valves accessible for operation from the normal operational position.
- Means provided to isolate every item of equipment (electrically and mechanical/process).
- Ease of placement and removal of consumables (i.e. belts, bearings, seals etc.) for cleaning, repair and replacement purposes.
- Ease of receiving chemicals and lifting of equipment, minimise structure penetrations where possible.
- Automated with essential alarms.
- Provide suitable and safe functionality to allow for sampling of key process lines.

### 2.17.8 Access Structure Requirements

The following preferences for access structures layouts and arrangements are to be included in the design:

- Stairs are to be used in preference of ladders. Ladders may only be used on the exterior of structures with approval in writing from Council. Stepladders as a means of dedicated access are not to be used.
- All stairs, walkways and platforms are to be a minimum of 1m wide (minimum clear space on the inside of handrailing and other protrusions/obstructions) in addition to meeting the requirements of AS1657. Consideration to providing additional workspace where any operational panels, davits or other structures on walkways and where maintenance tasks are carried out, is to be made.
- Consideration to access platform arrangement and sizing for structures that may require diver cleaning or inspection e.g. treated water reservoirs.

## 3 Process Overview

This section provides a high-level overview of the treatment processes proposed for the Thrumster WWTP as shown in the process flow diagram in Figure 3-1 and detailed further in the P&IDs.

### *Inlet Reception*

Thrumster WWTP will accept raw sewage from Thrumster, Sancrox and diversions from the Port Macquarie wastewater network. Initially, two pumpstations will be connected (TH01 and PM87). Four additional penetrations are provided for the connection of future pumping stations. Each rising main can be dosed directly with sodium hydroxide if required for control of hydrogen sulphide or to increase plant alkalinity.

A dedicated septage receival area will accept and hold tankered waste delivered to the site. The tankered waste will be screened and transferred to the inlet works using a pumping station.

Foul water from various pumping stations throughout the plant will also be returned to the inlet works.

### *Preliminary Treatment*

Combined raw influent is screened using three 5mm aperture band screens. The screens operate in a Duty/Standby/Standby configuration at stage 1. A single screen will be able to accept the stage 1 PIF. If all screens fail, the water level will rise and overflow two bypass weirs. The screened and bypass flows combine in a downstream storm flow splitter. Captured screenings are transferred to and washed within one of two screenings wash presses. Washed and dewatered screenings are deposited into a bin for collection.

The storm flow splitter allows flows up to 4xADWF to pass through a penstock orifice to the grit chamber. Excess influent passes over a weir to the storm storage pond.

Grit in the raw influent is removed by a vortex style grit chamber. Dense particles settle to the bottom of the grit chamber, lighter organic particles continue to fine screening. The settled particles are fluidised using recycled water and drawn from the chamber by a pump. The pump transfers grit to the grit washer to separate any captured organic material. Cleaned grit is dewatered and deposited into a bin for collection.

Excess liquid from the screening and grit washing is returned to the inlet works via inlet works foul water pumping station.

Screened and de-gritted flow passes to the fine screens which operate in a 2x duty and 3x standby arrangement at stage 1. The fine screens are inclined drum screens that have an aperture of 2mm. Each screen has integrated screening washing and compacting and any captured screenings are deposited into their own bin.

Fine screened influent will gravitate through a pipe to the bioreactor anaerobic zone.

### *Storm Storage and Return*

Flows into the storm flow splitter greater than 4x ADWF will bypass the secondary treatment process and flow to the storm storage pond. The storm storage pond will have a working volume of 25 ML. It will have a controlled emergency flow relief to the nearby wetland during extended periods. Once flow returns back to less than 4x ADWF, storm return pumps will transfer stored storm flow back the process for treatment.

### *Secondary Treatment*

Three anaerobic zones in series combine sludge from the membranes (s-recycle) with the incoming raw feed. There are three cells separated by baffles and each zone has a submersible mixer. The sludge then enters the distribution channel to an oxidation ditch in the anoxic zone. The distribution channel provides the flexibility to introduce the anaerobic cell mixed liquor at different points within the oxidation ditch to fine tune nutrient removal performance. Feed location can be selected by operating manual penstocks.

Within the bioreactor, mixed liquor circulates around the ditch cycling between anoxic and aerobic conditions. Submersible banana blade mixers operate to maintain channel velocities to ensure mixed liquor remains in suspension. Diffused aeration grids with air supplied by blowers raise the dissolved oxygen concentration to the target levels. As the mixed liquor moves away from the aeration grids the dissolved oxygen decays, reaching anoxic conditions prior to the introduction of incoming sewage from the anaerobic zones. The location of the oxidation feed can be adjusted to change the anoxic and aerobic mass fractions of the oxidation ditch and optimise performance.

The sludge return (S-recycle) pumps (3x duty, 1x jockey, 1x standby) are dry mounted submersible pumps connected directly into the side of the oxidation ditch. These pumps transfer mixed liquor to the membrane trains. The S-recycle pumps will operate to maintain a set level in the bioreactor.

The membrane trains perform solid liquid separation, clean permeate is removed using a dedicated pump per train and the remaining solids will overflow the internal weir in the outlet channel and return by gravity fed back to the anaerobic zone of the oxidation ditches.

### *Effluent Management*

The membrane permeate will be pumped to the permeate storage tank, the permeate pumps can also operate in reverse for membrane cleaning. The permeate storage tank has two functions; hold permeate for use during membrane cleaning and onsite process service water use.

The permeate tank is designed to stay full unless a membrane maintenance or CIP clean is occurring. A high-level overflow to the treated effluent storage tank allows this to occur. The Kooloonbung Creek discharge pumps connected to the treated effluent storage tank will transfer effluent discharge flows to Kooloonbung Creek. These pumps are configured in a 2xDuty/1xStandby arrangement.

### *Solids Management*

Solids generated in the bioreactor are removed as waste activated sludge (WAS). WAS pumps will be used to maintain the required plant sludge residence time (SRT) and will be duty/standby dry mounted submersible pumps. The WAS pumps remove thickened sludge from the membrane outlet channel.

The WAS will be pumped to a feed averaging tank near the dewatering building. From this tank, it will be pumped to one of two centrifuges (duty/standby) and be dosed with dewatering polymer at the inlet. Dewatered sludge will enter a horizontal screw conveyor and be evenly distributed across the trailer using slide gates. Trucks will dispose of the dewatered biosolids offsite.

The foul water from dewatering will flow into the dewatering foul water pump station to be pumped back into the bioreactor anaerobic zone.

### *Chemical Systems*

Alum can be dosed into the aerobic zone of the oxidation ditch, just prior to the secondary anoxic zone. Sodium hydroxide can be dosed directly into each rising main, actuated valves open and close when flow is measured.

### *Recycled Water System*

A portion of the effluent will be transferred from the treated effluent storage tank, through an in-pipe UV system arrangement to a chlorine contact tank. The UV disinfected effluent is dosed with chlorine on the inlet. The chlorine contact tank will also act as a storage reservoir by maintaining a minimum level for chlorine contact. A single baffle is provided to ensure an effective baffle factor and residence time is maintained.

The recycled water will be pumped offsite for use in the Area 13 (Thrumster) dual reticulation network using a duty/standby transfer arrangement. A small booster pumpstation will supply recycled water around site which may come in contact with operators (i.e. hose reels and chlorine carrier water), it is also used for onsite toilet flushing.

### *Process Water System*

Process water used for equipment washing will be drawn from the permeate storage tank, this is for systems which have the appropriate guarding (i.e. screens, washing systems, carrier water, etc). The process water is distributed around site using a duty/duty/standby booster pumpstation.

### *Potable Water System*

Potable water is supplied to site via gravity and will be used for amenities, safety showers, polymer batching and firefighting purposes.

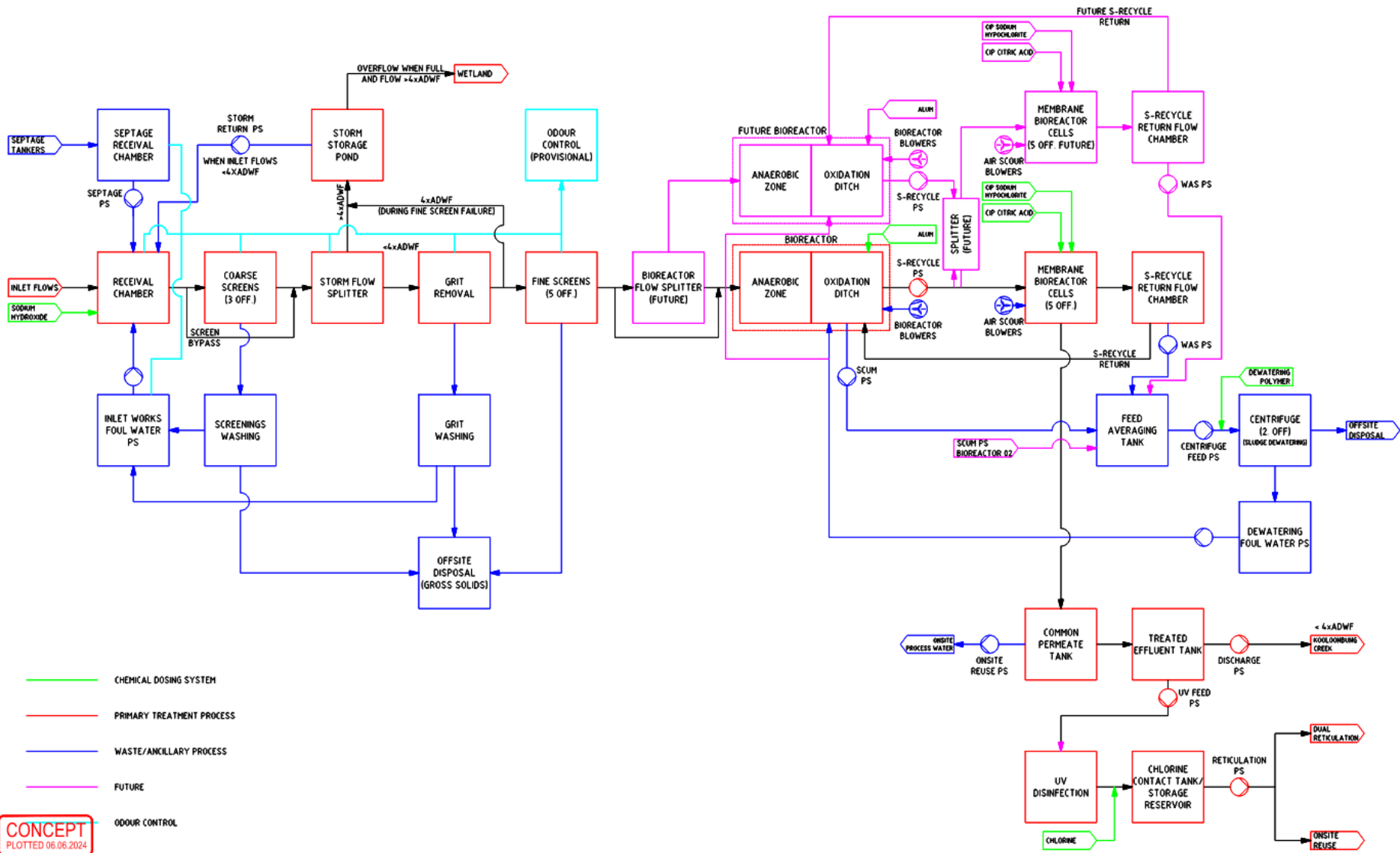


Figure 3-1: Process Flow Diagram

## 4 Process and Mechanical Design

This section describes the process and mechanical concept design of the treatment plant.

### 4.1 Septage Receival

This section describes the septage receival concept design.

#### 4.1.1 Description

A septage receival facility has been allowed for. The septage receival facility will be located close to the inlet works on the STP compound. The tanker driver will be required to swipe a card ID to activate the system for use.

Septage will be screened using a 20 mm aperture manually raked bar screen before being pumped to the inlet works to be screened with the automatic screens. Tankers up to 14 kL will connect to a 100 mm diameter rigid pipeline including flow meter which will direct the flow into a manual screen chamber and onto a pumping station.

Duty / standby pumps and pumping station will be used to store the discharge flow from a tanker. PMHC will be able to test the septage and confirm whether it can be accepted. An online pH probe and hydrocarbon sensor have been included for online monitoring of the contents. The pumps will not operate if the delivered septage is not within the nominated specifications.

It is recommended hoses no larger than 100mm are connected to the pipe which feeds the receival facility. Also, it is recommended tankers no larger than 14 kL can free drain into the facility. Larger tankers may be able to discharge if the tanker driver carefully watches and slows / stops flow if the level rises too high in the pump well. Tankers must also not discharge until the pump has stopped and cleared the well. The facility can accept and clear a 14 kL delivery within approximately 12 minutes.

#### 4.1.2 Design Assumptions

The following design assumptions have been made:

- The maximum septage tanker delivery is 14kL.
- The septage will be screened and treated in the main process train.
- Septage can only be delivered during operating hours.

#### 4.1.3 Process Sizing

Process sizing associated with the septage receival is presented in Table 4-1.

*Table 4-1 Septage Receival Process Sizing*

Item/ Parameter	Value	Unit	Comment
<b>Septage Receival</b>			
Septage discharge pump	20	L/s	
Pumping station volume	14	m <sup>3</sup>	As per PMHC requirements
Septage screen aperture	20	mm	
Receival pipe	100	mm	

#### 4.1.4 Turndown and Redundancy

Turndown and redundancy considerations associated with the septage receipt are summarised in Table 4-2.

*Table 4-2: Septage Receipt Turndown and Redundancy*

Item	Number	Configuration	Comment
Septage Pump	2	Duty/Standby	
Level Transmitter	1	Duty	Back up with high and low level switches.
pH probe	1	Duty	Not critical to operation.
Hydrocarbon sensor	1	Duty	Not critical to operation.

## 4.2 Flow Reception

This section describes the flow reception concept design. This is part of the larger inlet works structure.

### 4.2.1 Description

Raw sewage and return from the storm storage pond enters the inlet works through the floor of the receival chamber via a bellmouth. Tankered septage and plant foul water are transferred over the wall. All inlet flows are discharged above top water level to provide constant head and prevent backflow.

The receival chamber can accept up to 8x design ADWF at 80,000 EP (i.e. 1760 L/s) which is the concept design capacity of the network pumping stations.

Each rising main can be dosed directly with sodium hydroxide if required for control of hydrogen sulphide or alkalinity addition.

Flow is monitored on each of the inlet mains from the network and internal returns. Accepted flows from the receival chamber pass directly into the coarse screening area.

### 4.2.2 Design Assumptions

The following design assumptions have been made:

- A maximum hydraulic capacity of 1,760 L/s (8 x design ADWF at 80,000 EP).
- Future rising mains will be connected to using DN500 connection.
- Flowmeters will be local to the inlet works (i.e. at the end of the rising main).

### 4.2.3 Process Sizing

Process sizing associated with the flow reception and washing is presented in Table 4-3.

*Table 4-3 Flow Reception Process Sizing*

Item/ Parameter	Value	Unit	Comment
<b>Flow Reception Chamber</b>			
Inlet Top Water Level	12.73	mRL	
Top of Inlet Bellmouth	12.83	mRL	Each
Hydraulic capacity	1,760	L/s	8xADWF + Recycles (Ultimate)

### 4.2.4 Turndown and Redundancy

Turndown and redundancy considerations associated with the flow reception are summarised in Table 4-4.

*Table 4-4: Flow Reception Turndown and Redundancy*

Item	Number	Configuration	Comment
Flow monitoring	As per number of inlet connections	Duty each	Flows are monitored individually via the incoming mains.

## 4.3 Coarse Screens and Washing

This section outlines the flow reception, coarse screens and washing. This is part of the larger inlet works structure.

### 4.3.1 Description

Three band screens operate in duty/assist/standby at the stage 1 capacity. Flow enters the centre of the band and flows outward through the screens. The bands rotate, lifting screenings up the inside of the screens. The screens rotate intermittently in response to screenings channel level, timers or recorded inflow. Each screen can be isolated with the use of upstream and downstream penstocks and stopboards. The downstream splitter sets the maximum possible tailwater level for the screens running at maximum instantaneous flow.

If the band screens are isolated, or if the screens blind due to failure, sewage passes over weirs either side of the screens into a bypass channel and recombines in the flow splitter downstream of the band screens. Overflow into the bypass channel are alarmed using a high level switch.

A manually raked bypass screen has not been provided, the approach to the inlet works coarse screening is as follows:

- A single online standby screen has been provided at stage 2 flow; this results in two online standby screens available at 40,000 EP.
- Downstream fine screens protect the membrane process if a bypass occurs.
- Major power outage is unlikely due to provision for back up generation and dual power supplies to the site.

Wash water is used to wash screenings collected by the band screens into a sluice for transfer to one of two washpactors (duty/standby). Screenings are initially drained under gravity through a sieve in the duty washpactor. This drain water is sent to the foul water pump station and returned to the head of works for treatment. After a certain number of screen operating cycles, or based on washpactor level, the drain valves closes, water is added and an impellor is used to agitate and wash the screenings. A separate shaftless screw moves and compacts the screenings as they are washed. The cleaned and dewatered screenings are deposited into a bin. The washpactor then rinses, drains and is ready to accept more screenings. Screenings can continue to be deposited into the washpactor during the washing cycle. If a washpactor fails, then the standby is made the duty.

Reclaimed effluent (RE) is used for screenings extraction, sluicing and washing. These functions are controlled by solenoid valves. A lack of RE will result in screen and/or washpactor failure.

From the band screens or manual bypass channel, the sewage enters a storm flow splitter.

### 4.3.2 Design Assumptions

The following assumptions have been adopted for the process design.

- The maximum screen feed flow is the sewage PIF of 1,760 L/s (aligning to 8x ADWF at 80,000 EP).
- The overflow is designed for PIF.
- No manual screen is provisioned due to redundancy in automatic screens.
- Screening spray water, sluice water and wash water flow are based on supplier advice.
- Screening spray water, sluice water and wash water use under typical conditions is based on estimates.

### 4.3.3 Process Sizing

Process sizing associated with the coarse screening and washing is presented in Table 4-5.

Table 4-5 Coarse Screening and Washing Process Sizing

Item/ Parameter	Value	Unit	Comment
<b>Coarse Screens</b>			
Type of automatic screen	Band Screen		
Aperture of Band Screen	5	mm	
Number of Band Screens	3		Lead/Lag/Follow. One screen required for operation at stage 1. Two screens required for operation at stage 2.
Screen Capacity	880	L/s/screen	
Headloss	260	mm	Supplier information at PIF and 60% blinding
<b>Band Screen Washing</b>			
Band screen water sluice flow	4	L/s/screen	Supplier information
Sluice sparge flow	2	L/s	
Washwater pressure	4	bar	
<b>Screenings Washing</b>			
Number of screening washing systems	2		Duty/Standby
Adopted capacity of washing system	2.8	m <sup>3</sup> /h	Each machine based on supplier information
Washwater use	1.8	L/s	Supplier information
Washing system performance	40	%	Solids content range
Organic content in dry solids	20	mg BOD /L	
<b>Washed Screenings Production</b>			
Screenings Production	1	m <sup>3</sup> /week	
Number of Screenings Bins	2		
Bin Volume	1	m <sup>3</sup>	Each
<b>Bypass Weirs and Channel</b>			
Number of Weirs / Channels	2		
Bypass Weir Length	6.5	m	Each
Channel Width	2	m	Each

#### 4.3.4 Turndown and Redundancy

Turndown and redundancy considerations associated with coarse screening and washing are summarised in Table 4-6.

*Table 4-6: Coarse Screening and Washing Turndown and Redundancy*

Item	Number	Configuration	Comment
Screens	3	Duty/ Standby/ Standby	
Level element	1	Duty	Upstream of band screens
Concrete structures	1	Duty	
Screenings wash press	2	Duty/Standby	Essential for screenings operation. Standby required
Screenings sluice	1	Duty	

## 4.4 Storm Flow Splitter

This section outlines the storm flow splitter. This is part of the larger inlet works structure.

### 4.4.1 Description

From the coarse screens and bypass channels, flow will enter the storm flow splitter structure. The splitter also allows some balancing. The main outlet of the splitter is a manual penstock, this is optimised and set at commissioning to only allow the PFTF to pass through the downstream processes. The immediate downstream process is the grit removal chamber. Flows above PFTF, overflow to the storm storage pond via an overflow weir.

### 4.4.2 Design Assumptions

The following assumptions have been adopted for the process design.

- The peak inflow to the splitter is 8x ADWF at 80,000 EP (i.e. 1760 L/s).
- The outflow through the orifice has been sized to only allow 4xADWF through the orifice, a manual penstock will allow adjustment at stage 2 commissioning.
- Flows greater than approximately 4xADWF will overflow a weir to the emergency storage lagoon.

### 4.4.3 Process Sizing

Process sizing associated with the storm flow splitter is presented in Table 4-7.

*Table 4-7 Storm Flow Splitter Process Sizing*

Item/ Parameter	Value	Unit	Comment
<b>Bioreactor Flow Splitter Orifice</b>			
Outlet Orifice Area	0.12	m <sup>2</sup>	Tuned using a manual penstock Value represents the requirement for 4xADWF at stage 1 design. Concrete cut out is 500mm high and 600mm wide.
Outlet Orifice Height	0.19	m	To be increased at stage 2 commissioning.
Overflow Weir Length	9.1	m	
Weir Height	12.14	mRL	
Top Water Level	12.20	mRL	
Splitter Volume	132	m <sup>3</sup>	Volume to be confirmed during detailed design once feeder pumpstation operating volumes are known. Overflow should be avoided during typical operation.
Maximum Bioreactor Flow	464	L/s	Equal to PFTF at the stage 1 design.

### 4.4.4 Turndown and Redundancy

Turndown and redundancy considerations are summarised in Table 4-8.

*Table 4-8: Flow Reception Turndown and Redundancy*

Item	Number	Configuration	Comment
Level switch	1	Duty	For operator notification.

## 4.5 Grit Removal and Washing

This section describes the grit removal and washing concept design. This forms part of the larger inlet works structure.

### 4.5.1 Description

After the storm flow splitter, the raw sewage will pass through a vortex grit chamber. A single, vortex type grit tank is used to separate grit from other solids. The grit falls to the bottom of the grit tank, where it is collected and stored. Lighter solids remain in suspension and pass through the grit tank. The grit paddle helps maintain the vortex and keep organics in suspension regardless of flow and operates continuously. If the grit paddle fails, the grit tank can be kept online, but organic separation will suffer. This is not a major issue because grit washing is later undertaken in the grit classifier. Stop boards can be used to manually isolate and bypass the grit tank for maintenance.

The grit extraction sequence is triggered by elapsed time or cumulative sewage volume. A reclaimed effluent sparge mixes and suspends the grit. The grit extraction pump is used to control the flow of suspended grit delivered to the classifier. A manual valve can direct reclaimed effluent to the grit pump suction line which can be used to clear blockages in the grit extraction pipework.

There is a single, fluidised bed grit classifier. Grit slurry is pumped from the grit tank to the agitator chamber of the classifier where it is fluidised and washed. Organics flushed from the grit overflow the chamber into a bell mouth and are directed to the foul water pump station. The organics are returned to the process for treatment.

The classifier screw is controlled separately. Grit accumulation in the agitator chamber eventually leads to an increase in pressure (at the base of the classifier). A high pressure set point triggers the screw to start. It then runs for a pre-set time to extract some of the grit from the classifier. The classifier screw lifts the washed grit, allowing water to drain back through the screw. The washed grit falls from the end of the classifier to the grit bin.

The grit classifier and bin are located within a bund. This bund also drains to the foul water pump station. Contaminated rainwater that collects in the bund is treated through the STP.

The de-gritted flow is gravity fed into the inclined drum fine screens. A channel at the outlet of the drum screens directs flow into a pipe to be gravity fed to the bioreactor flow splitter, where it is hydraulically split into each bioreactor evenly.

Degritted sewage flows out of the grit chamber, into the outlet channel and to the fine screen channel.

### 4.5.2 Design Assumptions

The following assumptions have been adopted for the process design.

- The grit system is based on 4x ADWF at stage 2 design.
- The maximum grit sparge and wash-water flow and typical duration has been based on supplier advice.

### 4.5.3 Process Sizing

Process sizing associated with the grit removal and washing is presented in Table 4-9.

Table 4-9 Grit Removal and Washing Process Sizing

Item/ Parameter	Value	Unit	Comment
<b>Grit Removal</b>			
Grit Vortex Diameter			To align with standard Jeta Grit Trap Design Sizes
Number	1		
Adopted capacity	930	L/s	Supplier information
Grit sparge flow	1.2	L/s	
Number of grit pumps	1		Duty
Pump duty	16	L/s	Flow matched to the recommended capacity of the Classifier
<b>Grit Classification</b>			
Grit classification system	1		Kuhn Grit Washer KSW-S RW16. 100% duty
Grit Classifier Hydraulic Capacity	16	L/s	Based on supplier information.
Washwater requirement	4	L/s	Based on supplier information.

### 4.5.4 Turndown and Redundancy

Turndown and redundancy considerations associated with the grit removal and washing system are summarised in Table 4-10:.

Table 4-10: Grit Removal and Washing Turndown & Redundancy

Item	Number	Configuration	Comment
Grit Chamber	1	Duty Only	Grit system will still function (although efficiency reduced) upon agitator failure.
Grit Handling	1	Duty Only	Grit extraction suspended, non-critical and inlet works can remain online until fault rectified.

## 4.6 Fine Screens and Washing

This section describes the fine screens and washing concept design. This forms part of the larger inlet works structure.

A fine screening facility has been provided to further screen sewage to prevent debris impacting on the membrane system. Fine sharp objects such as PVC swarf can cause membrane damage if it floats around in the membrane tank. The build-up of hair and fibres in the membrane tank can also matt the membrane surface causing long term issues with operations and maintenance.

### 4.6.1 Description

De-gritted sewage flows from the girt chamber enter the fine screen feed channel. The fine screen facility consists of five inclined drum screens (2mm aperture) operating in 2x Duty/3x Standby at stage 1 capacity.

The feed channel distributes flow to the open end of the inclined screen basket and then through the screen. Suspended particles are captured by the screen basket. The basket rotates when an upstream water level is reached. The rotating screen drum lifts the screenings and drops them into the centrally arranged trough. Screenings removal from the drum is aided by a brush and process water spray nozzles. A screw conveyor in the trough rotates with the drum and transports the screenings through a closed and inclined pipe. The conveying screw transports, dewateres and compacts the screenings.

The system has been designed such that no modification works are required for the stage 2 design. This provides increased redundancy as only 2 screens are required for full flow operation (4x required at stage 2). The others can be offline for maintenance with the remaining drives servicing the maximum inflow. Each of the screening channels can be isolated using upstream actuated penstocks. Downstream levels have been designed so that the water level will not back up into the screen discharge channel. The structure has been designed such that the maximum water level provides sufficient driving head to gravitate into the bioreactor.

The actuated penstocks will also close in the case of a plant failure. This will direct all flow over a weir and to the storm storage lagoon.

The washed and compacted screenings exit the top of the screens. The screenings drop down chutes into screenings bins.

The screenings wash water is sent to the Inlet Works Foul Water Pump Station and returned to the head of works for treatment.

### 4.6.2 Design Assumptions

The following assumptions have been adopted for the process design.

- The maximum fine screen feed flow is the PFTF plus recycles.
- The overflow is designed for PFTF with all screens isolated.
- Screening spray water and wash water flow are based on supplier advice.

### 4.6.3 Process Sizing

Process sizing associated with the fine screens and washing is presented in Table 4-11.

Table 4-11 Fine Screens and Washing Process Sizing

Item/ Parameter	Value	Unit	Comment
<b>Screening</b>			
Type of automatic screen			Inclined Rotating Drum Screen
Screen Diameter	1,600	mm	Based on supplier information
Aperture of Drum Screen	2	mm	
Number of Drum Screens	5		2x Duty and 3x Standby at stage 1 4x Duty and 1x Standby at stage 2
Screen Capacity	230	L/s/screen	
Maximum Headloss Differential	350	mm	Based on supplier information
Screen motor power	1.5	kW	Based on supplier information
<b>Drum Screen Washing</b>			
Drum cleaning washwater usage	1.6	L/s/screen	Based on supplier information
Auger cleaning washwater usage	N/A	L/s/screen	Based on supplier information
Washwater pressure	5	bar	Based on supplier information

### 4.6.4 Turndown and Redundancy

Turndown and redundancy considerations associated with the fine screens and washing system are summarised in Table 4-12:.

Table 4-12: Grit Removal and Washing Turndown & Redundancy

Item	Number	Configuration	Comment
Incline drum screen	5	2x Duty / 3x standby	
Upstream level transmitter	1	Duty	

## 4.7 Inlet works Foul Water Pump Station

This section describes the fine screens and washing concept design. This forms part of the larger inlet works structure.

### 4.7.1 Description

The Inlet Works Foul Water Pump Station (IW FWPS) collects foul water from:

- Coarse screening washwater.
- Grit washing washwater.
- Inlet works hard stands.

All these streams drain to the IWFWPS.

Two variable speed return pumps are provided in duty/standby configuration. The pumps are controlled via the level element, or if a level element failure occurs, by the level switches. The variable speed drives are only in place for soft starting the pumps and will always operate at a fixed speed or flow.

Foul water return flow is monitored in real time and the daily volume is also calculated and displayed. This is used along with the inlet flow elements to calculate the bioreactor feed flow and volume.

To limit the size of the pump station, inflow to the pump station will be inhibited as the level increases, as summarised below in Table 4-13. It is envisioned that the pump station will operate between Low Low and Low levels, with the other elements in case of abnormal or emergency circumstances.

Table 4-13: IW FWPS Level Operation

Pump Station Level	Level Element	Switch	Action
1	Setpoint 1	Low Low	Stop All Operating Pumps / Remove All Level Inhibits
2	Setpoint 2	Low	Start Duty Pump
3	Setpoint 3	High	Inhibit grit and screenings washing
4	Setpoint 4	High High	High Level Overflow Alarm Inhibit all inflows if not inhibited

### 4.7.2 Design Assumptions

The following assumptions have been adopted for the process design:

- The IW foul water pumps are sized to accommodate:
  - Duty screen operation with accompanying washing.
  - Rainfall on hardstands.
- The storage capacity in the IW FWPS is based on control and failure objectives only. There is no attempt at flow attenuation.
- An allowance for a 1 in 100 year storm event for a hard stand area of 150 m<sup>2</sup> (sufficient to accommodate inlet works hard stand area).

### 4.7.3 Process Sizing

Process sizing associated with the fine screens and washing is presented in Table 4-14

*Table 4-14: Inlet Works Foul Water Pump Station Process Sizing*

Item/ Parameter	Value	Unit	Comment
<b>Inflows</b>			
Inlet Works Foul Water	20	L/s	
Rainfall on Hardstands	4	L/s	
<b>Pump Station Well</b>			
Operating volume	5.5	m3	
Pump runtime	200	s	
No. pumps	2		
Pump capacity	24	L/s/pump	

### 4.7.4 Turndown and Redundancy

Turndown and redundancy considerations associated with the inlet works foul water pumping station are summarised in Table 4-15:

*Table 4-15: Inlet Works Foul Water Pumping Station Turndown & Redundancy*

Item	Number	Configuration	Comment
Submersible return pump	2	Duty/Standby	Critical
Flow element	1	Duty	Not critical

## 4.8 Storm Pond and Return Pumps

This section describes the storm pond and return pump concept design.

### 4.8.1 Description

A 25ML storm pond has been provided on the eastern side of the pad to capture wet weather overflows. During extended wet weather it is possible for the storm pond to completely fill. To manage emergency flow relief, a controlled overflow point is required.

As part of project development, PMHC met with the NSW EPA and discussed alternative options for the overflow relief including:

- A piped discharge to Partridge Creek.
- A 250m long weir around the Storm Pond bank to distribute flows and overflow to the surrounding area.
- A causeway overflow weir discharging to a grass swale channel that drains to the wetland area and Partridge Creek.

The causeway overflow weir and swale channel was selected as the preferred option as this provided better containment and would facilitate sampling and flow monitoring during overflow events.

The selection of the discharge point and design of the swale channel was outside the scope of this concept. PMHC advised on the 7 May 2024 that flow will be directed to the northwest wetland and then into Partridge Creek. A sketch of the swale path from the storm pond is provided in Figure 4-1.

On this basis, the storm pond includes a 10m long overflow weir for emergency overflow relief on the north-western embankment. The weir is fitted with a 10m weir plate that is adjusted at the time of commissioning. The overflow from the storm pond is contained within a concrete lined channel down the eastern embankment of the storm pond with a rock energy dissipator at the base to prevent localised scouring and deterioration to the embankment and nearby wetland area. From here, storm pond overflows are directed into a 10m wide grass swale trapezoidal channel. The slope of the swale is intended to follow the approximate grade of the natural surface and the width has been selected to reduce the overall height/depth of the swale while minimising the discharge velocity to reduce the likelihood that erosion of the swale would occur. Consideration to the swale not being fully vegetated has also been made when sizing the width of the swale to determine velocity. A wider shallower swale is also expected to have less impact on natural flow paths during flood scenarios.

Flow relief to the adjacent wetland is to be monitored to allow volumes and durations to be reported to the regulators. The design includes level instrumentation on the storm pond for overflow event detection and calculation of overflow volumes. Access for sampling is provided.

The pond will be accessible by use of emergency egress mat and ladders which traverse down the side of the HDPE liner.

Duty/standby storm pond return pumps will allow return of storm sewage to the inlet works. The pumps will adjust their speed to target a return rate to the inlet works. The return rate will be calculated by the difference between the inflow and PFTF.

Hose reels with a 20m maximum length spaced equally 40m apart will be required around the storm pond to enable cleaning of the pond after use. A minimum of two hydrants will also be required.



Figure 4-1: Sketch of Swale Pathway as Provided by PMHC on the 7 May 2024

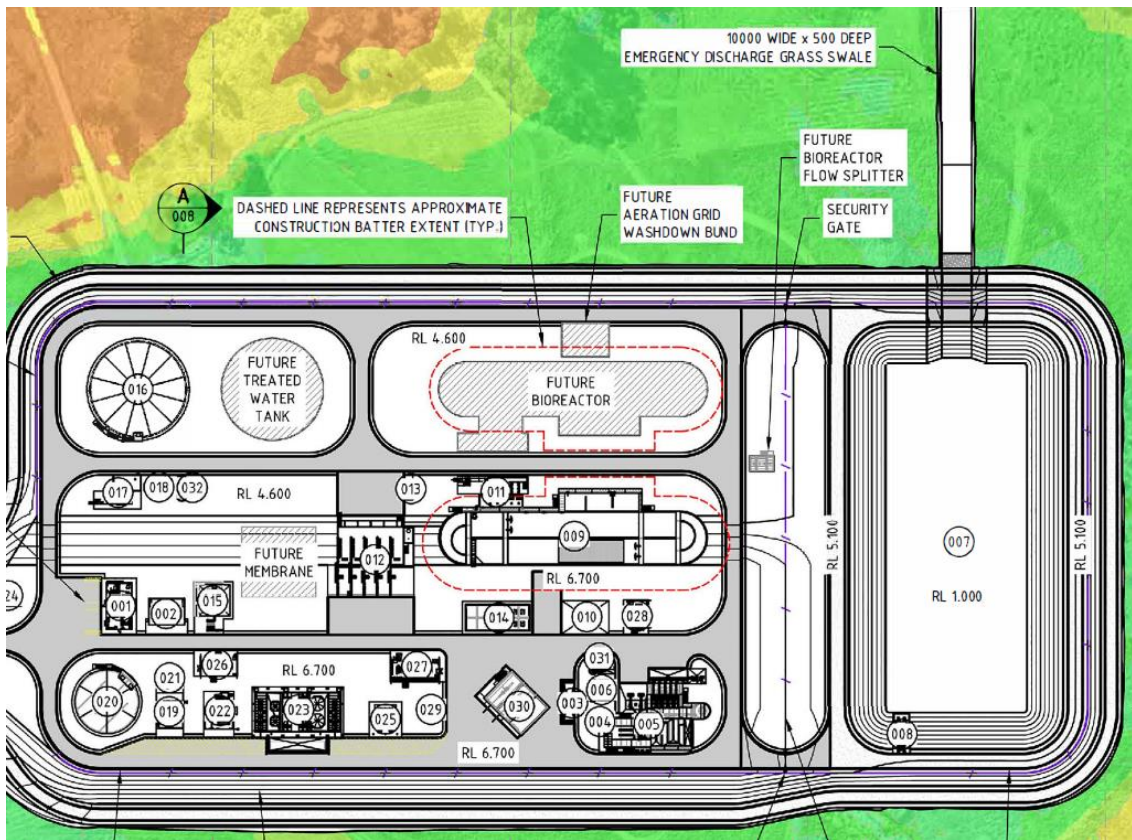


Figure 4-2: Emergency Storage Pond Configuration

## 4.8.2 Design Assumptions

The following assumptions have been adopted for the design:

- Sizing is based on the data presented in section 2.4 and Appendix Q.

## 4.8.3 Process Sizing

Process sizing associated with the storm pond is presented in Table 4-16.

*Table 4-16: Emergency Storage Lagoon and Return Pump Process Sizing*

Item	Value	Unit	Comment
<b>Storm Pond Sizing</b>			
Storm Pond Size	25	ML	Turkeys Nest Style Lagoon
Overflow Weir Length	250	m	Approximate combined weir length. Contractor to revise.
Overflow Weir RL	4.60	mRL	Set at FPL3 (1/100 ARI flood level + 500m freeboard).
<b>Storm Pond Pumps</b>			
Number of Pumps	2		Duty/Standby
Maximum Flowrate	320	L/s	
Minimum Flowrate	106	L/s	Equal to 1x ADWF at stage 1. If running minimum flowrate and plant inflow is greater than 3x ADWF, than some may return to the storm pond.

## 4.8.4 Turndown and Redundancy

Turndown and redundancy considerations associated with the emergency storage lagoon are summarised in Table 4-17:.

*Table 4-17: Emergency Storage Lagoon Turndown & Redundancy*

Item	Number	Configuration	Comment
Submersible return pump	2	Duty/Standby	Critical
Flow element	1	Duty	Not critical

## 4.9 Bioreactor

This section describes the bioreactor concept design.

### 4.9.1 Description

The activated sludge process facilitates the necessary organics and nutrient removal required to meet effluent quality requirements. The activated sludge system comprises the following key components:

- Oxidation ditch including submersible mixers.
- Three anaerobic tanks including submersible mixers.
- Diffused aeration system.
- Membrane feed system.
- WAS pump station.
- Scum Harvester.

Under normal conditions, screened sewage flows from the fine screens into the first anaerobic cell where it contacts mixed liquor returned from the membrane s-recycle. The sewage then flows through the anaerobic tanks before entering the distribution channel. The distribution channel provides the flexibility to introduce the anaerobic cell mixed liquor at different points within the oxidation ditch to fine tune nutrient removal performance.

The anaerobic cells provide low nitrate and oxygen conditions required for biological phosphorus (Bio P) removal. These conditions promote release of stored phosphorus specialist bacteria known as Polyphosphate Accumulating Organisms (PAO's). At time of the release, the PAOs take up biodegradable carbon. Once the PAOs find their way to the aerobic zone, they then release the carbon and take up more phosphorus than originally released. The cells are kept completely mixed by dedicated submersible mixers within each cell. Biological phosphorus removal can be subject to reduced performance during wet weather events or from competition with other organisms known as Glycogen Accumulating Organisms (GAOs). Therefore, to ensure the licence requirements are met, full chemical phosphorus has been included for the reactor sizing.

Submersible banana blade style mixers within the oxidation ditch maintain channel velocities to ensure mixed liquor remains in suspension and provide high levels of internal recycle that enhances nitrogen removal efficiency. The anaerobic cells discharge into the anoxic portion of the oxidation ditch, biodegradable COD is utilised by specialist bacteria to convert nitrate (generated within the aerobic section of the oxidation ditch) to nitrogen gas (denitrification).

A series of liftable diffused aeration grids fed by a series of positive displacement blowers raise the dissolved oxygen concentration to target levels. The dissolved oxygen is utilised by specialist bacteria to convert ammonia to nitrate, uptake phosphorus and consume residual biodegradable substrate. As the mixed liquor moves away from the aeration grids the dissolved oxygen decays as it is utilised by the bacteria before reaching anoxic conditions prior to the introduction of incoming sewerage. The size of the aerobic and anoxic zones is controlled by targeting a low DO setpoint near the end of the aerobic zone as measured by a series of DO probes. The speed of the blowers is adjusted to achieve the DO setpoint.

Three (3) positive displacement, variable speed blowers operating in a duty / assist / standby arrangement provide the necessary air for the aeration diffusers. A fourth and fifth blower is required to meet stage 2 aeration demands. The blowers are housed within a dedicated blower building that accommodates the stage 2 requirements, the membrane system blowers and compress air system. All blowers are contained within a dedicated acoustic enclosure. The acoustic enclosure includes a cooling fan, inlet filter and inlet and pressure relief silences. The blowers are fitted with inlet and outlet pressure switches to identify fault conditions. The diffused aeration manifold includes a pressure and flow element for monitoring purposes and is fitted with an actuated bleed off valve to provide additional aeration turndown. The blower building has no allowance for lifting equipment, instead blowers will be installed and removed using a motorised pallet jack.

Mixed liquor is extracted from the oxidation ditch by a series of five (5) dry mounted, variable speed membrane feed pumps and delivered to the membrane tanks. The pumps are designed to operate in a duty / assist / assist / jockey / standby arrangement. At stage 1, a jockey pump is provided to achieve lower flows during commissioning. A magnetic flow meter monitors and controls the flow rate from the membrane feed

pump station to 3x the PFTF. The pumps selected are large dry mounted submersible pumps to ensure operation during a flood and reduce recovery time once flood waters recede.

The mixed liquor overflows each membrane tank and enters a common channel before returning to the oxidation ditch anaerobic zone via gravity.

Under normal conditions WAS is drawn from the membrane outlet channel and pumped to a feed averaging tank by a pair of dry mounted, variable speed pumps operating in a duty / standby arrangement. The membrane channel outlet is hydraulically connected to the bioreactor and will always maintain a suitable suction level. A magnetic flowmeter monitors and controls the flow rate from the pumps.

A scum harvester has been included in the design to remove the build-up of scum from the bioreactor and deliver it to the dewatering system. The scum harvester uses a system of scum collectors which scrape the oxidation ditch surface minimising the entrainment of water from the oxidation ditch. A spray system is provided to assist in wetting of the scum as it is discharged to a hopper. A positive displacement pump transfers collected scum from the hopper to the feed averaging tank. A mag flow meter monitors the scum flow rate.

Alum can be dosed to the oxidation ditch to facilitate phosphorus removal and finite tuning of the effluent concentrations. An allowance has been provided for full chemical phosphorus removal in the event that biological phosphorus removal is not possible.

#### 4.9.2 Design Assumptions

The following assumptions have been adopted for the process design:

- A maximum MLSS of 7,600 mg/L in the oxidation ditch.
- A maximum MLSS of 11,500 mg/L in each membrane tank based on supplier information.
- A minimum SRT of 12 days, with a normal operating SRT of 22 days this is to allow effective management of the bioreactor sludge concentration and dewatering arrangement.
- Minimum winter temperature equal to 16 degrees Celsius and minimum SRT to maintain effective nitrification.
- Allowance to clear a one hour 1%AEP rainfall event over 24 hours from the bioreactor.

#### 4.9.3 Process Sizing

Process sizing associated with the bioreactor is presented in Table 4-18.

*Table 4-18: Bioreactor Process Sizing*

Item	Value	Unit	Comment
<b>Bioreactor Sizing</b>			
Minimum Temperature	16	°C	In winter.
Minimum Sludge Age	12	days	Operation at aerobic mass fraction greater than 50% is required to operate at this sludge age to maintain nitrification performance. This can be achieved by adjusting the feed location and DO setpoint in the oxidation ditch.
Normal Operating Sludge Age	22	days	To allow stable sludge, contingency for maintenance down time and no dewatering over the weekend.
Total Bioreactor Volume	7,000	m <sup>3</sup>	
Anaerobic Mass Fraction	9	%	Anaerobic zone to facilitate biological phosphorus removal.
Oxidation Ditch Mass Fraction	81.7	%	With variable inlets to optimise performance. Mass fraction of MBR is 9.2%.
Modelled MLSS	7600	mg/L	Assuming no biological phosphorus removal.

<b>Anerobic Zone Mixers</b>			
Mixers	3		One per zone
Size	2.2	kW	From supplier information
<b>Oxidation Ditch Internal Recycle</b>			
Number of Recirculation Mixers	4		2x prior to aeration to assist in pushing through aeration curtain and 2x halfway around the ditch.
Oxidation Ditch Velocity	0.2 to 0.3	m/s	To prevent settling
Average Recycle Rate	75 to 1		Approximately at 0.2 m/s and design ADWF.

Process sizing associated with the aeration system is presented in Table 4-19.

*Table 4-19: Aeration System Process Sizing*

<b>Item</b>	<b>Value</b>	<b>Unit</b>	<b>Comment</b>
<b>Bioreactor Aeration</b>			
Number of Blowers	3		Duty/Assist/ Standby. Two more duty required for Stage 2.
Alpha Factor	0.43		At MLSS concentration of 7600 mg/L
Average aerobic zone DO concentration	2.0	mg/L	To be achieved at design load peak diurnal.
Aeration Peaking Factor	1.6	x Average	Equals a nutrient peaking factor of 2.
Minimum Aeration Factor	0.64	x Average	Equals a minimum nutrient peaking factor of 0.45
Minimum SOTR	155	kgO <sub>2</sub> /h	At minimum connected load
Average SOTR	475	kgO <sub>2</sub> /h	At stage 1 design loads
Peak SOTR	735	kgO <sub>2</sub> /h	At stage 1 design loads
<b>Preliminary Air Flow</b>			
Maximum Operational Blower Power	220	kW	Total blower operational power based on supplier information at stage 1.
Power Per Blower	110	kW	2x Duty / 1 x Standby
Maximum Air Flowrate	8,500	Nm <sup>3</sup> /h	Based on supplier information.
Minimum Air Flowrate	1,500	Nm <sup>3</sup> /h	Based on supplier information.

Process sizing associated with the s-recycle pumps is presented in Table 4-20.

*Table 4-20: S-Recycle Process Sizing*

Item	Value	Unit	Comment
<b>S-Recycle</b>			
Number of Pumps	5		2 duty, 1 standby and 1 jockey at Stage 1.
Design Recycle Ratio	3	to 1 inflow	Required to maintain MLSS at a level to not exceed the membrane solids flux.
Required Permeate Flow	460	L/s	PFTF plus allowances for internal recycles.
Required Peak Permeate Flow Capacity	525	L/s	Total peak flow required to allow for membrane system downtime due to relaxation.
Peak Total Membrane Feed Capacity	1,575	L/s	Flow ratio of membrane feed to permeate of 3 to 1.
Minimum Membrane Feed Capacity	120	L/s	Commissioning ADWF at a 3 to 1 membrane feed to permeate ratio.

Process sizing associated with the waste activated sludge pumps is presented in Table 4-21.

*Table 4-21: Waste Activated Sludge Pump Process Sizing*

Item	Value	Unit	Comment
<b>Waste Activated Sludge Pump</b>			
Maximum flow per day	460	m <sup>3</sup> /d	Membrane thickened sludge. Approximately 12 day sludge age. Over 35 hours per week.
Typical flow per day	330	m <sup>3</sup> /d	Membrane thickened sludge. Approximately 22 day sludge age. Over 35 hours per week.
No. Pumps	2		1xDuty and 1xStandby
Max pump capacity	25	L/s	
Typical pump operation flow	15	L/s	

#### 4.9.4 Turndown and Redundancy

Turndown and redundancy considerations associated with the bioreactor are summarised in Table 4-22:

Table 4-22: Bioreactor Turndown & Redundancy

Item	Number	Configuration	Comment
Bioreactor	1	Duty	Additional duty at stage 2. Lifiable aeration grids mean the internal equipment can be serviced without taking the plant offline.
Bioreactor Recirculation Mixers	4	Duty	If one fails than there is no impact to the operation of the plant.
Bioreactor Anerobic Mixers	1	Duty	Per zone. If one fails it doesn't not affect the operation of any other equipment. Cold standby is recommended.
Diffused aeration grid	TBC	Duty	Lifiable grids allow maintenance without taking the bioreactor offline. Number is dependent on supplier selected.
Blowers	3	2x Duty / 1x Standby	If one fails, then the full airflow can still be maintained.
S-recycle pumps	5	3x Duty / 1x Standby / 1x Jockey	If one pump fails, max flows can be maintained. Jockey pump provided to allow minimum flow operation at commissioning.
WAS Pumps	2	Duty / Standby	If one fails, there is no impact on wasting.
Flow elements		Duty	Backup control is available in the event of flow element failure

## 4.10 Membrane System

This section describes the membrane system concept design.

The membrane system has been designed based on information provided by suppliers. There are three major MBR membrane suppliers in Australia. Each are suitable and capable of meeting the treatment requirements for this plant. Each supplier has a slightly different design factors, operational philosophy, installation requirements, geometry differences and air supply demand. The final selected supplier details will need to be adopted.

The current geometry is based on the Memcor B50N.

### 4.10.1 Description

For the 40,000EP design, the MBR system consists of five membrane trains and are configured in a 4x duty and 1x standby arrangement. The four duty trains will be able to extract up to 4x ADWF as permeate (matching the plant PFTF). The membrane racks are fixed to brackets mounted on the concrete tank walls and support brackets on the floor. Each rack is connected to permeate and air supply headers that respectively remove permeate and provide process air to the system.

The feed is introduced into each membrane tank through a channel and inlet plate designed to direct the flow between the membrane trains for even distribution.

The permeate pumps provide the suction across the membrane to draw permeate (effluent) through the membrane and deliver it to the permeate storage tank. Each train has a dedicated variable speed rotary lobe pump which is reversible to facilitate both production and cleaning functions. The pumps are fitted with an integral pressure relief valve to prevent pipework damage. This design simplifies the pipework (as separate cleaning pipework and pumps are not required). Reverse operation allows flow through the membranes and into the membrane tanks during maintenance washing and clean in place.

The drain down of the membrane tanks has been designed to empty the tank within 20 minutes to prevent the membranes being excessively exposed (membranes are damaged when allowed to dry out or exposed to direct sunlight for extended periods). Each membrane tank has an actuated valve on each drain down line, only one valve can be open as requested during a membrane recovery, the common membrane drain down pump will be connected to each membrane tank and will discharge directly to the bioreactor (regardless of membrane contents). A minimum of one day between recovery cleans should be provisioned to avoid excessive application of chemicals to the bioreactor biomass.

The air scour and permeate headers are located on top of the membrane tanks to provide access to the flexible couplings that allow easy removal of membrane racks from the header pipework. The membrane racks are fitted with designated lifting points for installation and removal that requires the use of a mobile crane. Sufficient space has been allowed to park a crane on the road or washdown bund behind the membrane facility (on the lower tier level). Access has been provided across the whole membrane structure to enable safe access to all equipment and racks for removal.

An area designated for membrane maintenance has been provided. Drainage from this area is returned to the foul water pumping station.

The level within each membrane tank is continuously monitored by a level transmitter. The permeate and backwash flows are monitored and controlled by a flow meter. Sample lines upstream and downstream of the permeate pumps allow use of turbidity analysers in both forward and reverse. Flow through the sample lines is regulated by a solenoid valve to ensure samples can be collected when the pump is running in either direction. Sample drains are directed towards a common drainage system that gravitates back to the inlet works.

Each actuated valve is fitted with open and closed limit switches to prevent membrane damage in the event of incorrect valve position.

## 4.10.2 Membrane System Considerations

The following provide considerations regarding the membrane system arrangement.

### 4.10.2.1 Maintaining Membrane Performance

The membrane system incorporates a number of clean in place (CIP) sequences to manage and restore membrane performance as the solids build-up and foul the membrane surface to increase the pressure drop (i.e. transmembrane pressure) and reduce system capacity. These methods include:

- Relaxation – stopping of the filtration process, accompanied by air scouring (every 10-12 minutes).
- Maintenance clean – reversing flow through the membrane using chlorinated permeate (sourced from the permeate storage tank), with membrane in-situ with mixed liquor (every 1-2 weeks).
- Recovery clean – draining the cell, flushing with permeate, then soaking of the membrane in cleaning solution (chlorine or citric acid) over an extended period. These are typically done every 3-6 months per train. The chlorine (sodium hypochlorite) cleaning is used to remove organic foulants from the membrane and restore membrane permeability (a concentration of 600 ppm is typically targeted). The acid cleaning (using citric acid) is used to remove inorganic foulants (a concentration of 0.5% is typically targeted).

The infrequent timing for recovery cleans (every 3-6 months per membrane tank) means that these cleans can be scheduled such that the return of chlorine solution does not impact on the biological process. Ammonia removal can be impacted by too many recovery cleans at one time. Therefore, there will be a limit to how many recovery cleans can occur per period of time. In this design it is likely to be no more than one recovery clean every two days.

At some other facilities, a small sulphuric acid dosing system is also used to enhance acid recovery cleans. The cost and benefit of a sulphuric acid system is to be confirmed during detailed design following confirmation of membrane selection.

#### Air Scour

The membrane system utilises air scour system that is integrated into the membrane system. The air scour grid is provided by the supplier and header plus blowers provided by others. It generally takes a continuous flow of air into the air scour device and releases intermittent plug flow pulses of bubbles which travel upwards and provide scouring of the membrane fibres. This action assists to remove sludge on the membrane surface and control fouling. This air scour results in a high DO concentration within the membrane tank.

Air is provided by three membrane system blowers, operating in a duty /assist/ standby configuration. The blowers will operate at a fixed pressure. The airflow to each membrane train is controlled using the aeration actuated control valve and targeting a flow as measured by the individual flowmeters for each membrane train.

The blowers are housed within a dedicated blower building that also accommodates the bioreactor blowers and are contained within an acoustic enclosure. The acoustic enclosure includes a cooling fan, inlet filter and inlet and pressure relief silences. The blowers are fitted with inlet and outlet pressure switches to identify fault conditions. The membrane tank manifold includes a pressure element for monitoring and control purposes. The inlet to each membrane tank is fitted with an air flow meter for monitoring and control purposes.

The blower room layout has been designed to allow for additional blowers to cater for the additional Stage 2 air flow requirements.

#### System Priming

The membrane system utilises compressed air driven ejectors on each permeate header to provide vacuum for the priming of the system upon start-up of each train. These ejectors can also operate intermittently during permeate production to remove any air entrained in the permeate header.

### 4.10.3 Design Assumptions

The following assumptions have been adopted for the process design:

- A daily treatment capacity of 4xADWF plus recycles and rainfall.
- A maximum peak flow operation of 14 days.
- One standby train is required to ensure effective treatment capacity.
- A maximum MLSS of 11,500 mg/L in each membrane tank.
- A total operational efficiency of 88% to allow for relaxation, maintenance clean, priming and pump start up. (i.e. up to 3 hours downtime per day – excluding CIP cleans).
- Inlet and outlet pipework to the membrane system is to be ductile iron epoxy lined to avoid concrete erosion onto the membranes.

### 4.10.4 Process Sizing

Process sizing associated with the membrane system is presented in Table 4-23.

Table 4-23: Membrane System Process Sizing

Item/ Parameter	Value	Unit	Comment
<b>Membrane Tanks</b>			
Membrane Train Volume	95	m <sup>3</sup>	Individual tank volume includes membranes.
Total Membrane Volume	475	m <sup>3</sup>	
<b>Membranes</b>			
No. Trains	5		4xDuty/ 1xStandby
Sustained Peak Flow	525	L/s	Based on 4 trains and allows for relaxation downtime. Average sustained peak flow is 460 L/s.
Total surface area	80,000	m <sup>2</sup>	Based on supplier information.
Net Flux	27	L/m <sup>2</sup> /h	Peak net flux. Based on supplier information.
Instantaneous Flux	30	L/m <sup>2</sup> /h	Peak instantaneous flux. Based on supplier information.
Peak solids flux	348	g/m <sup>2</sup> /h	Based on supplier information.
<b>Air Scour Blowers</b>			
Peak air flow	9,600	m <sup>3</sup> /h	Total
Peak airflow per blower	4,800	m <sup>3</sup> /h/blower	Each
Minimum airflow per blower	1,000	m <sup>3</sup> /h/blower	For one train
<b>Membrane Tank Drain Down Pump</b>			
Pump Capacity	20	L/s	Duty only. Sized for fast return of waste (20 minute return time).

Process sizing associated with the membrane system maintenance is presented in Table 4-24.

Table 4-24: Membrane System Maintenance Cleaning Process Sizing

Item/ Parameter	Value	Unit	Comment
<b>Membrane Relaxation</b>			
Operating Cycle	10-12	Minutes	
Relaxation time	60	Seconds	Based on supplier information.
<b>Membrane Maintenance Clean</b>			
Frequency	1-2	Weeks	
Chlorine Concentration	200	ppm	
Chlorine Usage	60	L/wash	Based on supplier information at 12.5% w/w liquid concentration.
<b>Membrane Recovery Chlorine Clean</b>			
Frequency	3-6	Months	
Chlorine Concentration	1000	ppm	
Chlorine Usage	360	L/wash	Based on supplier information at 12.5% w/w liquid concentration.
Recovery Clean Frequency	2	Days	One clean every two days recommended to avoid excessive deterioration of biomass and nutrient removal performance.
<b>Membrane Recovery Citric Acid Clean</b>			
Frequency	3-6	Months	
Citric Acid Usage	600	L/wash	Based on supplier information at 50% w/w liquid concentration.

#### 4.10.5 Turndown and Redundancy

Turndown and redundancy considerations associated with the membrane system are summarised in Table 4-25.

*Table 4-25: Membrane System Turndown & Redundancy*

Item	Number	Configuration	Comment
Membrane trains	5	4x Duty / 1x Standby	Single standby membrane train to ensure redundancy during failure.
Flowmeters	5	Duty	1 per membrane train
Membrane Blowers	3	2x Duty / 1x Standby	
Membrane Air Flowmeter	5	Duty	1 per membrane train
Turbidity Analyser	5	Duty	1 per membrane train
Level Transmitter	5	Duty	1 per membrane train

## 4.11 Permeate Tank and Process Water Pumping

This section describes the permeate tank and process service water pumping concept design.

### 4.11.1 Description

Permeate extracted from the membrane system is transferred to the permeate tank. Its purpose is to ensure permeate is available for CIP of the membranes. The tank has a high level overflow to allow excess permeate to pass to the effluent storage tanks. Two level transmitters are provided. These constantly measure the level of the tank and low level pump protection.

A process service water pumping station connected directly to the permeate tank. This pumping station provides process service water around site (i.e. screen washing, screening and grit washing, chemical carrier water, etc). The purpose is to supply all process mechanical equipment that requires washing but won't come in contact with operations staff.

### 4.11.2 Design Assumptions

The following assumptions have been adopted for the process design:

- The permeate tank will remain full while not doing a maintenance or CIP clean.
- The membrane tank operation is not affected by the level of the tank.
- Additional tanks are not required at stage 2 design due to more membrane tanks being operational.
- Process water demand allows for two coarse screens, one screening washpactor, grit sparge, grit washing and three fine screens operating simultaneously.

### 4.11.3 Process Sizing

Process sizing associated with the permeate tank is presented in Table 4-26.

Table 4-26: Permeate Tank Process Sizing

Item/ Parameter	Value	Unit	Comment
<b>Permeate tank</b>			
Number of tanks	1		No increase required at stage 2.
Volume	460	m <sup>3</sup>	Total volume.
Working Volume	320	m <sup>3</sup>	
Tank Width/Length	10	m	
Working Height	5	m	
Weir Height	12.0	mRL	
<b>Onsite Process Service Water</b>			
Number of Pumps	3		Duty/Assist/Standby
Required Flowrate	47	L/s	
Pressure	8	bar	

#### 4.11.4 Turndown and Redundancy

Turndown and redundancy considerations associated with the permeate are summarised in Table 4-27.

*Table 4-27: Permeate Tank and Process Service Water Pumps Turndown & Redundancy*

Item	Number	Configuration	Comment
Permeate Tank	1	Duty	Permeate can be bypassed if required. No process water or membrane cleaning will be available.
Onsite Process Service Water Pumps	3	Duty / Assist / Standby	Supply is important for system performance. An online standby provided.

## 4.12 Effluent Storage and Kooloonbung Creek Transfer Pumps

This section describes the effluent storage and transfer pumps concept design.

### 4.12.1 Description

Treated effluent produced onsite will be discharged to the existing PMWWTP discharge point at the Lake Road Lagoons before ultimate release to Kooloonbung Creek. This discharge location is approximately 8km away from the site and requires pumping.

A single treated water reservoir is to be constructed for storage and flow balancing prior to transfer. There is no equipment within the tank and should not be required to be taken offline. During normal design dry weather operating conditions, the reservoir will fill and draw twice per day.

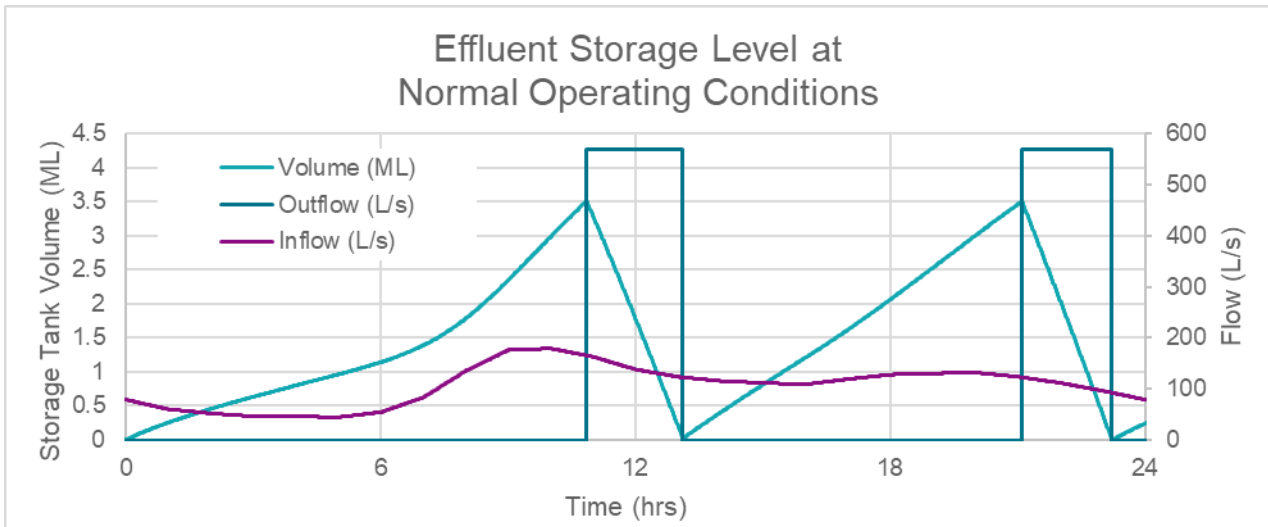


Figure 4-3: Normal Operation of the Effluent Storage Tank Fill and Draw

Three transfer pumps operating as duty/assist/standby will facilitate transfer. The pumps selected are large dry mounted submersible pumps. This is to ensure that effluent transfer will still occur during a flood event and that there will be little recovery time once flood waters recede.

Figure 4-4 provides an overview of the preliminary rising main arrangement.



Figure 4-4: Discharge to Kooloonbung Creek

### 4.12.2 Design Assumptions

The following assumptions have been adopted for the process design:

- PMHC requires four hours per day of downtime while operating at PFTF pump flowrate and storage volume accommodates this.
- At least one standby pump is required.

### 4.12.3 Process Sizing

Process sizing associated with the effluent storage and transfer pumps is presented in Table 4-28.

*Table 4-28: Effluent Storage and Kooloonbung Creek Transfer Pumps Process Sizing*

Item/ Parameter	Value	Unit	Comment
<b>Effluent Storage</b>			
Tank Size	5	ML	Total volume (from tank BOC to TWL).
Working Volume	4	ML	Allows for a total of approximately 5 to 6 hours downtime per day operating at PFTF.
Reservoir Diameter	31	m	Internal diameter.
Reservoir Height	7	m	Water depth is 6.5m and 0.5m freeboard.
<b>Kooloonbung Creek Transfer Pumps</b>			
Number of Pumps	3		Duty/Assist/Standby. Stage 2 required 1 additional assist pump.
Pump Flowrate	568	L/s	Two pumps operating at BWL. Approximately 650 L/s operating at TWL.
Operating Time	18	hours/day	
Duty Head	37	m	Combined static and dynamic headloss operating at BWL. Equalisation chamber inlet level for rising main discharge is 27mRL.

### 4.12.4 Turndown and Redundancy

Turndown and redundancy considerations associated with the effluent storage and transfer are summarised in Table 4-29.

*Table 4-29: Effluent Storage and Kooloonbung Creek Transfer Pumps Turndown & Redundancy*

Item	Number	Configuration	Comment
Kooloonbung Creek Transfer Pumps	3	Duty / Assist / Standby	If one pump is required to be taken offline for maintenance or has failed than the maximum duty can still be met.
Treated Water Reservoir	1	Duty only	All equipment installed outside of tank. Cleaning to occur while online.
Level Transmitters	2	Duty/Standby	Two level transmitters provided for redundancy.
Discharge flowmeter	1	Duty only	Back up control mode will be adopted. Discharge volume can be calculated based on pump run, tank level and inlet flow.

## 4.13 Sludge Handling System

This section describes the sludge handling system concept design.

### 4.13.1 Description

Waste activated sludge is taken from the membrane system outlet using duty/standby dry mounted submersible pumps. The purpose of this is to make use of the thickening that takes place in the membrane tanks. Typically, the volume is reduced by one third, therefore concentration increased by one third (assuming a 3 to 1 membrane feed to permeate flow).

Thickened waste activated sludge (TWAS) and bioreactor scum is directed to a dewatering feed averaging tank with a peak hydraulic residence time of 3.5 hours at the stage 1 design horizon. A jet aeration pump has been installed to keep the tank mixed and partially aerated for dewatering. The key purpose of this tank is to smooth any variation in the TWAS concentration from the membrane tank outlet. The tank is fitted with a level transmitter and high and low level switches. A mixed liquor suspended solids probe will be installed to monitor solids concentration.

Sludge from the dewatering feed averaging tank will be extracted using duty/standby dewatering feed pumps. The pumps are configured in such a way that both pumps can direct sludge to either centrifuge. Motorised actuated valves on both feed lines and in the cross connection allow this to occur.

Two centrifuges will be provided and operate in a duty/assist configuration to enable biosolids dewatering. Centrifugal forces applied to polymer conditioned sludge within the rapidly rotating bowl separate the solids from liquid. Sedimentation occurs on the bowl wall as it rotates, i.e. solids accumulate on the outside of the bowl with 'water' forming a supernatant (centrate) layer 'on top' of the solids.

At steady state, the liquid level is constant and supernatant overflows a conical weir at one end of the machine, which is discharged as centrate and flows to the dewatering foul water pumping station (DFWPS). The differential speed of the 'scroll' rotating inside the bowl pushes accumulated solids into a conical beach zone at the opposite end of the machine. As the solids move up the beach they emerge from the liquid and are discharged as dewatered biosolids. Conditioned sludge is fed towards the centre of the bowl allowing time for sedimentation and generation of a clear supernatant interface prior to discharge. It is possible for the centrifuges to operate without feed for a set period of time nominated by the supplier.

Dewatered biosolids will be discharged into a horizontal screw conveyor for distribution across the trailer. A series of slide gates will determine the location of where the biosolids are deposited. The centrifuges and conveyor are elevated above the trucks. Trucks can drive in one end of the building and out of the other, facilitating a drive through arrangement. Position sensors and traffic light (red/green) notification will indicate to the truck driver when the trailer is in the correct position. Level of the trailers is to be monitored using cameras.

Polymer dosed for the centrifuges will be an emulsion type polymer that aligns with the Port Macquarie WWTP. Deliveries either bulk or in IBCs can be accepted and transferred to a polymer storage tank via a duty-only loading pump. Two duty / assist polymer blending units, each comprising a dosing pump and mixers draw emulsion from the storage tank and transfer it to the maturation/storage tank. A set of duty / assist dosing pumps (one for each centrifuge) delivers matured polymer to the dewatering units. Potable water is used to dilute the emulsion stock solution in the blending unit and prior to dosing to the dewatering unit. All storage tanks contain vertical shaft mixers to maintain homogenous mixes.

Centrate and foul water from the dewatering system is directed to a dewatering foul water pumping station.

### 4.13.2 Design Assumptions

The following assumptions have been adopted for the process design:

- Both centrifuges can be operated to allow flexibility in the dewatering sequencing.
- The maximum dewatering period is 35 hours per week on a single centrifuge.
- The actual dewatering period is based on the typical TWAS volume (bioreactor sludge age) and the centrifuge hydraulic capacity.
- The centrifuge wash water flow and operating period is based on supplier advice.
- The makeup polymer concentration for dosing is 0.25%.

- The solids recovery and biosolids solids content is based on supplier advice.

### 4.13.3 Process Sizing

Process sizing associated with the sludge handling system is presented in Table 4-30.

Table 4-30: Sludge Handling System Process Sizing

Item/ Parameter	Value	Unit	Comment
<b>Dewatering Feed Averaging Tank</b>			
Total volume	150	m <sup>3</sup>	
Working volume	120	m <sup>3</sup>	80% of total volume, 3.5 hours of WAS flow at stage 1.
<b>Average Dewatering Feed</b>			
TWAS volume	1,630	m <sup>3</sup> /week	22 day SRT
TWAS volume	2,330	m <sup>3</sup> /week	12 day SRT
<b>Centrifuge</b>			
Type			Centrifuge
No. Units	2		Duty/Assist
Required hydraulic capacity	47	m <sup>3</sup> /h	Each, based on 7 hours operation 5 days per week
Required solids capacity	500	kg/h	Each, based on 7 hours operation 5 days per week
Solids concentration in	1.1	%	Minimum of 0.75%
Solids concentration out	16-20	%	Average concentration of 18%
Solids capture rate	97-99	%	Based on supplier information.
Flushing Washwater Rate	2.8	L/s	For 40 minutes at shutdown.
<b>Distribution Conveyor</b>			
Type	Horizontal		
Capacity	3.5	m <sup>3</sup> /h	Dewatered biosolids to be distributed along trailer.
<b>Dewatering Polymer Storage and Dosing</b>			
Dry Polymer Dose	10	kg/ t DS	Based on supplier range of 8-10 kg/ t DS
Neat Dry Polymer Usage	5	kg/h	
Replacement Ratio	1.4	kg/kg	Powder to emulsion ratio
Emulsion Polymer Dose	14	kg/ t DS	
Neat Emulsion Polymer Usage	7	kg/h	
Neat Polymer Storage Time	40	Days	

Neat Polymer Storage Volume	2	m <sup>3</sup>	Two 1m <sup>3</sup> IBCs per 40 days of operation.
Polymer Batch Strength	0.25	%	
Total Polymer Batch Dose	2,800	L/h	
Polymer Flowrate Rate	3,000	L/h	Pump capacity to each centrifuge
Dosing Tank Residence Time	30	minutes	
Dosing Tank Working Volume Required	1,500	L	75% of the total volume
Assumed Total Volume	2,000	L	

#### 4.13.4 Turndown and Redundancy

Turndown and redundancy considerations associated with the sludge handling system are summarised in Table 4-31.

*Table 4-31: Sludge Handling System Turndown & Redundancy*

Item	Number	Configuration	Comment
Dewatering feed averaging tank	1	Duty	Wasting can be suspended for up to 2 days if required to be taken offline.
MLSS probe	1	Duty	Not critical to operation.
Centrifuge Feed Pumps	2	Duty/Assist	Full redundancy.
Centrifuge flow meter	1	Duty	No critical for operation.
Centrifuge	2	Duty/Assist	Full redundancy.
Polymer dosing pumps	2	Duty/Assist	Full redundancy.
Polymer dosing tank	2	Lead/Lag	Redundancy provided in 2 tanks.
Polymer mixing tank	2	Lead/Lag	Redundancy provided in 2 tanks.

## 4.14 Dewatering Foul Water Pump Station

This section describes the sludge handling concept design.

### 4.14.1 Description

The Dewatering Foul Water Pump Station collects foul water from:

- Centrate from centrifuges.
- Dewatering feed averaging tank overflow.
- Foul water from hardstands and polymer bunds.

Two variable speed return pumps are provided in duty/standby configuration. The pumps are controlled via the level element, or if a level element failure occurs, by the level switches. The variable speed drives are only in place for soft starting the pumps and will always operate at a fixed speed or flow.

Foul water return flow is monitored in real time and the daily volume is also calculated and displayed. This is used along with the inlet flow elements to calculate the bioreactor feed flow and volume.

### 4.14.2 Design Assumptions

The following assumptions have been adopted for the process design:

- The dewatering foul water pumps are sized to accommodate two centrifuges operating.
- The storage capacity in the Dewatering FWPS is based on control and failure objectives only. There is no attempt at flow attenuation.
- All hard stands in the sludge handling area are directed to the Dewatering FWPS.
- An allowance for a 1 in 100 year storm event for a hard stand area of 150 m<sup>2</sup> (sufficient to accommodate inlet works hard stand area).

### 4.14.3 Process Sizing

Process sizing associated with the dewatering foul water pumping station is presented in Table 4-32.

Table 4-32: Dewatering Foul Water Pump Station Process Sizing

Item/ Parameter	Value	Unit	Comment
<b>Inflows</b>			
Dewatering Foul Water	25	L/s	Two centrifuges operating at typical hydraulic rate of 47 m <sup>3</sup> /h.
Rainfall on Hardstands	4	L/s	
<b>Pump Station Well</b>			
Operating volume	6.0	m <sup>3</sup>	Two centrifuges operating.
Pump runtime	200	s	
No. pumps	2		Duty/Standby
Pump capacity	29	L/s/pump	Two centrifuges operating plus rainfall on hardstand.

### 4.14.4 Turndown and Redundancy

Turndown and redundancy considerations associated with the dewatering handling foul water pumpstation are summarised in Table 4-33.

Table 4-33: Dewatering Foul Water Pumping Station Turndown & Redundancy

Item	Number	Configuration	Comment
Dewatering Foul Water Pumps	2	Duty / Standby	The loss of one pump has no impact on operation. The failure of both pumps will prevent dewatering for continuing. This is not critical.
Flowmeter	1	Duty	Failure of the flowmeter will not impact operation.
Level Transmitter	1	Duty	Failure of the level element will lead to a change to backup control using the level switches.

## 4.15 Bulk Chemical Storage and Dosing

The bulk chemical dosing system consists of the storage of alum and sodium hydroxide to meet licence requirements and ensure process stability. Membrane CIP bulk chemical storage for sodium hypochlorite and citric acid is also included in the bulk chemical storage area.

Additional consideration should be made for sodium hydroxide to confirm chemical dosing storage for odour management, if required.

Polymer dosing is considered separate, operating exclusively in the dewatering building.

### 4.15.1 Description

Alum and sodium hydroxide chemical is delivered by bulk delivery tanker and stored in the bulk storage tank. Level alarms measured by the dual radar level instrument indicates when the storage tank nears empty so that a delivery can be ordered.

Deliveries arrive by tanker and are pumped from the tanker to the storage tank, the pump is powered by a local panel at the filling station. The power to the pump is automatically inhibited once the bulk storage tank is full, preventing overflows. The local level indicator panel also assists the tanker delivery operator with filling. Any spills that occur are captured in a road delivery bund and are transferred to the septage pump station; this is existing.

Membrane CIP chemicals are delivered in 1 m<sup>3</sup> IBCs and are transferred manually by the operator to the storage and dosing tank using the fixed transfer pump.

The storage tank and dosing pumps are located within a bunded area. The bund is sized to contain more than the volume of the storage tank in case of tank or pipe rupture. A sump within the bunded area allows a portable sump pump to be used to extract any chemical captured. The chemical facility is to be bird proofed using shade grip fasteners from V-grip or similar to those used at the Wauchope Fluoride Facility.

Each chemical has two digital dosing pumps in duty/standby configuration are provided for inlet works dosing. The rate of dose can be varied based on the selected mode; the default mode varies with influent flow (flow paced mode) so that the chemical dose matches the incoming flow/load. The alum dose is capped and sodium hydroxide pump run time set to prevent overdosing during wet weather.

Flush points are provided for each pump and dosing line to allow flushing of chemical prior to maintenance. Eyewash and safety showers are in the unloading area, within the bund and near the dosing pumps. If a safety shower is used for a delay time, an alarm will be raised.

### 4.15.2 Design Assumptions

The following assumptions have been adopted for the process design.

- Default steady state kinetics have been assumed to predict rudimentary biological uptake of phosphorus prior to chemical precipitation and alkalinity consumption from nitrification, denitrification, ammonification and chemical P removal.
- Sizing is based on full chemical phosphorus removal. This is conservative to allow for interruptions to biological phosphorus removal from polyphosphate accumulating organisms (PAOs).
- The phosphorus precipitation chemical storage and dosing facility has been sized on Alum as this is the most conservative approach for both sizing and alkalinity consumption.
- The alkalinity adjustment storage and dosing facility has been based on 25% sodium hydroxide as this is the most conservative for sizing, it also prevents lagging of pipework to prevent freezing.
- The stoichiometric (molar) rates to achieve the desire PO<sub>x</sub>-P concentrations are based on experience and are intentionally conservative (i.e. 2.5:1).
- The alum and sodium hydroxide storage tank has been sized to accept a complete tanker compartment.
- Membrane CIP volumes are based on supplier information.
- Provision is included to enable sodium hydroxide to be dosed directly to the bioreactor anaerobic zone for improved dose control during wet weather flow conditions.

### 4.15.3 Process Sizing

Process sizing associated with the bulk chemical storage and dosing is presented in Table 4-34.

Table 4-34: Bulk Chemical Storage and Dosing Process Sizing

Item/ Parameter	Value	Unit	Comment
<b>Alum Storage and Dosing</b>			
Al content	4.22%	w/w	
Specific Gravity	1.3		
Nutrient Peaking	2	:ADWF	Capped at 2xADWF for peaking of nutrients.
Primary Alum Molar Rate	2.5:1	Al:P	Alum per mole of phosphorous.
Effluent TP	0.5	mg/L	
Alum Storage Tanks	2		
Alum Tank Working Volume	50	m <sup>3</sup>	20 days per tank.
Total Usable Volume	90	m <sup>3</sup>	90% usable volume.
Average Dose	14	mg/L	Aluminium metal dose.
Peak Dose	200	L/h	Solution dose.
Storage at Average Conditions	40	days	
<b>Sodium Hydroxide Storage and Dosing</b>			
Influent Alkalinity	2,340	kg/day CaCO <sub>3</sub>	
Nitrification Demand	-2,770	kg/day CaCO <sub>3</sub>	
Denitrification Credit	1,240	kg/day CaCO <sub>3</sub>	
Ammonification Credit	310	kg/day CaCO <sub>3</sub>	
Chemical P Removal	-700	kg/day CaCO <sub>3</sub>	
Final	420	kg/day CaCO <sub>3</sub>	Approximately 45 mg/L of Alkalinity
Required Alkalinity Addition	55	mg/L	To meet 100 mg/L of Alkalinity or approximate dose for odour control. Further consideration in detailed design for H <sub>2</sub> S exposure at the inlet works.
Sodium Hydroxide Storage Tanks	2		
Sodium Hydroxide Tank Volume	25	m <sup>3</sup>	
Total Usable Volume	45	m <sup>3</sup>	90% usable volume.
Average Dose Rate	18	L/h	
Inlet Works Mains Peak Pump Dose Rate	300	L/h	To meet stage 1 peak pumped flowrate.
Anaerobic Zone Peak Dose Rate	54	L/h	Limited to 3x ADWF at stage 1 design.

Storage at Average Conditions	49	days	
<b>Sodium Hypochlorite CIP Storage and Dosing</b>			
Usage Per Maintenance Wash	305	L/week	61 L/wash, 5 per week.
Usage Per CIP Clean	1,800	L/regime	357 L/clean, five every 3 months
Storage Tank Volume	3	m <sup>3</sup>	
Storage Time Maintenance Clean Only	10	weeks	
Storage Time CIP Clean and Maintenance Clean	2	Weeks	CIP clean of each membrane train and 2 weeks of maintenance washes.
Additional storage allowance	2x IBC		2x 1 m <sup>3</sup> IBC can be stored in bund.
Pump rate required for Maintenance Clean	335	L/h	
Pump rate required for CIP Clean	1,760	L/h	
<b>Citric Acid CIP Storage and Dosing</b>			
Usage Per CIP Clean	3,000	L/regime	357 L/clean, 5 every 6 months
Storage Tank Volume	3	m <sup>3</sup>	
Storage Time CIP Clean	1	Regime	CIP clean of each membrane train
Additional storage allowance	2x IBC		2x 1 m <sup>3</sup> IBC can be stored in bund.
Pump rate required for CIP Clean	3,000	L/h	

#### 4.15.4 Turndown and Redundancy

Turndown and redundancy considerations associated with the bulk chemical storage is summarised in Table 4-35.

*Table 4-35: Bulk Chemical Storage and Dosing Turndown & Redundancy*

Item	Number	Configuration	Comment
Alum Storage	2	Duty	Approximately 40 days of storage at peak average design rates and full chemical phosphorus removal. Long effective life.
Sodium Hydroxide Storage	2	Duty	Approximately 49 days of storage at peak average design rates. Long effective life.
Sodium Hypochlorite Storage	1	Duty	Additional IBCs can be stored in the bunded area. 10 weeks of storage without CIP cleans.
Citric Acid Storage	1	Duty	Additional IBCs can be stored in the bunded area. Only required every 3 to 6 months.
Dosing Pumps Per Chemical	2	Duty/Standby	Per chemical. The loss of one pump has no impact on operation. Dosing pump that can be kept as a cold spare as required. Sodium hydroxide has two dosing points and two separate duty/standby pump sets.

## 4.16 Recycled Water System

The following relates to the production of dual reticulation quality recycled water.

### 4.16.1 Description

The recycled water produced by the Thrumster WWTP is to be to of a dual reticulation standard that aligns with the current Australian Guidelines for Water Recycling (AGWR).

The Recycled Water Treatment Plant is to consist of:

- The secondary treatment plant with integrated membrane filtration claiming 0.5 log adenovirus removal.
- Ultraviolet (UV) disinfection USEPA validated to achieve 2 log inactivation of adenovirus.
- Chlorination and chlorine contact sized to achieve 4 log inactivation of adenovirus .

Effluent produced from effluent storage tanks will be pumped using the UV feed pumps to the chlorine contact tank via the in-pipe UV disinfection units. The incoming main will have monitoring for turbidity and UVT.

Post UV disinfection, the effluent will be chlorinated using chlorine solution. The chlorine contact tank will provide the necessary contact volume to provide the required performance for virus removal. The contact tank will have a high level inlet, flow baffles and a low level outlet. The chlorine residual will be measured on both the inlet and outlet for finite control and critical control point monitoring. The chlorine contact tank will have duty/standby level instruments to monitor level and control production start and stop.

A duty/standby dual reticulation pumping station will transfer disinfected effluent into the dual reticulation network and to the Area 13 storage reservoir. A connection on the discharge main will provide onsite use of recycled water for hose reels, amenities toilet flushing and chlorine service water.

Chlorine gas will be provided to enable disinfection. The system will be contained in a standalone building with a drum storage room and ejector room. The storage room has space for 3x 920 kg drums and the ejector room includes the dosing equipment and service water line. Two drums are connected at any one time, draw off occurs from a single drum only. Both drums are fitted with an automatic change over. The third is a cold spare. The chlorine rooms will be fitted with mechanical ventilation, chlorine leak detection and provision made for a chlorine scrubber.

Gas is drawn from the drums under a vacuum created by an ejector. The ejector mixes the gas and service water to produce a concentrated liquid for dosing. The chlorine liquid is dosed directly into the main using a retractable dosing lance.

### 4.16.2 Design Assumptions

The following assumptions have been adopted for the process design.

- The WaterVal Tier 1 MBR LRVs could be targeted to avoid challenge testing. An additional 0.5 LRV protozoa will need to be claimed on top of the minimum requirements of the AGWR.
- Challenge testing or validation may be required for the secondary and membrane system to confirm the protozoa LRVs. Advice from the supplier indicates a performance of 0.2 NTU can be achieved for 95%ile of samples and 0.5 NTU for all samples. This does not align with the Water Val requirements of 0.2 NTU max and further consideration is required for challenge testing at the next stage of negotiation with regulatory stakeholders. Depending on the requirements set by regulatory stakeholders, this may need continued challenge testing as the membranes age.
- Operational requirements will be tested at each relevant stage of the plant.
- The adopted UVT of effluent is 45% under a worst-case scenario. The UVT directly effects the performance of the UV system to inactivate virus. Analysis of the existing Port Macquarie WWTP shows a 5th Percentile UVT of 60% and minimum of 47%. The measured results noted to be taken after the existing lake road lagoons.
- UV validation is based on supplier information and US EPA 2006 UV Disinfection Guidance Manual.

- Chlorination adopts the requirements set out by guidance documentation and literature. Specifically Smart Water Fund 2012 (Keegan, Wati, & Robinson, 2012), Getting Chlorination Right (NSW Office of Water, 2015) and WaterVal Validation Protocol for Chlorine Disinfection (Water Secure, 2017).
- The plant is to be operational for 22 hours per day.

Target control points for alert of operators of the recycled water system will be determined through a recycled water risk assessment workshop with PMHC and NSW Health. The target setpoints will include:

- Combined membrane system outlet turbidity.
- Monitor each individual train to enable troubleshooting.
- UV transmissivity and UV dose rate.
- Chlorine contact time x free residual (Ct).
- pH.
- Temperature.
- Peak flux.
- Transmembrane pressure.

Preliminary critical control points for shutdown of the recycled water system below are suggested based on the WaterVal requirements. These should be confirmed within a recycled water risk assessment workshop and documented in the recycled water management plan:

- Combined membrane outlet turbidity of greater than 0.2 NTU for greater than 15 minutes.
- UV dose rate less than 100 mJ/cm<sup>2</sup> as per supplier information.
- Chlorine contact time of less than 16 mg.min/L and pH greater than 8.

These target and critical control points should be tested during proof of performance testing and challenge testing if required.

Figure 4-5 provides a high level flow diagram for the recycled water plant configuration.

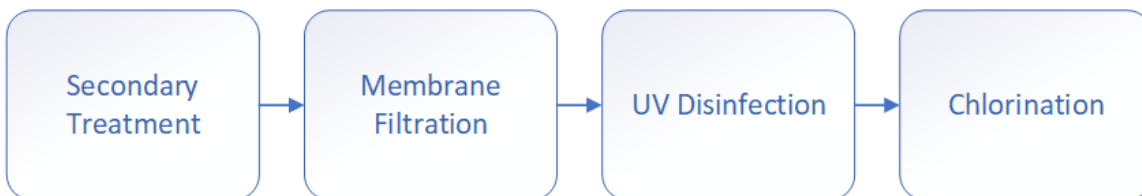


Figure 4-5: Adopted Recycled Water Configuration

Table 4-36 provides an overview of the log reductions claimed by each process. Performance testing will need to be completed to ensure the log credits are achieved.

Table 4-36: Log Reduction Claims for Dual Reticulation Quality Recycled Water

	Secondary Treatment	Membrane Filtration	UV	Chlorination	Total Claimed	AGWR Requirement
Virus	0.5	0.0*	2.0	4.0	6.5	6.5
Protozoa	0.5	0.5 <sup>+</sup>	4.0	0.0	5.0	5.0
Bacteria	1.0	0.0*	4.0	4.0	9.0	5.0

\*Required log credits to be claimed from the membrane system. Tier 1 default LRV based on WaterVal 2017 Membrane Bioreactor could be considered for performance requirements. Challenge testing the combined secondary and membrane for protozoa may be required for the system to confirm the additional 0.5 LRV protozoa required. This validation is for the contractor to confirm and liaise with PMHC and the relevant stakeholders.

\*Virus and bacteria LRV credits for membrane filtration have not been claimed and a reduced value for protozoa for this process. However, suppliers indicate that >2 log removal virus, >4 log protozoa and >4 log

removal bacteria have been demonstrated at other plants and WaterVal Tier 1 notes 1.5 LRV virus, 2 LRV protozoa and 4.0 LRV bacteria can be adopted if the requirements are met.

WaterVal 2017 states requirements for MBR operation in order to claim the conservative Tier 1 LRVs. These will set the minimum requirements for the membrane system without the need for challenge testing. The operating requirements are provided in Table 4-37.

*Table 4-37: WaterVal 2017 MBR Requirements to Claim Tier 1 LRVs for MBR*

Item/ Parameter	Value	Unit	Comment
<b>WaterVal 2017 MBR Requirements</b>			
Membrane Pore Size	0.04 – 0.1	µm	Minimum – Maximum
Bioreactor pH	6 – 8	-	Minimum – Maximum
Bioreactor Dissolved Oxygen	1 – 7	mg/L	Minimum – Maximum. Assumed as average for the oxidation ditch aerobic zone and in the membrane system.
Bioreactor Temperature	16 – 30	°C	Minimum – Maximum
Solids Retention Time	11	Days	Minimum
Hydraulic Retention Time	6	Hours	Minimum based on previous 24 hours of data
Mixed Liquor Suspended Solids	3	g/L	Minimum within the bioreactor.
Transmembrane Pressure	3	kPa	Minimum
Instantaneous Flux	30	L/m <sup>2</sup> /h	Maximum
Turbidity	0.2	NTU	Maximum

### 4.16.3 Process Sizing

Process sizing associated with the recycled water system is presented in Table 4-38.

*Table 4-38: Recycled Water System Process Sizing*

Item/ Parameter	Value	Unit	Comment
<b>System Production Requirements</b>			
Dual Reticulation Supply	59.3	L/s	Equal to 4.7 ML of production over 22 hours.
Onsite Reuse Supply	7.7	L/s	
Total Production	67.0	L/s	
<b>UV System</b>			
Number of reactors	3		Duty/Assist/Standby
UV Dose Rate	100	mJ/cm <sup>2</sup>	As per supplier information and WaterVal 2017/US EPA 2006.
Capacity (Minimum UVT)	30	L/s/reactor	Operational at 45% UVT to achieve 2 log virus inactivation.

Capacity (PMHC 5 <sup>th</sup> Percentile UVT)	60	L/s/reactor	Operational at 60% UVT to achieve 2 log virus inactivation.
<b>Chlorine Dosing System</b>			
Disinfection Flowrate	67	L/s	
Chlorine Residual Target	1.5	mg/L	
Chlorine Demand from Ammonia	4.0	mg/L	Based on 0.5 mg/L Ammonia in the effluent and 8 mg/L chlorine per 1 mg/L of ammonia to reach breakpoint.
Chlorine Demand from Organic	4.0	mg/L	Assumed based on experience.
Chlorine Residual Dose Requirement	9.5	mg/L	
Chlorine Usage per Day	50	kg/d	
Chlorine Usage per Hour	2.3	kg/h	Operating at maximum capacity for 22 hours. Two ejectors operable in duty/standby.
Number of Chlorine Drums	3		Two connected and one in storage.
Drum Size	920	kg	
Storage Time	37	Days	Two drums.
<b>Chlorine Contact Tank</b>			
Contact Tank Size	1.5	ML	Total volume Includes chlorine contact
Chlorine Contact Time (C.t)	16	mg.min/L	
Baffle Factor	0.3		High level inlet, low level outlet and single baffle.
Minimum Volume for C.t	250	m <sup>3</sup>	
<b>Dual Reticulation Transfer Pumps</b>			
Number of Pumps	2		Duty/Standby
Transfer Flowrate	67	L/s	4.7 ML/d over 22 hours (59.3 L/s) plus onsite reuse demand.
<b>Onsite Reuse Demand</b>			
Onsite peak demand	7.7	L/s	Connected to the discharge of the dual reticulation transfer pumps. Contractor to confirm minimum pressure for service can be met.  For hose reels, amenities and chlorine service water.

#### 4.16.4 Turndown and Redundancy

Turndown and redundancy considerations associated with the recycled water system is summarised in Table 4-39.

Table 4-39: Recycled Water System Turndown & Redundancy

Item	Number	Configuration	Comment
UV Feed Pumps	2	Duty/Standby	Fitted with VSD. Full redundancy provided.
UV Disinfection	3	Duty / Assist / Standby	Capacity highly dependent on UVT.
Chlorine Gas Drums	3	Duty / Standby / Offline	Draw off one drum at any one time. Automatic change over. One cold standby.
Chlorine Gas Ejectors	2	Duty/Standby	One ejector can achieve the maximum capacity.
Chlorine Contact Tank	1	Duty Only	All equipment installed outside of tank. Cleaning to occur while online.
Dual Reticulation Transfer Pumps	2	Duty/standby	One pump can meet the required duty. Full redundancy.
Onsite reuse pumps	2	Duty/standby	One pump can meet the required duty. Full redundancy

#### 4.16.5 Use as a Water Supply for Firefighting

A bushfire assessment for the Thrumster WWTP has been completed (GHD, July 2024). As part of the bushfire protection measures, this report identifies that the Chlorine Contact Tank could be used as an onsite water supply for firefighting. The report recommends that the Chlorine Contact Tank is fitted with an appropriate water outlet point for this purpose. An outlet is shown on the P&ID.

The further design development of the Chlorine Contact Tank should note this requirement and review and further develop the design to meet the requirements of a Static Water Supply as specified in Table 7.4(a) of the Planning for Bush Fire Protection guideline (NSW Rural Fire Service, 2019).

# 5 Civil and Structural Design

## 5.1 Existing Site

The existing WWTP site is a relatively greenfield development, previously being farmland with some small structures (house, shed etc.) located primarily along the western property edge. Some minor unsealed roads and culverts are present around the property. The main infrastructure present at the proposed WWTP are incoming sewer mains that have previously been installed via directional drill entering the site from the south-eastern corner.

## 5.2 Survey

A site survey was undertaken by Beca HunterH2O using aerial drone mapping and supplemented by a control survey. A detailed surface produced from the survey data has been incorporated into the 3D model. Existing services have been identified through existing record drawings and Dial Before You Dig Enquiries.

## 5.3 Geotechnical

### 5.3.1 General

As outlined in Section 2.17.1 of this report, the site has been elevated on a fill pad to mitigate against flooding. The site is located near the Hastings River and directly bordered by Fernbank Creek to the north and Partridge Creek to the east. Large areas of the site are low-lying and form natural wetlands, with the proposed treatment plant location being located on higher areas to the south of the site. As part of the flood mitigation measures raised access roads have also been proposed to facilitate access to the fill pad during wet weather events.

Excess fill from another PMHC site at Cowarra is being considered for re-use at this site, with some general testing to confirm the qualities of this fill undertaken. This fill was found to comprise primarily of residual clay and weathered rock.

### 5.3.2 Field Investigations

Fieldwork for the geotechnical investigation was undertaken in late March 2024 by Regional Geotechnical Services (RGS).

The investigation scope included the following:

- Mapping of site features and other observations relevant to the site geotechnical conditions.
- Six test pits at various locations (depths to 1.2m).
- Six boreholes to rock (depths to 18-19m or prior refusal).
- Two boreholes cored into rock (depths to 21-23m).
- DCP testing adjacent to each borehole.
- Two temporary ground water monitoring wells (depth to 3m), monitored for four weeks after completion of drilling.
- Sampling and laboratory testing for plasticity, pavement design, dispersion, acid sulphate screening and soil aggressivity analysis.

### 5.3.3 General Site Subsurface Conditions

The site is situated on a Pleistocene dune that can include marine sand and indurated sand, in an area underlain by deeply weathered geological units. The northern proposed access road is located on a Holocene backswamp that includes units of organic mud, peat, silt and clay.

### 5.3.4 Investigation Findings

The bore logs typically indicate the presence of sandy silty clay to depths of up to 15m prior to termination of the bore. Shallow layers of sand and gravel were also intermixed with in some bores. Highly weathered siltstone was encountered on a number of bores at an approximate depth of 13m. Highly fractured sandstone was encountered at depths up to 30m from the surface where bores were continued via coring.

Two samples were submitted to a NATA accredited laboratory for chemical aggressivity analysis with the following results:

- pH of 5.65 (BH1) and 6.35 (BH4).
- Chloride contents of <10 for both samples.
- Sulphate contents (SO<sub>4</sub>) of less than 1000ppm.
- Resistivity of 19,231 and 90,909 ohm.cm.

In accordance with AS2159-2009 the coarse soils are considered to be mildly aggressive towards concrete and non-aggressive towards steel elements, and the fine soils are considered non-aggressive towards concrete and steel elements. Consideration to the aggressivity of the final fill material should also be made in the design of structural elements by the detail designer.

### 5.3.5 Fill Pad

The site has been elevated on a fill pad to mitigate against flooding based on the requirements outlined in Section 2.17.1 of this report. The following extract from the geotechnical report (RGS, 2024) summarises the expected requirements of the fill pad construction including additional investigations where required:

All fill placed for the support of structures or pavements should be placed and compacted as outlined below:

- Proposed fill material should comprise suitable fill as defined in AS 3798-2007 Guidelines on Earthworks for Residential and Commercial Developments. Inspection by a geotechnical authority may be required to confirm suitability of proposed fill material.
- Unsuitable material should be stripped and the exposed natural subgrade should be proof roll tested to highlight any soft, wet or excessively deflecting areas. Where these are encountered, they should be over-excavated and removed to spoil. Excavated areas should be backfilled with an approved granular material.
- Following this process, where a sand foundation is exposed a grid of penetrometer tests should be undertaken across the sand foundation area to confirm a density index of 60% in the foundation sands to at least 1.5m depth, prior to placement of fill.
- In areas where pavements are proposed, the subgrade will be required to be within  $\pm 2\%$  of OMC prior to placement of pavement layers. Moisture conditioning of the subgrade may be required prior to compaction.
- Drying back of the foundation and the site won fill materials is likely to be required prior to filling. Some subgrade improvement works may also be required in the low lying areas of the site. Treatment options can be determined once the materials are exposed, or predicted once the depths of excavations are known.
- Fill is likely to be predominantly site won material from Cowarra Treatment Plant excavations and, depending on the depth and location of the excavations could comprise site won sand, clay, or weathered rock.
- Maximum particle size for general building area and road embankment fill is 100mm.
- Where filling is required beneath structures, approved fill should be placed in layers not exceeding 250 mm loose thickness and compacted to a minimum dry density ratio of not less than 98% of standard compaction. Clay fill should be placed and maintained at no more than  $\pm 2\%$  of standard optimum moisture content. Sand fill should be compacted with the addition of water and use of a vibratory smooth drum roller to a minimum density ratio of 65% Density Index.
- Where filling is required beneath pavement layers, suitable fill should be placed in layers not exceeding 300 mm loose thickness and compacted to a minimum dry density ratio of 98% standard compaction. The top 300mm of natural subgrade below pavements or the final 300mm of placed road subgrade fill should be compacted to a minimum density ratio of 100% Standard Compaction. Clay fill should be

placed and maintained within 2% of standard optimum moisture content. Sand fill should be compacted to a minimum density ratio of 65% Density Index.

- All fill for the support of structures should be placed and compacted in accordance with the recommendations outlined in AS3798-2007 Guidelines on Earthworks for Residential and Commercial Developments, under Level 1 supervision. Areas of the site that are filled to support pavements should be filled under Level 2 supervision and testing.
- Fill batters should be over-placed and trimmed back to the design batter to ensure that compaction is achieved to edge of formation.
- Careful management of moisture sensitive blended clay and rock material will be required during and after placement as fill. This may include grading of the subgrade towards embankment shoulders or edges of fill platforms and temporary drainage diversion measures to prevent water pooling on the surface.

### 5.3.6 Foundations

Appropriate foundation design and preparation will be a critical aspect of this project, given the entire treatment plant will be founded on an elevated pad.

Much of the proposed building area will comprise controlled fill. One of the investigated sources of fill is excess material from the Cowarra Treatment Plant, expected to be comprised primarily of residual clay and excavated weathered rock. Based on the subsurface conditions and details available of the proposed development, it is considered that shallow footings founded in controlled fill won from the Cowarra site will likely be adopted for the majority of structures.

Larger or heavier structures such as the bioreactor or structures founded across the multiple pad levels are expected to require additional foundation works to prevent differential settlement occurring. These additional foundation works are expected to comprise of piling, with the arrangement and extents to be confirmed by the detail designer. Structures expected to include additional foundational works such as piling include but are not limited to the following:

- Stage 1 Bioreactor.
- Membrane Facility.
- Permeate Tank.

#### 5.3.6.1 Shallow Foundations

The following shallow foundation design parameters presented in Table 5-1 will apply. These values should be reconfirmed by a geotechnical specialist once the final fill material has been selected.

*Table 5-1: Shallow Foundation Design Parameters*

Material / Unit	Allowable Bearing Pressure (kPa)
Controlled fill comprising stiff clay or better compacted to not less than 95% Standard Compaction under Level 1 supervision and testing	100
Unit 3A – Marine Sand	100
Unit 4B – Alluvial Clay	100

For pad and/or strip footings or stiffened raft footing beams up to 2 m wide, 100 kPa may be adopted as the allowable bearing pressure. Under applied loads of this order, total settlements are anticipated to not exceed 15 mm.

All structural footings should be founded as follows:

- All footings should be founded in Controlled Fill or natural marine sands or alluvial clay soils, below all topsoil and any uncontrolled fill materials.
- All footings, edge beams and internal beams should be founded on similar material outside or below the zones of influence resulting from existing or future service trenches, retaining walls or other subsurface structures.

- Prior to the placement of concrete, footings are to be observed and assessed by a suitably experienced geotechnical engineer to ensure that the correct founding material has been achieved. Concrete should be placed immediately after excavation and assessment to avoid softening of the foundation, or blinding concrete placed.

Shrink-swell related movements can be affected by alterations to the soil profile by cutting and filling, and by the suction related effects of trees close to the building area. The effects of any such cutting, filling, tree planting should be taken into account when selecting design values for differential movement across the building.

#### 5.3.6.2 Piled Foundations

Recommended piling options include non-displacement piles comprising of bored reinforced concrete piles or grout injected continuous flight auger piles.

Construction of open bored piles is expected to typically require drilling below the groundwater level, which was encountered from 1m below the natural ground surface through much of the proposed building area during site investigations. If open bored piles are preferred, allowance should be made for use of casing advancement systems during drilling. Open bored piles founded on clay soils should either be dewatered prior to pouring concrete or a tremmie mix and a tremmie pouring method should be used. Dewatering may be impractical in the profile encountered and may promote collapse of the walls of the excavation prior to pouring. Alternatively, continuous flight auger piles may be considered by the detail designer.

The following design parameters will apply to non-displacement piles founded in in-situ soils.

*Table 5-2: Non-Displacement Pile Design Parameters*

Material Unit	Friction Angle	Ultimate End Bearing, $f_b$ (kPa)	Ultimate Skin Friction, $f_s$ (kPa)	Vertical Youngs Modulus (MPa)	Horizontal Youngs Modulus (MPa)
Units 3B/3C – Marine Sands	35°	900	30	16	12
Unit 3B/3D – Alluvial Clay	-	500	25	10	7.5
Unit 3C – Alluvial Clay (very soft)	-	N/A	N/A	N/A	N/A
Unit 5 – Residual Clay	-	900	50	20	16
Units 6A/6B – EW Rock	-	1000	90	24	18
Units 7A/7B – HW Rock	-	2000	140	40	30

A geotechnical reduction factor in accordance with AS2159 Piling Design and Installation should be applied to the ultimate values shown in the table above to derive ultimate geotechnical strengths for limit state design. The final reduction factor should be selected by the detail designer in conjunction with a geotechnical professional based on the design and construction assumptions and the recommendations in the geotechnical report.

Piles may be founded in coarse soils that are considered mildly aggressive to concrete. The Contractor will need to consider the impacts of both the in-situ soils and imported fill in the durability design of the any piles or other structures/footings founded in these soils. The design life of the piles is to be in accordance with the project technical specifications.

#### 5.3.6.3 Crane Pad Foundations

Crane outrigger ground pressures of up to 100kPa and an outrigger pad bearing area of 1.5m wide by 1.5m long have been assessed, with a factor of up to 2.0 applied (assuming a scenario where no work platform is construction during the construction phase), resulting in a maximum bearing pressure of 200kPa. Assuming

the crane outrigger pads are founded on a subgrade of controlled fill (comprising of very stiff residual clays or weathered rock i.e. fill profile from materials won from Cowarra site), will provide sufficient bearing pressure for these maximum crane outrigger loads of 100kPa. Where a different final fill is selected or the proposed crane loading configuration changes, this will need to be reassessed by a qualified geotechnical professional.

It is recommended to prevent deterioration of the exposed foundations (where clay or sand), a working platform comprising of a 300mm granular material, compacted to 100% Standard Compaction, is constructed across all parts of the lift area where the cranes or similar heavy plant are likely to traffic.

### 5.3.7 Construction Considerations

The following additional considerations for the bulk earthworks phase of construction that need to be considered as part of the detail design are:

- Earthworks should be undertaken progressively, minimising the area and length of time that any part of the site is denuded of vegetation at any one time.
- Fill batters should be over placed to allow appropriate preparation.
- Re-vegetation or other erosion protection should be undertaken as soon as possible.
- The erodibility of the soils should be taken into account in the long-term stormwater management plan for the site.
- The clay soils that will be exposed by the pile boring will be prone to rapid softening, fretting, and potential strength loss on exposure. It is therefore critical that concrete be poured as soon as the drilling of the pile is completed. A geotechnical professional should be on site at least during the initial stages of pile drilling and installations to assess the founding materials encountered and confirm required founding depths.
- An acid sulphate management plan will be required where alluvial sands (below 2.5m) are disturbed and if greater than 1000 tonnes of alluvial clays (Unit 4B) is disturbed during the works.

It should be noted that the above considerations are given based on the known site characteristics and potential fill characteristic from the identified fill available from Cowarra. Once the final source of fill has been selected (and additional testing completed if required), geotechnical advice needs to be reconfirmed.

## 5.4 Environmental

Several environmental studies have been completed that cover the site area including:

- Thrumster Sewage Transfer Scheme Review of Environmental Factors (ERM, August 2008).
- Thrumster Wastewater Treatment Scheme Preliminary Assessment (Ramboll, February 2023).

Areas of high biodiversity value have been identified as part of the ecological survey completed for Ramboll and will be further assessed in the EIS.

As the design progresses further works will be required including acid sulphate soil assessments, targeted species/habitat surveys and further consultation with key regulatory agencies and stakeholders.

## 5.5 Site Layout



Figure 5-1: Site Overview

The site arrangement for the Thrumster WWTP has been developed based on experience with similar facilities. The site arrangement considerations include:

- Locating the operator amenities building at the entrance to the site to provide operators with good visibility of people accessing the site and incoming chemical deliveries. Parking has been provided at the amenities building to help reduce unnecessary traffic moving further into the plant.
- Road design of the treatment plant that separates heavy vehicle traffic from other operational areas. The heavy vehicle traffic route onsite incorporates dedicated pull-off areas for chemical delivery, septage delivery, dewatered sludge removal and removal of screening and grit skips from the site. This separates this heavy vehicle traffic from the operational areas. Appendix S provides a sketch of for chemical delivery, screening pick up and biosolids transport.
- Providing a space allowance on site for a future expansion for construction of a future bioreactor, membrane system and additional treated water tank.
- Providing space allowance for construction sequence considerations. This includes including space allowances for the construction batters required for excavation of the bioreactor and a work pad area at the base of the bioreactor. This allows construction of adjacent structures to be undertaken and limits impacts to the overall construction timing and sequencing.
- Location of the blower building close to linked structures allowing air transfer pipework to be constructed in overhead main and reducing the need to underground pipe runs.
- Locating switch rooms close to equipment with the larger power demands to reduce the run lengths and improve supply efficiency.

The current layout also includes corridor allowances for plant pipework, electrical conduits and other services.

## 5.6 Reinforced Concrete Structures

The minimum durability requirements for liquid retaining concrete structures are to be in accordance with Table 4.1 and 4.2 of AS3735. The following additional assumptions are to be used to inform the durability requirements:

- Design life as per Table 2-17 of this report.
- Use of an S40 concrete mix in accordance with the project specification.

- Standard formwork and compaction techniques will be used in the construction of liquid retaining concrete structure.
- Reinforcement in accordance with Section 3 of AS3735.

## 5.7 Buildings

The amenities, blower and switchroom buildings are proposed to be blockwork construction with consideration given to concrete tilt panel construction to improve sustainability where possible.

The dewatering building will be a steel framed portal with sheeted cladding.

## 5.8 Plant Access

The plant main access road will connect to Fernbank Creek Road, located at approximately 433 Fernbank Creek Road. The connection to Fernbank Creek Road will be at the same RL level, slowly grading up to the treatment plant pad level. The main access road will allow access for a 19m articulated vehicle to enter the site.

An alternative access road will be provided across the neighbouring property directly west of the site, connecting directly with Fernbank Creek Road. This road will be used only in flood conditions. This connection will allow access during a 1% AEP event. The alternate access will allow for heavy rigid vehicles to enter/exit the site.

Roadworks to support plant access will comprise of sealed pavement with rollover kerb and gutter. In areas where heavy vehicles are turning, rigid pavement will be provided to maximise the service life of the road.

The administration building overlooks the main access road and parking has been provided at near the plant entrance to reduce unnecessary vehicle traffic around the plant and help alert operators to incoming traffic such as chemical deliveries.

The structure and road arrangement are such that heavy vehicles will remain on the top pad and a separate bay is provided for delivery vehicles to pull into adjacent to the chemical storage area, minimising traffic disruption to the rest of the plant.

Dedicated areas have been provided for the trailer bays at the dewatering facility and industrial bins for screenings from the inlet works. A demarcated area for the septage receival zones has also been provided.

Security fencing is to be provided around the site to prevent unauthorised access. A manual gate will be provided to the lot boundary, an automatic gate will be provided upon entry to the site compound. A separate internal fence and manual security gates will be provided around the storm pond. The security provisions will need to incorporate access for septage receival.

## 5.9 Stormwater Drainage

The erodibility of the soils on both the fill pad and the natural surround areas should be taken into account in the long-term stormwater management plan for the site. The clay soils present are moisture sensitive and as part of preliminary works it is recommended that a series of swale drains be constructed across the slopes to improve drainage, reduce water surface flow and prevent water logging of the profile.

While a storm pond has been provided for on the site (for increased wet weather inflow beyond the capacity of the plant), the infrastructure and additional volume required to handle stormwater drainage from the impervious areas of the fill pad into this pond is considered unlikely to be feasible. Additionally, PMHC have advised that all flow relief from the storm pond (when overflowing) is to be directed to the northeast wetland and into Partridge Creek. This flow must also be monitored to allow reporting of flow and duration to the regulator. In order to correctly report the overflows from the storm pond to the regulator, all site stormwater drainage is proposed to be captured in zones on each of the pad levels either as overland flow channels/dish drains or a pit and pipe network to designated outlets around the perimeter of the pad. The use of separate zones will help reduce flow concentrations and the size of the required infrastructure to manage flows. Protection and/or localised dissipation structures will likely be required at each of the outlet locations to

protect the embankment. This is considered likely to be in the form of a pit or headwall with scouring protection around this outlet point.

The detail designer will need to consider the extents of protection (ensuring lower levels of the embankment remain protected downstream of these outlet points), in addition to preventing flow concentrations into the natural surrounding areas. It is recommended that geotechnical advice be sought regarding the protection of the embankment based on the final fill material selected.

## 5.10 Site Services

Sewer for the site amenities building will be transferred to the inlet works via the Foul Water Pumping Station. The plant will also supply itself with recycled water, refer to Section 4.16 for further details on the recycled water system.

A potable water connection to service site amenities will be provided by PMHC.

## 5.11 Landscaping

Landscaping in order to minimise maintenance works and protect the embankment will be key.

Topsoil removed from areas that are to support foundations can be retained for re-use in landscaping. The topsoil and underlying sands and clays at the site are considered susceptible to erosion on exposure where vegetation is removed or where exposed to concentrated flows. It is therefore essential that the detail designer considers the following aspects regarding landscaping maintenance during and post construction:

- Earthworks should be undertaken progressively, minimising the area and length of time that any part of the site is denuded of vegetation at any one time.
- Re-vegetation or other erosion protection should be undertaken as soon as possible.
- The erodibility of the soils should be taken into account in the long-term stormwater management plan for the site.

# 6 Electrical and Control Design

## 6.1 Electrical Concept Design

This section provides additional details on the electrical and control elements of the proposed upgrade. The electrical concept design drawings are included in Appendix O. The following drawings are included:

- Single Line Diagrams:
  - Main Switchboards, accepting transformer and generator feeds and distributing power to site.
  - Motor Control Centres, located at three major plant areas supplying power to local equipment in each area (Inlet works and Bioreactor(s), MBR Plant and Final Effluent Storage, Chemical Dosing and Sludge Handling).
- PLC and Control Network diagrams, showing the site wide optical fibre networks and local sub-networks.
- General Arrangement Diagrams:
  - Main Switchboard arrangements.
  - Motor Control Centre arrangements.
  - Switch room layouts.
- Typical Drive Schematics:
  - Direct Online (DOL) starting.
  - Variable Speed Drive (VSD) starting.

## 6.2 Design Considerations

Development of the electrical design for the site has considered ways to reduce power use and associated emissions and means to improve resilience to climate change.

Measures adopted in the design include:

- Improving energy efficiency through power quality monitoring, harmonic correction, and power factor correction.
- Selection of key equipment based on best operating point.
- Active power monitoring of drives using Next Generation Operating Systems to monitor efficiency, identify maintenance requirements and optimise energy use.
- Providing resilient power supply architecture including back-up power generator.
- Locating critical electrical equipment above flood level.
- The plant is capable of being operated using field push buttons whenever there is a failure of automatic operation.

Further consideration will be given to:

- Use of local onsite PV solar generation for powering the amenities building or behind the meter usage. Refer Appendix T for Solar System Feasibility Study
- Use of solar hot water or heat pump hot water for the amenities building.

## 6.3 Site Power Supply Arrangements

The site will require a power supply upgrade. The distribution authority is Essential Energy and it is intended that the Supply contestable works (extension of the Distributors network infrastructure) will be completed under a Pioneering Scheme agreement.

The power supply to Thrumster WWTP will originate from the Boronia Street Zone Substation via the grid in Boundary Street. Essential Energy will also install power conduits from the future Thrumster Zone substation as an alternative future power supply. The conduits will be installed in the same trench for recycled main and optics fibre with the required separation.

The location of the point of connection for the power supply to the WWTP is preferred to be located within 300m radius of the existing pole mounted substation:2-987824 and within the Lot14; DP1139180. PMHC preferred to remain a Low Voltage customer.

Considering the flood prone nature of the site the substation and all infrastructure associated with supply connection will be installed above Probable Maximum Flood level.

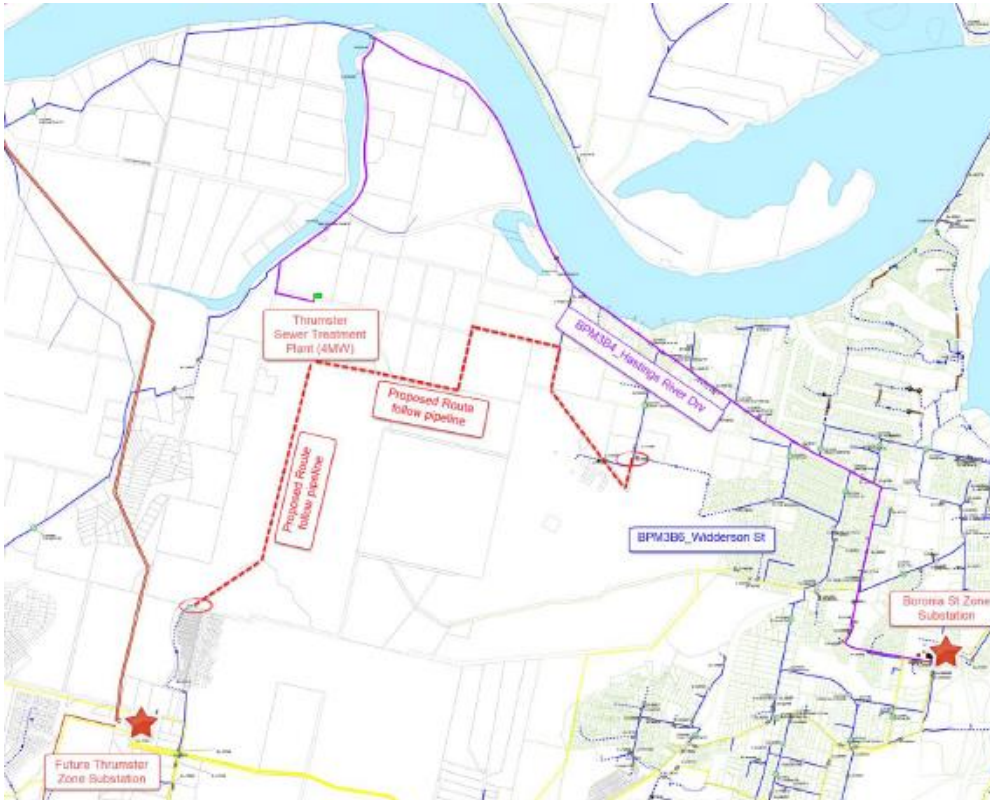


Figure 6-1: Overview of the Proposed connection with Essential Energy's Network

## 6.4 Site Power Distribution Architecture

The assessed Maximum Demand for Stage 1 works is 1.47MVA. The final Plant including Stage 2 upgrade Maximum Demand is assessed at 2MVA.

The Proprietary pad mount Substations sizes utilised by Essential Energy's Network are:

- 315 kVA.
- 500 kVA.
- 750 kVA.
- 1000 kVA.
- 1500 kVA.

The incoming supply arrangements consist of two E.E. Transformer sub stations (with integral or separate HV switching stations), each supplying power to the MSB's via a Service Protection (SPD), Main Switch. A generator changeover switch enables loss of supply to be minimised by automatically starting a fixed generator and applying the alternate supply to the MSB.

The power system architecture for the site is shown in the single line diagrams in Appendix 0. The site supply will originate from an Essential Energy 11kV/400V transformers connected to the Plant Main Switchboards (MSB1000B and B) which distributes power around the plant via process specific motor control centres.

The MSBs are used for power distribution to the Motor Control Centres (MCCs) and will not contain any motor control. This design strategy reduces the maintenance requirements for accessing the MSB which

improves switch room safety and reliability. Remote switching function (via SCADA) of the circuit protection devices on the MSB and the incomers on each of the Process MCCs has been incorporated, further enhancing safe operation by removing operators from the vicinity of the switch board should an arc fault occur during switching.

The MCCs contain all the motor controls and final distribution for the motors and process loads. Allocation of these process loads across each distribution system is generally by process roles to minimise the disruption to operations due to the loss of one distribution system.

Further consideration should be given to Providing bus-coupling functions between the Motor Control Centres in each switch room to enable each MCC to be supplied via alternate MSBs. Given the assessment of the Maximum Demand for Stage one as approaching the rating of a nominal E.E. transformer this arrangement may also facilitate supply of the entire Stage 1 Plant via one transformer unit for periods of time improving transformer operating efficiencies for the period between Stage 1 and Stage 2 works.

## 6.5 Backup Generator

Backup power to the MSB is provided by dedicated onsite diesel generators.

Two (2) of 800kVA 400VAC generators are proposed. Each generator will be permanently connected to each MSB through an Automatic Transfer Switch (ATS). In the event of a mains power failure, the ATS will automatically start the generator and switch the MSB source of supply from transformer to the generator. The switchgear and transfer switch arrangement will prevent paralleling of the supplies from the generator and the transformer. Electronic controls shall be provided for the unattended, fully automatic starting and operation of the Genset to achieve the functional performance. All controls and protection shall be incorporated in a single generator control panel.

The generators have been sized giving consideration to critical drives required. A PLC/SCADA coding 'sequence' shall be developed to ensure that whilst running on generator the rating and running characteristics of the generator is not exceeded and less critical loads are shed as more critical loads are required to operate.

The fuel requirements for the generators have been assessed to allow both generators running at 100% capacity. Based on a CATC18, DE780E0, 780kVA Diesel Generator set the fuel consumption at full load will require in the order of 4 kL of fuel storage for each generator; a total onsite stored diesel fuel storage of 8 kL.

PMHC intend to review the required generator run time and fuel storage requirements as part of the detailed design.

## 6.6 Maximum Demand

The maximum demand for the site is calculated to be 2.5MVA (3582A) based on the Concept Design equipment loads and using a diversity factor as allowed in AS3000. The detailed calculations are provided in Appendix M, and a summary provided in Table 6-1.

Table 6-1: *Thrumster WWTP Maximum Demand*

			CONNECTED POWER (kW)	CONNECTED LOAD (A)	Demand Apparent Power (kVA)	Demand Reactive Power (KVAR)	Demand Real Power (kW)	Demand Current (A)	Power Factor	Harmonic Current (A)
	20%	Future Allowance	4084	6781	2477	610	2380	3582	0.97	NA
INCLUDES STAGE 2	MAIN SWB #1	MSB-100A	1372	2260	799	206	762	1154	0.97	270
INCLUDES STAGE 2	MAIN SWB #2	MSB-100B	2032	3391	1268	302	1221	1831	0.97	452
	SWR#3 - Inlet works	MCC200	286	488	144	55	130	208	0.93	NA
	SWR#3 - Bioreactor #1	MCC300	597	969	332	69	324	480	0.98	NA
	SWR#3 - Bioreactor #2 <del>FUTURE</del>	MCC400	505	819	332	69	324	480	0.98	NA
	SWR#2 - MBR Stage #1	MCC500	394	645	244	65	232	352	0.97	NA
	SWR#2 MBR Stage #2 <del>FUTURE</del>	MCC600	246	394	184	38	180	266	0.98	NA
	SWR#1 - Chemical Dosing	MCC700	244	408	138	44	128	200	0.95	NA
	SWR#2 - Sludge Handling	MCC800	327	550	220	64	207	319	0.96	NA
	SWR#1 - Treated Water	MCC900	806	1376	472	104	458	681	0.98	NA

The 2.5MVA demand nominated includes Stages 1 and 2 works and a 20% allowance for expansion.

Loads have been assigned to each MCC based on the process Duty/Standby assignment.

To ensure the electrical infrastructure has capacity to supply all connected duty loads, it is necessary to consider the Standby loads as Duty loads on the individual distribution systems. Table 6-1 calculates the full load rating of the loads connected to each MCC for this purpose, and the site total shows the true demand load for the site.

Based on this, two (2) 1500kVA transformers have been proposed for the site which will have capacity to run all connected load to each process system and be loaded to approximately 53% and 84% during normal operation.

The power factor (kVAR) is calculated on the same basis. Further details are provided in Appendix M. The power factor is calculated at each switch board, and overall, the site has a calculated power factor of 0.97 lagging and therefore there is no dedicated power factor correction equipment proposed for this project. The good power factor is predominately due to the large number of VSDs used in the project which return good front end power factor regardless of the connected motor.

The design includes several variable speed drives to allow efficient process control. The variable speed drives (VSDs) have very good power factors compared to traditional starting methods, but adversely affect the power quality of the electrical distribution due to the harmonics they generate as part of their operation.

The harmonic current expected to be generated by these VSDs and injected into the distribution system is in the order of 720 Amps on the MSBs the point of common coupling with Essential Energy. Two (2) 400A active harmonic filter has been included on each MSB, which will have capacity for full correction under normal operation.

## 6.7 Switch Rooms and Site Arrangements

Due to the size of the site, there are three switch rooms in the design which are located at beneficial locations across the site to service the power and control needs of the local equipment. The switch rooms are identified in the design as Inlet works and Bioreactor(s) (SWR#3), MBR Plant and Sludge Handling (SWR#2), Chemical Dosing and Final Effluent Storage (SWR#1).

It is intended that the Essential Energy supply will connect to MSBs located in SWR#1, the closest to the intended point of connection. Sub-mains from MSBs distribute power to all motor control centres in the plant switch rooms in this way minimising the volume (size and length) of the final circuits cabling.

The switch room designs are similar, with the MCCs installed in the centre of each switch room with the MCCs installed back-to-back. The VSDs, distribution boards and ancillary equipment are installed along the switch room walls. The MSB in the main switch room are installed along the switch room wall to provide easy access for the large incoming cables from the supply transformers and reduce overloading the underfloor cabling system. All switch boards will be installed on steel fabricated stands so as not to overload the flooring system.

Cabling between the switch rooms is via underground pit and conduit system.

The switch rooms will include a raised floor system and all cables run under the floor with bottom entry into the switchboards and equipment. Cable pits located outside of the switch room will be used to transition into the pit and conduit system for distribution of cables throughout the site.

The switch rooms are air-conditioned with a redundant capacity, to provide a controlled environment for the PLC and electrical equipment and compensate for the heat generated by the variable speed drives and other hardware. The demand shows duty/standby for these which is for the purpose of load allocations and is designed such that both will run concurrently at reduced loads to help with even distribution throughout the switch room.

## 6.8 Control and Communications

The switch rooms and Amenities building (Control Room) are connected via multi-core multi-mode optical fibre cable designed in a self-healing, redundant ring architecture. The SCADA Network and the Control Network traffic are segregated networks on the fibre ring, with dedicated fibre pairs allocated to each. A ring

topology provides improved reliability and simplifies connection of network equipment in future, such as CPU/RIO panels, security, CCTV etc.

Each MCC contains a dedicated PLC panel which is used to marshal I/O within that MCC to a PLC/CPU & IO (RIO) PLC rack. A control network switch connects the smart starters, power meter and any other communications equipment related to the individual MCC.

Each switch room has a stand-alone PLC panel containing CPU rack, RIO racks and communications equipment, which is used for all of the field-mounted process instrumentation and valves, and switch room-mounted equipment such as VSDs.

Remote access to the plant will be provided via Council's secure network and a dedicated site VPN connection. This will allow operators to access the plant SCADA remotely for detailed monitoring, control and alarm management.

A provision has been included for an offsite Microwave link to connect the plant to Council's main Head Office SCADA system. This will allow critical plant status information to be displayed and monitored remotely via RTU network.

The Main Plant PLC will be in switch room 1, adjacent to the Control Room. Two additional PLCs with CPU panels will be installed, one in each of the other switch rooms. Each PLC will contain the sequence code functions for the connected Process drives and instrument devices.

Mobile phone reception has been noted as being unreliable onsite. As well as operational reasons, reliable phone reception could be required for contacting emergency services. A mobile phone booster (repeater) system is to be investigated during detailed design by the Contractor.

## 6.9 Motor Starters

There are two major categories of motor starter used in this design, being VSD and DOL starters. Typical starter schematic drawings are provided with the concept drawing set in Appendix O for DOL motors, small VSDs and large VSDs for use as templates in developing the starter designs during the detailed design. These designs use the traditional designs with hardwired IO to the PLC for DOL motor starters and utilise the onboard I/O for the VSD motor starters which are connected to the PLC via ethernet. All starters make provision for selection into AUTO, controlled via the SCADA PLC system; OFF – not available for use and MANAUAL, controlled via field hand stations. Manual mode facilitates maintenance activities and when the Automatic control system is unavailable.

Residual current device shall be considered for all process equipment (nominally small sump pumps, agitators, etc) that during routine maintenance and operations would require a manual lift in and out of final position where the task poses a risk of damage to the pump cable fixings, terminations or insulation.

Start, stop motor control push buttons shall be provided for all drives to ensure that during periods when the Plant PLC(s) are not operating in Auto, are off-line, or subject to maintenance, software and firmware download, etc the process drives shall be able to be started in a manual, field mode. These controls shall be incorporated into the MCC functional cell and mounted on the cell door. Where for the purpose of maintenance task (changing belt couplings, cleaning screens, unclogging muncher drives, etc) these push buttons controls shall be located adjacent to the drive in lieu of on the starter cell,

Additionally, the requirement for Local Field Isolators (which would be in addition to the lock out tag out isolation provided by the circuit protection device on each functional cell) shall be determined via Risk Assessment considering the nature and frequency of high-risk maintenance and operations tasks.

## 6.10 Site Lighting

All light fittings will be LED for energy efficiency and longevity. Lighting within buildings will be by motion sensor.

Outdoor general access lighting will be provided for safe access to the plant. Lighting will typically be provided for general transit through plant areas, on stairways and along raised walkways/structures. Operators will operate outdoor lighting via the SCADA.

Lighting will be designed to mitigate light noise to the surrounding areas. Consideration shall be given to the effect of 'spill' lighting noise outside the plant boundary. Consideration is to be given to red light sources at the access points to minimise spill. In all areas a lighting design shall be undertaken to ensure that light falling outside the area or object intended to be illuminated is minimised.

All lighting Designs must comply with the requirements of AS1680 and AS1158 suite of Standards. Trickle charged emergency lighting must be provided indicating the exit and lighting the room sufficiently for personnel to safely exit during a full night-time power blackout. Each room must be provided with an emergency exit light at each exit. Emergency lighting system testing facility must be provided in each switch rooms. All design and work must be carried out in accordance with AS 2293.

Street lighting shall be provided in accordance with relevant Australian standards, typically located at 30m intervals around the Plant internal and external access roads.

## 6.11 Earthing and Lightning Protection

An AS1768 Lightning Protection Assessment will be undertaken during the detailed design. As the plant is classified as critical infrastructure under this Standard, the protection measures will likely include surge protection and lightning conductors. Earthed systems, equipotential bonding of structures and systems and general earthing of equipment shall be designed, installed and tested in accordance with AS3000, AS3010, AS2067 and AS3017.

## 6.12 Site Services

During detailed design site services including Closed Circuit TV system, smoke and fire detection and alarm systems, site and building security and access control systems design will be undertaken. As a minimum site security and access control shall be provided at all access points; main gate, person gates, etc, that allow access onto and within the Plant. Each of these access points shall include CCTV.

Site security shall incorporate access control to the Septage receivals system which will initiate process control of the inlet control valve to the septage receivals pit.

The Main Switch boards and all motor control centres shall have integrated Vesda (or equivalent) fire suppression systems design and installed. The inert gas bottles associated with the suppression system shall be housed external to the switch room and provide facility to isolate and remove any individual bottle during maintenance without shutting the system down. The Vesda (or equivalent) system, fire indicating panel and gas fire suppression system shall be integrated and communicate its status and observations to the PLC/SCADA system.

## 7 Hydraulic Design

Preliminary hydraulics have been developed for the Thrumster WWTP. This section provides an overview of the key hydraulic considerations. For the basis of the hydraulic calculations, the following design inputs were applied (unless specified otherwise):

- Minimum of 300mm free fall on all weirs (i.e. space between the weir and downstream water level).
- Minimum of 500mm free board on all structures (i.e. space between the highest water level and top of concrete structure).
- A maximum pipe velocity for gravity lines of 1.5 m/s at the design and minimum of 0.2 m/s operating at commissioning flow.
- The minimum structure top of concrete is to be greater than or equal to the probable maximum flood level.
- Broad crested weir equation.

Three key interconnecting gravity pipes set the level of the key structures. These include and are further described below.

- Bioreactor to the inlet works fine screens.
- Bioreactor to the membrane outlet channel.
- Treated water reservoir to the permeate tank.

All other structures are pumped to and therefore are not limiting factors to the hydraulic requirements.

### 7.1 Bioreactor to Inlet Works Fine Screens

The bioreactor to inlet works fine screens considers two key flow paths:

- Bioreactor 1 directly to the inlet works fine screens.
- Bioreactor 1 to the inlet works fine screens via a bioreactor splitter. The bioreactor splitter is required for stage 2 upgrade.

The hydraulic level of the fine screens has been set by the future hydraulics of the pipelines between the bioreactor, bioreactor splitter and inlet works fine screens. The future bioreactor splitter was modelled to have equally sized 4.5m weirs. Inlet and outlet pipework was DN600 DICL.

### 7.2 Bioreactor to Membrane Outlet Channel

Pumped mixed liquor from the bioreactor to the membrane trains is returned using a pipeline to the anaerobic zone under gravity. In addition to the hydraulics, the return pipeline has been sized to de-aerate the return mixed liquor prior to entering the first anaerobic zone during peak dry weather. This minimises oxygen entering this zone.

A minimum size of DN1400 DICL has been provisioned for the return pipeline. This provides a maximum pipe velocity of 1 m/s at peak flows. Minimum velocity is not considered important in this instance as activated sludge settles very slowly at the high MBR concentrations. In combination with the return channel provides a de-aeration volume of approximately 220 m<sup>3</sup> and should be considered in the bioreactor volume.

### 7.3 Treated Water Reservoir to Permeate Tank

Effluent from the membrane tanks is pumped to the permeate tank, the permeate tank maintains a high level by use of a weir. A free discharge and gravity feed to the reservoirs sets this weir level.

As a result of the permeate tank height there is potential for reverse flow through the membrane pumps from the permeate tank. This may cause issues with reverse operation of the rotary lobe pumps (operating off curve) as they will be pumping to a low net head. Discharge isolation valves prevent back flow during pump shutdown but can be a key risk during membrane recovery and maintenance cleans. The detailed designer will need to employ adequate preventions this could include reduction of static head or providing a breaking action on the lobe pumps electrically.

## 8 Operational Control Philosophy

This control philosophy provides the overall control strategy for each of the main process units for the purpose of providing an overall understanding of the control intent.

The Thrumster WWTP plant consists of the following unit processes:

- Septage receipt.
- Inlet receipt.
- Coarse screening and washing.
- Storm flow splitter.
- Grit removal and washing.
- Fine screening.
- Bioreactor configured as an oxidation ditch.
- Membrane bioreactor (MBR).
- Aeration for bioreactor and MBR air scour.
- Permeate storage.
- Effluent storage and transfer.
- Sludge handling system.
- Bulk chemical dosing systems.
- Recycled water treatment plant.
- Various foul water pumping stations.
- Various booster service water pumping stations.

A detailed functional description and specification will be developed by the contractor during detailed design phase. This section provides a high-level overview of the control philosophy only.

### 8.1 Septage Receipt

The septage receipt volume will be measured. All flow will pass to a pumpstation that operates based on a fill and draw regime.

### 8.2 Flow Reception

Incoming flow is measured by the incoming flowmeters. A moving average inlet flow will be calculated in the SCADA system and be used for flow pacing of key equipment in the plant.

### 8.3 Primary Screening

Three coarse screens are to be provided in the design.

Depending on the design provided screen rotation and washing will be based on preliminary head loss across the screen. There will be screen activation and washing based on a minimum timer if head loss does not trigger activation.

The screens will operate on timer only if there is a loss of level instrumentation for head loss determination.

### 8.4 Screening Washing

There is two screening washpactors (duty/standby or lead/lag). Each includes a fixed speed, reversible impeller drive, a fixed speed, reversible screw drive, an actuated drain valve (with open and closed switches) and two wash water solenoid valves. There is also a level transmitter.

There are two operating modes for the washpactor. These are:

- Normal mode – The washpactor operates in a washing and compacting sequence intermittently.

- Throughput mode – The screw and wash-water system operate continuously until the screen sequence ceases and a run-on time has expired.

## 8.5 Storm Flow Splitter

There is no control associated with the storm flow splitter. A high-level alarm will trigger if a bypass occurs.

## 8.6 Grit Removal

There is one grit removal systems which operate in a duty arrangement. The grit removal system can be bypassed manually using stopboards by the operator.

Inside the grit separator chamber, flow enters the grit chamber tangentially, which creates a vortex due to the shape of the chamber that forces grit particles to the centre where they drop into a collection chamber at the bottom of the unit.

A mechanical agitator is used to assist the vortex and operates continually to maintain an optimal fluid velocity that supports solids migration to the centre and bottom of the cone.

Grit is removed directly from the grit chamber by means of a duty, fixed speed, rotary lobe pumps, whereby the pumps draw a combined grit and water mixture from the grit sump. Grit pump operation is in one of two modes:

- Timer mode – operator selectable duration.
- Volume mode – operator selectable volume of screened raw sewage passes the grit system.

When grit removal is operating, fluidisation water will enter the bottom of the grit cone to assist the removal of the grit. Removed grit will then be pumped to the grit handling system.

When called to run the grit pump will run for an operator set time then stop and wait for the next cycle.

## 8.7 Grit Washing

The grit classifier screw operation is not linked directly to the grit extraction sequence. The screw drive is triggered based on a high pressure set point in the grit agitator tank. The following sequence then occurs.

- The inlet process water valve opens and fluidises the grit.
- The grit agitator starts and runs on a timer.
- The grit agitator stops.
- The classifier screw starts.
- After a run period has expires, the classifier screw drive stops.
- The screw drive is inhibited from operating for a dwell time. Thereafter, the high pressure set point can restart the sequence.

## 8.8 Fine Screens

The design of the fine screening system will be controlled using one of the following control modes:

- **Upstream Level Control Mode** – In Upstream Level Control Mode the screens will operate when an upstream level set point is triggered.
- **Timer Control Mode** – In Timer control mode the screens will operate intermittently when timer set points are triggered.
- **Volume Control Mode** – In Volume Control mode the screens will operate when an integrated volume has passed through the screens.

Operation of the screen will involve drum rotation and spray operation with run on timers based on the above triggers. In any of the head loss or level modes the screen will continue run until the head loss or level has reduced below a cut out trigger.

The integrated screw and compactor will operate whenever the drum operates.

## 8.9 Bioreactor

### 8.9.1 SRT Control

The new bioreactor will control the SRT by using a hydraulic sludge age control concept. There will be a set points for SRT and TWAS thickener solids capture percentage. A calculation algorithm will calculate the required WAS flow set point to meet the set SRT and be based on:

- The average flow rates for the S recycles.
- The total reactor and MBR volume.
- TWAS capture efficiency.

The WAS pump for each bioreactor will modulate speed to meet the calculated flow set point.

The recycles flows are required to be known as sludge can move between the various bioreactor and MBR trains based on the set S recycle ratios.

### 8.9.2 Mixer Control

Each bioreactor mixer will operate at an operator adjustable fixed speed.

### 8.9.3 Level

The bioreactor level will be monitored and controlled using level transmitters. If the high level setpoint is reached, then upstream flows will stop. If low level setpoint is reached the downstream plant operation is stopped.

The inlet flows to the bioreactor can be stopped by closing each inlet penstock of the fine screens. All flow would divert to the storm storage lagoon in this scenario.

### 8.9.4 Aeration and Blower System Control

For all modes airflow needs to be gradually altered as the load on the biological process changes throughout the day. Airflow is defined as the summation of all operating blower percentage speeds. The speed can therefore range from minimum speed of one blower to the maximum speed ach from two blowers (i.e. 50% to 200%).

The bioreactor blowers can operate in the following modes of operation:

- DO control mode (requires at least one DO probe).
- Time of day mode.

#### Automatic DO Control Mode

The DO control algorithm is slightly different to traditional DO control is in box style reactors. The probes are set well downstream of the aeration grids and a low DO ~ 0.3 mg/L targeted. Therefore, immediately downstream the DO will be near zero and anoxic. Using this approach, the size of the aerobic and anoxic zones is controlled rather than the DO in the aerobic zone. In oxidation ditches designed for low levels of nutrients this process has proven to be very robust and reliable.

In automatic DO control mode, the blowers will adjust their speed to achieve an operator adjustable DO setpoint. The operator selects the DO probes for control, and they are averaged. The average DO feedback is used to target a DO setpoint by adjusting the speed of the blowers. This is done using a PID loop.

A control delay equal to the time for the flow to move from the aeration grids to the DO probes is used to ensure aeration updates slowly and controls the aerobic zone size rather than hunt for a specific DO value.

In automatic DO control mode, one or multiple DO probes can be used as the DO input. Operators set the target DO concentration.

#### Time of Day Mode

Time of day mode is used when there is no pressure controller or reliable DO probes. Time of day mode is a table with the blower speed entered in % each hour of the day (range from 40% to 200%, representative of

the number of blowers required). This mode guarantees that if all control ability is lost the operator can ensure the aeration follows the flow profile of the plant and reasonable DO control is achieved.

## 8.10 Membrane System Control Philosophy

The control philosophy for the membrane system is set by the membrane system supplier. All membrane system control will be integrated into the plant SCADA system. No proprietary arrangements will be accepted.

Key control sequences involved with the membrane system include:

- Train Standby – Each tank while in standby will shut down the permeate. Sludge flow and air scour continues intermittently.
- Membrane Tank Start Up – this includes a prime of the header permeate and pump start up. Upon start up the prime motorised valve and process air solenoid will open. The ejector will create a vacuum removing air from the header. The prime will stop once the high-level switch in the header is activated. After prime, the pump will slowly ramp to its startup setpoint.
- Permeate Production – permeate pumps operate to maintain a set flowrate using feedback PID loop control to change the speed of the pump in the forward direction. The default mode is for the permeate pumps to meet a flow setpoint based on the inlet works moving average inflow.
- Membrane Tank Air Scour – operation of membrane air scour occurs using two feedback PID loops. The membrane blowers operate to meet a fixed pressure setpoint. The airflow per membrane train air flowrate is controlled by the dedicated air control valve. If an air flowmeter fails, the backup mode is to set an operator adjustable valve position and adjust the blower speed to achieve an airflow in the common header.
- Membrane Relaxation – in a typical cycle the membrane train will pause operation. This means stopping the permeate pumps only. The air scour will not stop. This occurs for 60 seconds every 10 to 12 minutes.
- Membrane Maintenance Clean – Membrane maintenance clean occurs up to once per week and is insitu (direct to the mixed liquor). The permeate pumps are stopped and placed into reverse drawing permeate from the permeate tank. The permeate pumps will ramp to meet a flow setpoint. Sodium hypochlorite is then dosed into the reverse flow.
- Membrane Recovery – Membrane recovery clean occurs every 3 to 6 months. The permeate pumps are stopped and inlet penstock closed. The membrane train selected is drained and rinsed with permeate. The permeate pumps operate in reverse taking effluent from the permeate tank at a fixed flow setpoint. Once rinsed the selected recovery chemical is dosed (either chlorine or citric acid). Once all cleaning sequences occur, then the tank is drained and returned to service.
- Membrane Drain Down – during membrane recovery the membrane tank will be emptied. When drain down is triggered, the corresponding drain valve will open and the drain down pump will start. The drain down pump will operate at an operator adjustable fixed speed.

Turbidity is measured on the permeate line of each MBR tank. This is to monitor filtration performance and confirm ongoing membrane integrity. The membrane tank is continuously monitored using a level transmitter. The flowmeter on each permeate pump will measure positive flow in both directions.

## 8.11 Permeate Tank Control Philosophy

There is very limited control associated with the permeate tank.

Two level transmitters constantly monitor the tank level. The main purpose of these is to provide low level pump cut out protection. This ONLY occurs if it is undertaking a clean. Membrane pumps operating in normal operation (forward flow) is not affected.

## 8.12 Kooloonbung Creek Transfer Pumping Station

The Kooloonbung Creek pumps will operate under two modes of operation.

- **Level control** – the transfer pumps will operate to a fixed flow setpoint based on the current level of the tank. There will be allowance for up to five setpoints. The operator can set the percentage level band within the tank and the associated pump flowrate.
- **Fixed speed mode** – the transfer pumps will operate to a fixed speed between an operator adjustable start and stop level.

## 8.13 Sludge Handling Control Philosophy

The below outlines the high level control philosophy for the sludge handling system operation.

Under normal operation the centrifuge feed pumps, polymer system and centrifuge all operate under one of the two modes below:

- **Time of Day** – time of day mode is intended to operate the sludge handling system at an operator adjustable start time for an operator adjustable time. The operator is also able to set the number of operational days (e.g. Monday to Friday).
- **Fill and Draw** – under fill and draw mode the sludge handling system will operate based on the level of feed averaging tank. The sludge handling system will run when the feed averaging tank level reaches the start level and stop when the level reaches the stop level.

### 8.13.1 Feed Averaging Tank

The level transmitter is the main source of control. A sludge handling system start and stop level setpoint is made by the operator. A high level setpoint will notify of a tank overflow and stop the WAS pumps. A low level setpoint will stop and inhibit the dewatering feed pump and jet aerator. The level switches will be back up for a failed level transmitter.

There is a single duty, variable speed jet aerator in the dewatering feed tank. The jet aerator will operate whenever the dewatering feed tank level is above the start level.

The centrifuge feed pumps will operate to achieve an operator adjustable flow setpoint.

### 8.13.2 Centrifuge Operation

The centrifuge runs to achieve a torque set point as recorded by the centrifuge PLC on the main motor. The centrifuge PLC adjusts the differential speed of the secondary motor to increase or decrease the quantity of solids being discharged from the machine to maintain the target torque. Upon start up and shutdown, the centrifuge may direct product to the dewatering foul water pump station using a slide gate. This ensures a suitable product is produced. The slide gate is also closed during a flushing sequence.

### 8.13.3 Horizontal Screw Conveyor

The horizontal screw conveyor will distribute solids throughout the trailer. The screw conveyor operates at an operator adjustable fixed speed and start and stops whenever the centrifuge is operational.

### 8.13.4 Polymer Dosing

The polymer dosing system will be a liquid emulsion polymer system. The makeup and batching sequences will be determined by the supplier.

Polymer dosing will be to the centrifuge inlet. This will be paced to the feed solids concentration and flowrate. Alternatively, the operator can set a fixed dose.

## 8.14 Foul Water Pumping Stations (Various)

Each foul water pumping station will operate in a fill and draw arrangement.

The duty pump starts when the level reaches a start level set point. While in this mode, the pump will run at an operator adjustable fixed speed. The duty pump stops if the level falls to a stop level set point.

A flowmeter on the discharge monitors flow only.

## 8.15 Bulk Chemical System Control Philosophy

### 8.15.1 Chemical Storage

The radar level element in the chemical storage tanks record the chemical level. Visual level is also provided. There are four level set points for alarming and control:

- High High – Overflow.
- High – Full.
- Low - Re-order.
- Low Low – Inhibit (with all dosing pumps stopped).

If the level falls below the low low set point, then all dosing pumps are inhibited. They can automatically restart once the tank fills above this level. If the level falls to the dry cut-out switch, then all dosing pumps fail and latch.

### 8.15.2 Bulk Delivery

A bulk delivery tanker is used to refill the storage tank. The tanker parks within a road bund (common to alum and sodium hydroxide). There is a local indicator panel at the truck fill station that shows various conditions in the field. Its purpose is to:

- Present the tank level as measured by the level elements.
- Provide visual and audible alarm if the tank level reaches the high level switch (full). It is possible to mute the audible alarm from the truck fill panel.

The tanker uses its own pump to transfer chemical from the tanker to the chemical storage tank. The power supply for this pump is located on the local indicator panel at the truck fill station. An emergency stop switch on the panel cuts the power supply to stop filling. The tanker operator can view the chemical storage tank level on the local indicator panel. A local visual and audible alarm is generated if the level reaches the high level switch. There is a hard-wired interlock that cuts the power supply to the pump if the high level switch is activated.

### 8.15.3 Alum Dosing Sequence

There are two possible control modes for the dosing pumps. These are:

- Flow Paced mode.
- Fixed Speed mode.

Flow paced mode is the default mode and relies on the moving average inlet flow. Failure of moving average inlet flow result in the chemical dosing pump control switching to Fixed Speed mode. The operator can select to use either mode.

#### Flow Paced Mode

The dosing pump is interlocked with the smoothed inlet flow. The dosing pump speed varies proportionally with the smoothed inlet flow to achieve a required dose flow. The operator can set the chemical dose rate required and the pump dose flow is calculated.

In flow paced mode the dose rate is calculated via the following relationship.

$$\text{Dose Flow } \left(\frac{L}{h}\right) = \frac{\text{Moving Average Inlet Flow } \left(\frac{L}{s}\right) \times \text{Chemical Dose Rate } \left(\frac{mg}{L}\right) \times 0.0036}{\text{Chemical Specific Gravity}}$$

#### Fixed Speed Mode

The dosing pump runs continuously at an operator adjustable fixed speed.

#### 8.15.4 Sodium Hydroxide Dosing Sequence

Sodium Hydroxide dosing will have the same sequence as the alum dosing, except for the following differences:

- Dose flow calculation will adopt the sum of the instantaneous flow of the rising main (as measured by the incoming flowmeter). For example, if TH01 rising main is operating, this will be used in the calculation, if both TH01 and PM Regional Pumpstation are operating the sum will be used.
- When flow is measured in each rising main, the corresponding chemical dose automatic valve will open. It will close once flow is no longer measured. Dosing only occurs when sewage is measured in the rising main.
- Trim will be available to adjust the sodium hydroxide dose to the measured pH in the inlet works.
- An operation timer will be available to avoid overdosing during wet weather.

#### 8.15.5 CIP Chemical Dosing Sequence

The CIP chemical dosing pumps operate at an operator adjustable fixed speed whenever called by the membrane cleaning sequence.

#### 8.15.6 Dosing Pipework Double Containment

Double containment of the dosing line is utilised to prevent spills. A level switch located in the low point of the containment line is to indicate a leak. If the level switches are activated, an alarm is generated and the dosing pumps will fail and latch.

### 8.16 Booster Pumping Stations

All booster pumping stations for onsite service water will operate to achieve a pressure setpoint in the water header.

### 8.17 Recycled Water System

The recycled water system encompasses the feed pumping station, UV disinfection system, chlorination system and chlorine contact tank. The recycled water system will start and stop based on the level in the chlorine contact tank.

A delay will be inbuilt to allow the UV system to complete its warmup before recycled water production starts.

#### 8.17.1 UV Feed Pumps

The UV feed pumps will start when called by the chlorine contact tank/storage reservoir and after UV system warm up is complete. The pumps will operate at an operator adjustable fixed flow. If the flowmeter is not available, then the pumps can operate at an operator adjustable fixed speed.

#### 8.17.2 UV Disinfection System

The UV disinfection system will be controlled by its own local control panel, consisting of its programmable logic controller (PLC) and Human Machine Interface (HMI). Key control and monitoring points will be taken back to the plant SCADA using ethernet.

When the UV disinfection system is called to start, it will complete a warmup sequence.

The local control panel will calculate lamp intensity to achieve a required UV dose. The dose is based on flow, UV Intensity and UV transmissivity.

### 8.17.3 Chlorination Gas System

Chlorine dosing will be flow paced to the combined UV feed pump flow and utilise a feedback control loop to target an operator entered free chlorine setpoint measured on the outlet of the CCT. The feedback control will work by varying the target “dosed free chlorine” measured on the inlet to the CCT, based on the reading at the outlet of the CCT. The actual chlorine dose rate would then be controlled by a standard feedback control loop (with restricted trim to a % of an operator entered value) to achieve this dosed free chlorine target.

This cascade feedback control method could also be switched off to allow the operator to enter a target dosed free chlorine setpoint directly if required (in mg/L). Alternatively, the feedback control could also be switched off altogether to allow the operator to enter a chlorine dose rate directly if required (which would still be flow paced).

### 8.17.4 Chlorine Contact / Storage Reservoir

A minimum contact time is associated with achieving disinfection performance. This level will be set in the plant PLC to ensure the contact time is always met for the maximum outlet flow. Online chlorine analysers will confirm the inlet and outlet chlorine concentration. The inlet analyser will be used for flow pacing of chlorine solutions.

### 8.17.5 Transfer Pumps

The transfer pumps will start and stop based on the level measured at the Area 13 reservoir. The pumps will operate at an operator adjustable flow. If the flowmeter is not available, the pumps will operate at a fixed speed.

The pumps will not transfer water if the critical control points for the systems have been breached.

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# Appendix A. Thrumster Wastewater Scheme Schematic

## Appendix B. Staging Allowances

Thrumster WWTP has been designed to be expandable in the future to an ultimate capacity of 80,000 EP. Development of the site arrangement considers the space requirements upgrade. Consideration for this future upgrade has also been given as part of the hydraulic design, site layout and process sizing of some treatment units that would be difficult to upgrade at a later date, such as the civil structures for the inlet works screening and grit removal facilities. Further detail on the staging allowances is given in the table below.

	Stage 1	Stage 2 (Ultimate)
Design Capacity	40,000 EP	80,000 EP
Septage Receptacle	Whole area built to accommodate ultimate.	No civil or mechanical construction.
Odour Treatment	Provisional allowance pending EIS.	No civil or mechanical construction.
Screening Arrangement	Concrete structure built to accommodate ultimate.  1x duty screens and 2x standby installed.	No civil or mechanical construction.
Grit Removal Arrangement	Concrete structure built to accommodate ultimate.  1x duty grit chamber internals and washing installed.	No civil or mechanical construction.
Fine Screen Arrangement	Concrete structure built to accommodate ultimate.  2x duty screens installed. 3x standby screen installed.	No civil or mechanical construction.  2x standby screens become 2x duty.
Storm storage	Pond built to accommodate ultimate.  1x storm storage pond constructed. 1 x duty return pump installed.	No civil construction.
Flow Splitter	Bioreactor feed pipework installed to Bioreactor 1.  Space allowance in site arrangement for future flow splitter.	Concrete flow splitter constructed to split flows between Bioreactor 1 and 2 to accommodate ultimate.
Bioreactor	Bioreactor 1 constructed with appropriate mechanical equipment installed.	Bioreactor 2 constructed with appropriate mechanical equipment installed to accommodate ultimate.
Blower Building	Blower building built to accommodate ultimate.  1x Blower Building	No civil construction.
Blowers	Blowers installed to accommodate stage 1 design.  2x duty blowers installed 1x standby blower installed	Blowers installed to accommodate ultimate.  2x additional duty blowers installed

S-recycle	<p>S-recycle pumps sized and installed to stage 1 requirements. Directly connected to bioreactor 1.</p> <p>3x duty pumps installed. 1x standby pumps installed. 1x jockey pump installed.</p>	<p>Duplication as part of the new bioreactor.</p> <p>3x duty pumps installed. 1x standby pumps installed. 1x jockey pump installed.</p>
MBR Trains	<p>Civil and mechanical construction to accommodate stage 1 design.</p> <p>4x installed duty MBR trains. 1x installed standby MBR trains.</p>	<p>Civil and mechanical built to accommodate ultimate.</p> <p>4x additional duty MBR trains. 1x additional standby MBR train.</p>
Permeate Storage	<p>Built to accommodate ultimate design.</p> <p>1x duty storage included.</p>	<p>No civil or mechanical construction.</p>
Storage Res / CCT	<p>Civil construction to accommodate stage 1 design.</p> <p>1x duty storage installed</p>	<p>Civil construction to accommodate ultimate.</p> <p>1x additional duty storage installed</p>
Kooloonbung Transfer Pumps	<p>Civil and mechanical construction to accommodate stage 1 design.</p> <p>2x duty pumps installed 1x standby pump installed</p>	<p>Civil and mechanical construction to accommodate ultimate.</p> <p>1x additional duty pumps installed</p>
Dewatering System	<p>Civil structure built to accommodate ultimate. Mechanical installation to accommodate stage 1 design.</p> <p>1x duty train installed 1x standby train installed</p>	<p>Likely centrifuge capacity upgrade or extend operating hours.</p>
Plant Chemicals	<p>Built to accommodate ultimate.</p>	<p>No construction.</p> <p>Increased pump capacity (replacement)</p>
CIP Chemicals	<p>Built to accommodate ultimate.</p>	<p>No construction.</p> <p>Increased pump capacity (replacement)</p>
RWTP	<p>Built to accommodate ultimate.</p>	<p>No construction.</p>
Switchroom Building	<p>Built to accommodate ultimate.</p>	<p>No construction.</p>

Appendix C.  
Register

Sustainability Innovation and Opportunity

# Appendix D. Operational Requirements Schedule

# Appendix E. Flow Balance

# Appendix F. Process and Instrumentation Diagrams

# Appendix G. Equipment List

# Appendix H. Instrument List

# Appendix I. Civil Drawings

# Appendix J. Hydraulic Profile

# Appendix K. Pump System Summary

# Appendix L. 3D Model

# Appendix M. Maximum Demand

# Appendix N. Control System Architecture

# Appendix O. Electrical and Control Drawings

# Appendix P. Preliminary Equipment Selections

## Appendix Q. Predicted Storm Pond Events (Based on Historical Data)

The table below summarises the volume discharged during the overflow event, the rainfall that occurred prior to the event and representative %AEP event. The majority of the emergency flow relief events would have occurred between February 2021 and July 2022.

Based on the below assessment, a 25 ML storm storage pond has been included in the design.

Table 9-1: Predicted Emergency Overflow Event Summary, Rainfall and %AEP event (2010 to 2022).

Event Date	Volume of Flow Discharged	Volume of Flow Discharged	Volume of Flow Discharged	Total Rainfall in 24 hours (mm)	Total Rainfall in 72 hours (mm)	Total Rainfall in 168 hours (mm)	Total Rainfall for 168 hours plus until event ends (mm)	Corresponding %AEP event
Ultimate Population	80,000 EP	80,000 EP	80,000 EP					
Storm Storage Pond Volume	10 ML	25 ML	40 ML					
15 June 2011	1.1 ML over 1 day	N/A	N/A	50	163	187	N/A – 1 day event	N/A
02 Feb 2012	4.8 ML over 1 day	N/A	N/A	83	145	162	N/A – 1 day event	N/A
02 May 2018	40 ML over 3 days	26 ML over 2 days	11 ML over 1 day	4	19	92	N/A – 1 day event	N/A
21 Feb 2021	6.6 ML over 1 day	N/A	N/A	6.4	24	245	N/A – 1 day event	50% to 20% AEP
19 Mar 2021	91 ML over 3 days	76 ML over 3 days	61 ML over 3 days	22	135	448	470	5% AEP
24 Feb 2022	22 ML over 1 day	8 ML over 1 day	N/A	29	37	164	N/A – 1 day event	N/A
25 Mar 2022	221 ML over 7 days	207 ML over 6 days	193 ML over 6 days	47	114	275	396	50% to 20% AEP
22 May 2022	40 ML over 1 day	25 ML over 1 day	10 ML over 1 day	0.2	16	154	N/A – 1 day event	N/A
6 July 2022	28 ML over 1 day	14 ML over 1 day	N/A	0	0.4	142	N/A – 1 day event	N/A

Based on BOM Intensity-Frequency-Duration (IFD) for this location:

\*A 50% AEP event represents 226 mm rain in 168 hours

+A 20% AEP event represents 318 mm rain in 168 hours

^A 5% AEP event represents 453 mm rain in 168 hours

# Appendix R. Safety in Design Report

# Appendix S. Heavy Vehicle Traffic Route Sketch



Figure 9-1: Chemical Delivery Articulated Vehicle (19m Long) Sketch

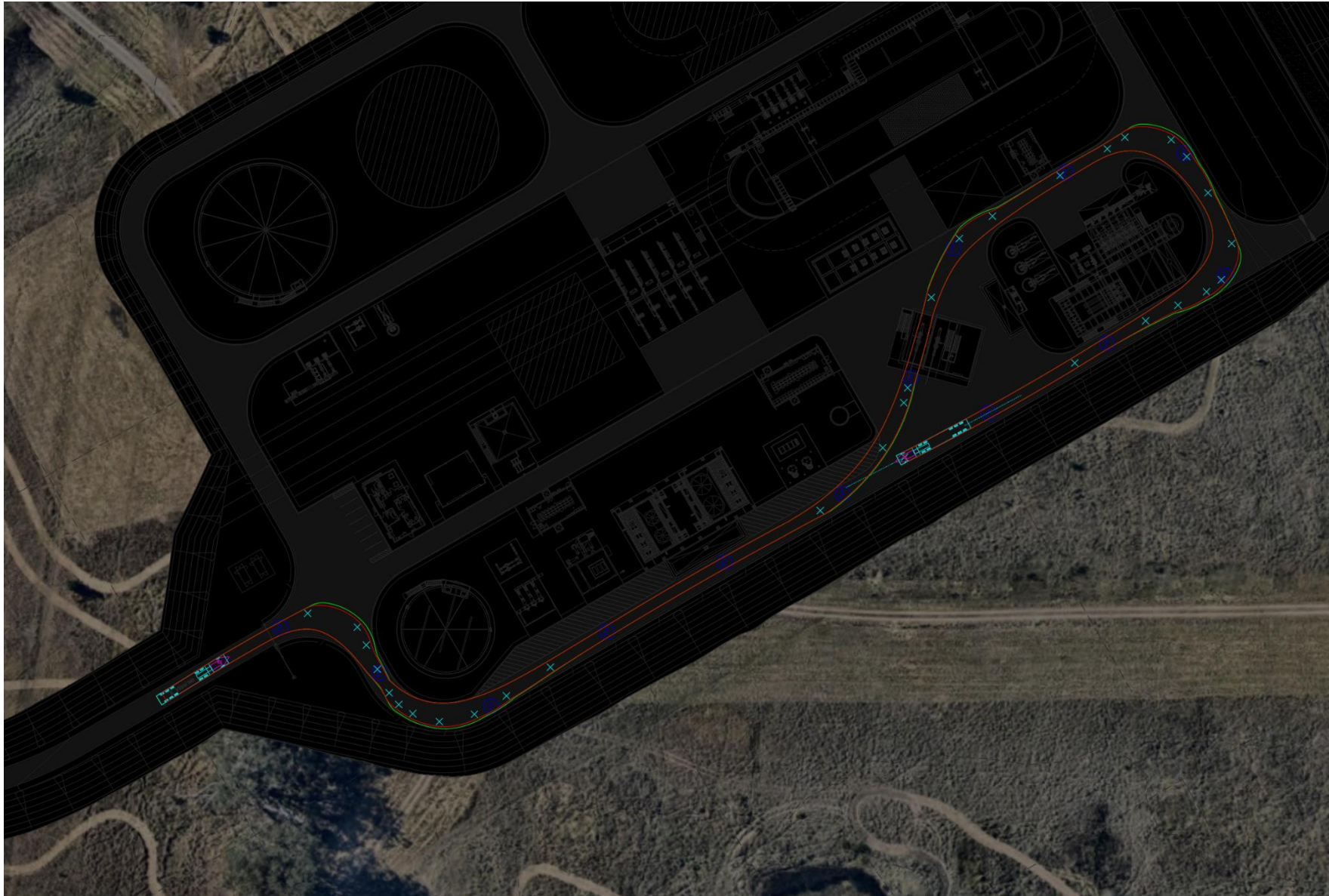


Figure 9-2: Biosolids Pick Up Articulated Vehicle (19m Long) Sketch



Figure 9-3: Inlet Works Bin Pick Up Heavy Rigid Vehicle (12.5m Long) Sketch

# Appendix T. Solar PV System Feasibility Study