# MANTEENA PTY LTD

# Design Brief

## for Selwyn Snow Resort STP


demem akwa

Office Address:
32 Cessna Drive, Caboolture,
Queensland 4510, Australia

[t] +61 7 5428 3265
[e] admin@dememakwa.com
[w] www.demembranes.com


| | |
|---|---|
| Date: | 11th May 2021 |
| De.mem Reference: | QU-0226-DB REV1 |
| De.mem Contact: | Josh de Denus /DK/TG |
| Customer Reference: | Selwyn Snow Resort |

# Table of Contents

# 1. Basis of Design

The Basis of Design is based on Influent generated only from contained sewage sources that are domestic in nature and only from the Selwyn precinct. It is therefore anticipated that standard domestic municipal wastewater influent characteristics will apply.

## 1.1. Sewage Sources

The Sewage sources are as follows:

- Main resort complex (Up to 2,000 persons per day) including:
  - Gift shop.
  - Kitchen / café / bar.
  - Kids play area.
  - Laundry.
  - Toilets.
- Workshop (up to 50 persons per day)
  - Toilet
  - Sink
  - Shower
- Staff Accommodation (Up to 50 persons per day) including:
  - Toilets
  - Showers
  - Kitchen
  - Laundry

The wastewater strategy for the centralised wastewater treatment system includes:

- Receiving of all wastewaters from the site during peak season (1st June to 30th September)

- Treatment of wastewater to a level suitable for pumping to the quarry dam for storage and for use in snow making and firefighting.

## 1.2. Influent Specification

The specification of inlet flow is given in table 1:

*Table 1- Influent's specification*

| Description | Feed Water | unit |
|---|---|---|
| **total inlet flow rate** | 44 | m3/d |
| **Chemical Oxygen Demand (COD)** | 900 | mg/l |
| **Biological Oxygen Demand (BOD)** | 450 | mg/l |
| **Oil & Grease (Non-hydrocarbon)** | 20 | mg/l |
| **Total Suspended Solids (TSS)** | 350 | mg/l |
| **TKN** | 60 | mg/l |
| **phosphorous** | 10 | mg/l |
| **ALKALINITY** | 400 | mg/l |

## 1.3. Recycled Water Product Quality

The treated effluent is expected to be fully used as a recycled water for firefighting and snow making.

Recycled water product quality is to be in accordance with the National Guidelines for Water Recycling, Managing Health and Environmental Risks, Phase 1, 2006 (AGWR).
The Table below outlines the likely uses of treated sewage effluent (recycled water) and the required log reduction values (LRV) of the product quality.

*Table 2- Recycled Water Product Quality- Pathogens*

| Pathogen | Bacteria | Protozoa | Virus |
|---|---|---|---|
| Required LRV snow making (#) | 4.0 | 3.7 | 5.2 |
| Required LRV toilet flushing (^) | 3.3 | 3.1 | 4.5 |
| Required LRV laundry (^) | 2.3 | 2.1 | 3.5 |
| Required LRV fire fighting (^) | 5.3 | 5.1 | 6.5 |
| **Notes** | | | |
| # Based on Table 3.7, municipal irrigation, AGWR (and international literature) | | | |
| ^ Based on Table 3.7 AGWR | | | |

The process train and equipment selection is appropriate to enable process validation and ongoing verification. The biological treatment, filtration, UV disinfection (including sufficient UVT and dose rate) and chlorine disinfection (including sufficient contact time) will meet the LRVs reliably.
Recycled water quality for other parameters is anticipated to be as per table below:

*Table 3- Recycled Water Product Quality*

| Parameter | Accepted levels achieved by modern technology (for discharge to inland waters) – $90^{th}$%ile limits |
|---|---|
| Biological Oxygen Demand | 10mg/L |
| Total Nitrogen | 10mg/L |
| Total Phosphorus | 0.3mg/L |
| Suspended Solids | 15mg/L |
| Ammonia – nitrogen | 2mg/L |
| pH | 6.5-8.5 pH units |
| Oil and Grease | 2mg/L |
| Pathogens (measured as faecal coliforms) | 200 colony forming units/100mL |

The following minimum online monitoring is anticipated for the recycled water product:

- pH
- Temperature
- Turbidity
- Free residual Chlorine
- For UV disinfection (UVT and dose)

# 2. Design Overview

## 2.1. General

Client has indicated a 40Kl/day (+/-10%) system in conjunction with 2 x 50Kl balance tanks would cover the maximum peak flow as per provided in the documentation and table here below.

The plant process design offered is a Modified Ludzack-Ettinger (MLE) process with MBR membrane polishing and disinfection using UV and liquid chlorine to achieve the required pathogen Log reduction for recycled water applications.

The Main Process Bioreactor and MOS Cell are fabricated in an Engineered Steel Shell format. The structure weighs in at approximately 8-10 tonnes. Engineered Drawings are available for Review prior to the system fabrication beginning.

The main plant room shall be a custom modified 12 mtr HC shipping container, complete with heavy duty vinyl flooring, safety shower, control room, ventilation and/or air conditioning. All major operating hardware including dry mounted submersible pumps, aeration blowers, chemical dosing, and control panel shall be installed inside the second plant container.

**Assumptions:**
Design is based on typical domestic influent values for the specified 40,000 litres a day.
Assumed Altitude 1500m
We have assumed a correctly sized grease trap is or will be installed upstream of the plant.

## 2.2. Basic PFD (PROCESS FLOW DIAGRAM):

The Treatment plant process flow diagram is shown on figure 1.

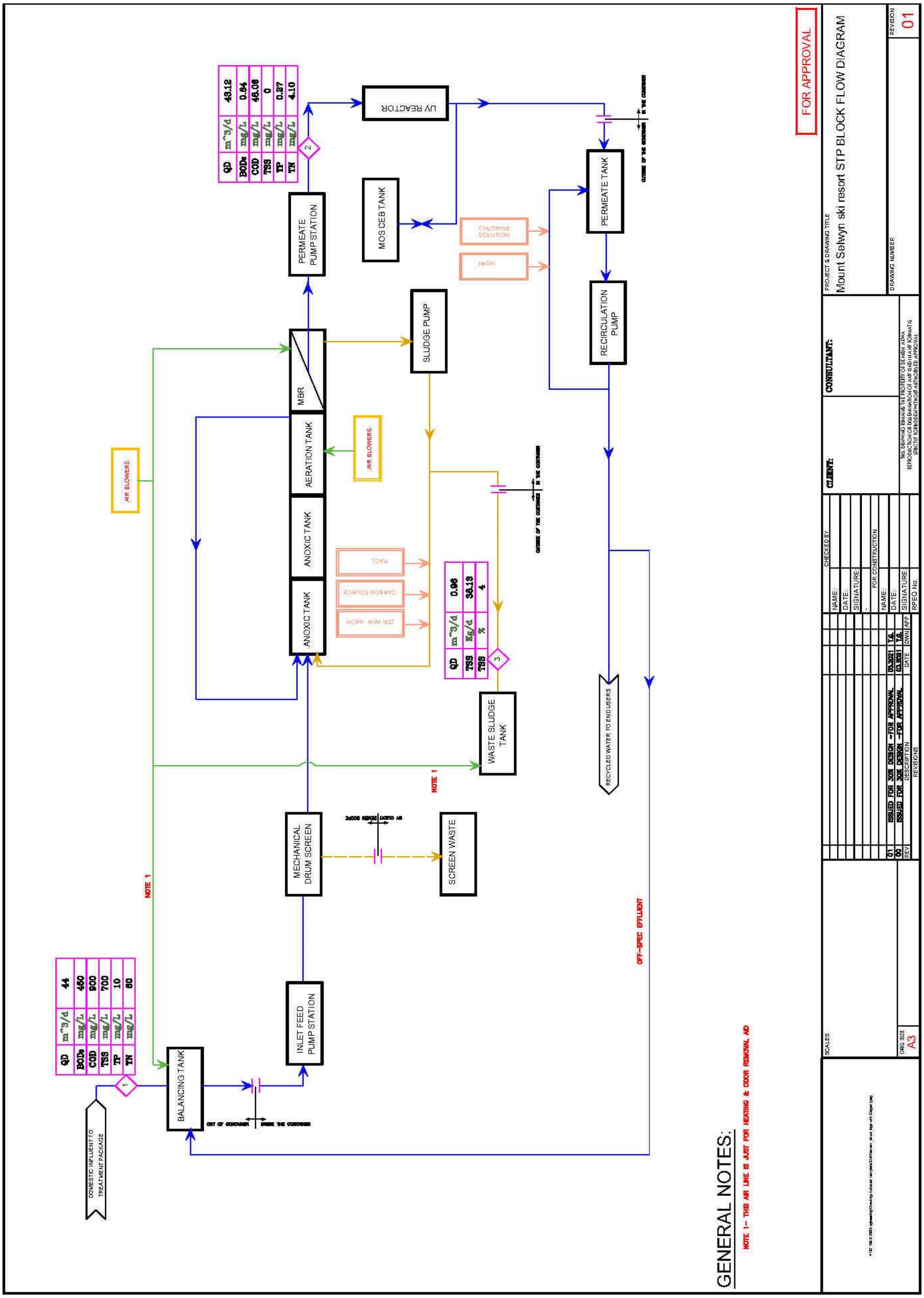



*Figure 1- WWTP BFD*

## 2.3. Process Units

### 2.3.1. Balance tanks and pump

To deliver raw influent from the flow balance tank to the main process bioreactor in a controlled manner, a duty/standby dry mounted submersible Grundfos SEV series or equivalent submersible pump system shall be installed.

The SEV Series pumps are a non-self-priming, single-stage, centrifugal pump designed for handling wastewater, process water and unscreened raw sewage. The pump is designed for intermittent and continuous operation. The liquid less and maintenance free cooling system ensures that the pump can be used for submerged or dry installation. The efficient Super Vortex impeller provides passage of long fibres and solids up to 65 mm and is suitable for wastewater with a dry matter content of up to 5 %. A unique stainless-steel clamp assembling system enables quick and easy disassembly of the pump motor from the pipe work for service and inspection. No special tools are required. Pipework connection is via a DIN flange.

Fabricated Schedule 80 UPVC suction and discharge manifolds complete with isolation ball valves and cast-iron ball check valves for each pump shall be provided. The flow balance pumps shall operate as required based on flow balance tank level and system demand. The pump system discharge pipe work shall include a diaphragm type flow control valve and magnetic flow transmitter to enable operator adjustment of the system feed flow rate to fine tune the system for site specific conditions.

**Equipment Specification:**

- 2 x 50Kl (P&ID ref: TK001A and B) LLDPE tanks with appropriate nozzles to be provided by the client (Demem-Akwa will provide design drawings and nozzle schedule)
- 5 x 2-meter tube air diffusers (VTA) will be installed inside the tanks in order to maintain effluent quality during peak load periods and maintain performance of the plant.
- Balancing pumps (P&ID ref: BP-001A and B) are set-up in duty/standby configuration. 14.4m3/hr @7m h – Power 1.3 KW

### 2.3.2. Inlet Screen

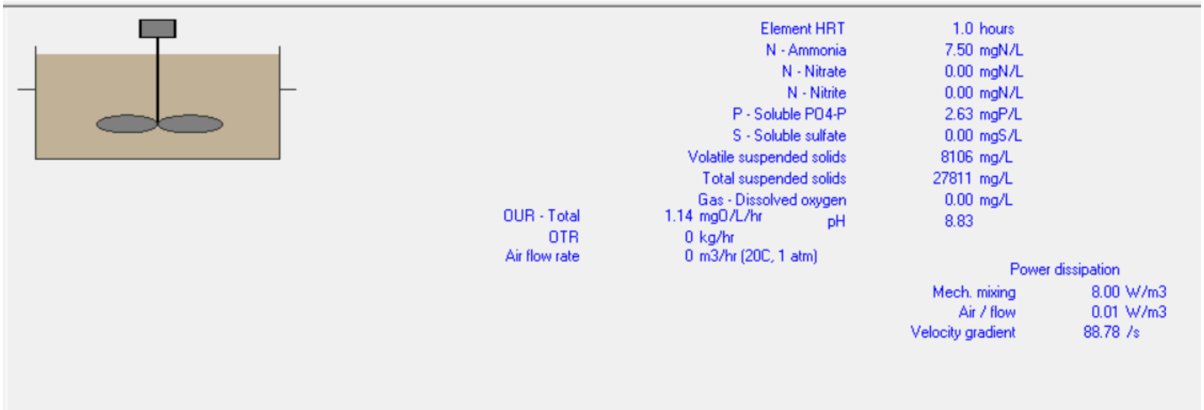
To remove large non-biodegradable solids prior to the biological treatment section of the system, the plant will feature an automatic inlet screening system. Raw influent entering the packaged plant shall be delivered to an Inlet Screen sized appropriately for the STP design loading. The Screen is a pre-treatment polishing stage designed to remove solid waste from liquid through a filter drum formed by a grating or perforated mesh of different apertures depending on the type and number of solids being treated.
Its task is to remove the solids carried by the water in order to avoid obstructions and mechanical problems in the plant.
The discharge to be treated enters through the flange located on the outside of the screen body, being uniformly distributed by the spillway and overflow over the drum filter. The solids are retained on the drum surface while it rotates, the discharge entering through the mesh performs a self-cleaning function as it passes again through the bottom of the drum. On passing through the external scraper, solids are detached from the mesh, and fall from the scraper thanks to gravity to a collection bin for removal.

**Equipment Specifications:**

| | |
|---|---|
| **Type:** | Mechanical fine screen drum |
| **Capacity:** | 7 m3/hr |
| **Screen size:** | TBA |
| **Power:** | 0.25 kW |

### 2.3.3. 1st Anoxic Tank

The process bioreactor is designed to operate with a mixed liquor concentration of ~6000 to 12,000 mg/l. The anoxic zone will accept recycled mixed liquor from the aerobic zone, as well as new screened influent from the flow balance tank. Anoxic bacteria are particularly efficient in nitrogen conversion, reducing the overall nitrogen level discharged by the system.
They will also provide additional BOD/COD reduction with a very low oxygen level present, and in turn will sacrifice the oxygen molecule in Nitrate and Nitrite to gain life preserving food and oxygen to allow them to multiply, which in turn will reduce Total Nitrogen levels in the final effluent stream and help protect the following aerobic zone from potential unwanted contaminants such as oil and grease.

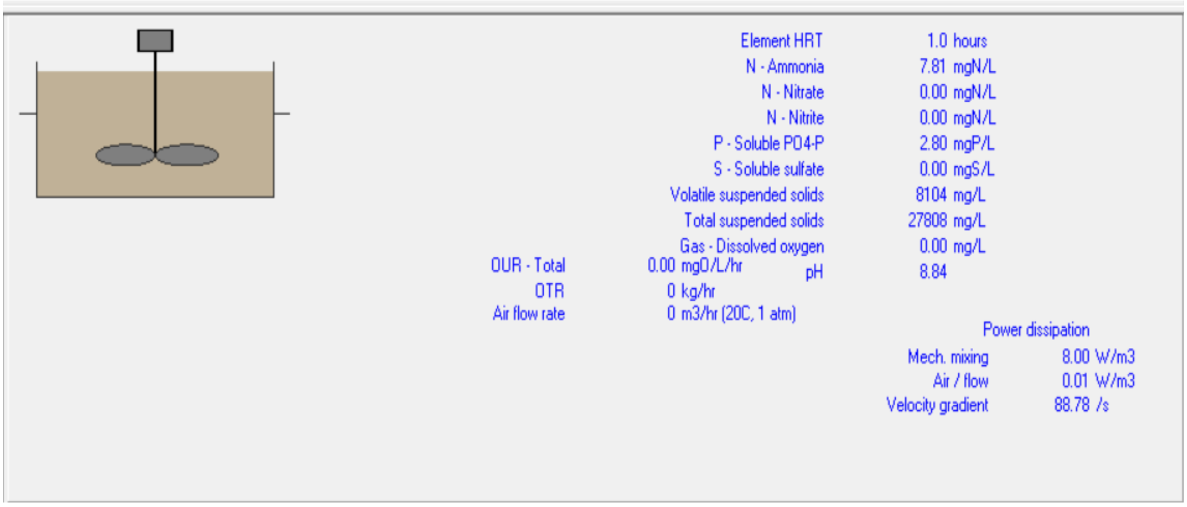


| Name: anoxic 1 | | Type: Bioreactor |
|---|---|---|
| Volume: | 11.40 | m3 |
| Area: | 4.56 | m2 |
| Depth: | 2.50 | m |

Both anoxic chambers will be fitted with 1 x 0.1kW submersible mixer (P&ID ref: MX-002 A and B).
An immersed 37kW heating element (P&ID Ref: IH-001) will be installed in tank TK-002 A.

### 2.3.4. 2nd Anoxic Tank

The second anoxic zone specification is:




The size of this chamber is:

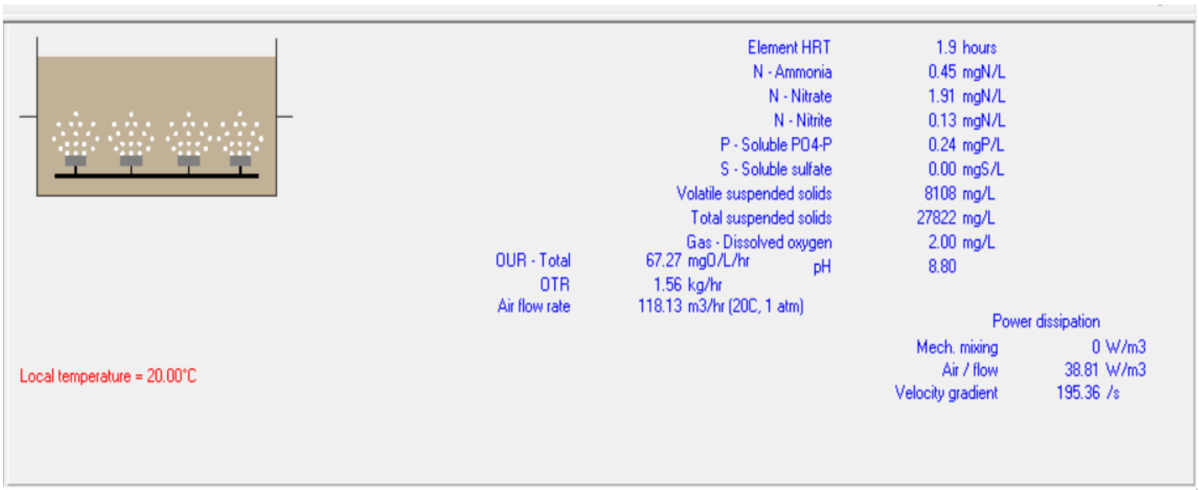
| Name: anoxic 2 | | Type: Bioreactor |
|---|---|---|
| Volume: | 11.40 | m3 |
| Area: | 4.56 | m2 |
| Depth: | 2.50 | m |

### 2.3.5. Aerobic Bioreactor

The aerobic bioreactor is designed to operate with a mixed liquor concentration of ~6,000 to 12,000 mg/l. The F:M ratio of the system is designed to operate at 0.08 using a volatile solids percentage of 80%. This is within the ideal operating range for MLE MBR treatment, allowing the system to maintain consistent effluent quality. A suitably sized section of the custom bioreactor will be dedicated as the aerobic bioreactor, complete with all necessary fixtures, pipework and spools required for the system design.
Oxygen is introduced into the system using fine bubble diffusers, and a duty only variable speed drive roots style compressor blower, ensuring good mixing of the mixed liquor occurs without damaging the mixed liquor bio-floc as well as providing the most efficient

introduction of dissolved oxygen into the bioreactor. Dissolved oxygen is delivered at 15 grams per hour per cubic metre of air delivered via the fine bubble diffusers. Dissolved oxygen levels shall be monitored via the installation of a DO and suspended solids monitoring package, which shall provide control signals for the variable speed drive blowers enabling automatic DO level set point control.

The aeration grids shall be set-up as independent grids. Based on the specified design BOD mass loading of 18kg/day, the system is capable of accommodating changes in incoming biological load. The aeration tank operating condition and size will be:




and

| Name: aeration | | Type: Bioreactor |
|---|---|---|
| Volume: | 22.80 | m3 |
| Area: | 9.12 | m2 |
| Depth: | 2.50 | m |

The system is capable of operating at a variety of sludge ages, on average approx. 21-28 days, with sludge age capable of dropping as low as 14 days to deal with influent increases to cover site specific requirements – the only detrimental effect being an increase in the sludge wasting volume and load on the Aerobic waste sludge tank. The oxygen delivery system is designed to accommodate the worst case absolute maximum loads for BOD, Hydraulic capacity and HRT – ensuring the system DO can be maintained at all times.
The Blower will be housed in the plant room and only the airline will run to the tank aeration system.

**Equipment Specification:**

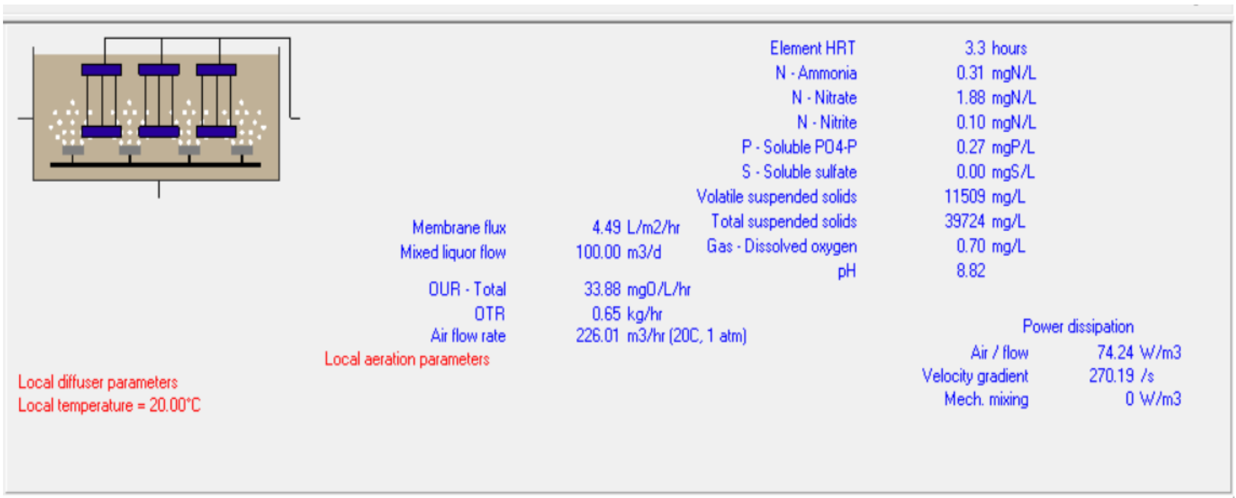
- 10 x 2-meter fine bubble tube diffusers of 8m3/hr/m capacity (P&ID Ref: DIF-003)
- 1 x Three Lobe 1.5kW Aeration Blower with 160.2/ 182.4 m3/hr capacity – DIFF Pressure 750 mbar

### 2.3.6. MBR Membrane Bioreactor

MBR membrane filtration is an advanced wastewater treatment technology using submerged membranes to extract liquid from an activated sludge treatment system. The Membrane Bioreactor (MBR) process replaces the secondary clarifiers and/or typically used in conventional waste treatment methods for solid/liquid separation.

Unlike secondary clarifiers, however, the treated water quality is not dependent on the mixed liquor suspended solids concentration, or the settling characteristics of those solids. In fact, MBR systems can operate at much higher mixed liquor suspended solids (MLSS) concentrations than conventional activated sludge systems. This also results in dramatically reduced plant bioreactor volumes and overall system footprint as well as providing a larger range of flexibility in the overall operation of the system.

The membrane system and overall STP design we propose can operate with an MLSS as low as 6000mg/l (to allow for lower incoming load periods) all the way up to 12,000mg/l to accommodate maximum design loadings needed. The target system design proposed for this STP is designed at an MLSS operational level of 8,000mg/l to 9,000mg/l – providing a suitable upper and lower adjustment at the target design. The MBR tank operating condition and size will be:




And

| | | |
|---|---|---|
| Name: MBR | Type: Bioreactor - MBR | |
| Volume: | 22.80 | m3 |
| Area: | 9.12 | m2 |
| Depth: | 2.50 | m |

For this packaged plant, there is a Stand Alone MOS (Membrane Operating System). A MOS typically incorporates one or more Membrane filtration cells located adjacent to or within the biological treatment system. The use of a separate MOS tank for the Membrane filtration modules provides a number of benefits, including:

- A controlled membrane environment
- Positive fluid transfer of mixed liquor through the membrane filtration modules and uniform distribution of flow and of solids (MLSS)
- Independent optimisation of biological and membrane processes
- A clean in place (CIP) system that allows chemical cleaning without membrane removal, providing safer operation and reduced downtime.
- Separation of biological processes from chemical cleaning systems

**The MOS for this plant will include the following;**

- One MOS tank will be installed. The MOS tank is a rectangular tank located inside the fabricated epoxy coated steel shell bioreactor vessel, in which membrane 'cell or cells' are fitted. The MOS tank shall hold Membrane Filtration modules totalling 1200m2 and has manifolds to collect filtrate and distribute low pressure air. The membranes shall be Hydranautics HSMM200-ES modules (or approved equivalent) with a nominal membrane pores size of 0.05um.
- An aeration system which continuously supplies low pressure air to the membrane filtration modules in the MOS tank. The MOS shall have a duty/standby side channel blower system for air scour on the membrane cells.
- A Duty/Standby Filtrate pump system, which draws filtered liquid from the membrane filtration modules in the MOS cell. The filtrate pump system for the MOS tank shall be variable speed drive stainless steel liquid ring pumps fitted with fabricated Schedule 80 UPVC suction and discharge manifolds including automatic and manual isolation valves for the pumps.
- Valves, instrumentation, Magnetic Flow Meters and controls.

**Equipment Specification:**

- 1 x MBR Module - Submerged Membrane (P&ID Ref: MBR-004 A and B) – Total surface area: 2x5x40 m2 – Flux: 7- 34 lmh - Max. TMP: -0.41 bar
- 1 x MOS air Blower – 2.2kW side channel blower – 216m3/hr capacity - Diff. Press.: 300/350 mbar
- 1 x MOS CEB Tank (P&ID Ref: TK-005) 1000L -LLDPE

**Maintaining Membrane Performance**

During membrane filtration, filtered solids tend to form a compressible filter cake on the membrane surface. The filter cake forms a filter in itself, and so adds to the filtration performance of the systems, but at the same time it increases the head loss or pressure drop across the membrane, commonly referred to as the Trans-Membrane Pressure (TMP). This filter cake must be controlled to maintain a reasonable TMP across the membranes during filtration.

The minimisation of this fouling layer or filter cake is regulated by three processes, namely;

- Relaxation and Air Scour
- Maintenance Clean (MC)
- Clean in Place (CIP)

Filtration rates are principally maintained by air scour and relaxation of the membrane fibres. However, a small residual amount of foulant remains on the membrane surfaces and accumulates over time. This is reflected by a slow increase in membrane resistance to flow. To remove these foulants, occasional chemical cleaning is carried out, either with a maintenance clean (MC) cycle, or with a Clean-in-Place (CIP) cycle.

**These three processes are described below;**

**1.) Relaxation/Air Scour**

To maintain low TMP and prevent solids accumulation on the feed side of the membrane fibres, air is continuously supplied to a coarse bubble air diffuser located below the membranes. Coarse bubbles, generated by the diffuser, rise through the membrane fibre bundles, creating a scouring effect which limits the amount of solids deposition on the outer membrane surface and pore plugging, thereby helping to maintain a low TMP.

After a set amount of filtration time, the membranes enter a relaxation step, or soak step. During the relaxation step, filtration stops while coarse air bubbles continue to create a scouring effect to remove extraneous particulate matter from the feed side of the membrane which may have been accumulated during filtration.

**2.) Maintenance Clean (MC)**

Typical MBR operation will include a MC every 1 to 2 weeks of operation. A MC is usually performed automatically after a pre-set total time in filtration.

During a MC, chlorinated filtrate is passed in the reverse direction through the membrane filtration modules to inhibit biological growth and reduce fouling on the membranes and in filtrate pipe work. During this process, membrane aeration continues, and the cell remains full of mixed liquor, although the mixed liquor feed is turned off. The whole cycle typically lasts for about 30 minutes after which the cell is returned to service.

**A MC sequence is as follows:**

- Reverse flow backwash of clean water dosed with approximately 200mg/l chlorine. The chlorine is dosed via the installation of a chemical metering pump. Magnetic flow meters installed on the filtrate pumps, which feed the backwash enable automatic flow paced control of the chlorine dosing pump. The dosing pump shall be mounted on a fabricated UPVC dosing skid incorporating 60 litre chlorine dosing tank and bund, fitted with a dosing pump shelf.
- Relaxation for 5 to 10 minutes
- Repeat of reverse flow backwash with chlorine solution and relaxation steps up to a total of 3 times.
- Resume mixed liquor recirculation with aeration for 5 minutes.
- Start filtration, returning the first few minutes of filtrate production to the MOS cell. Confirm rinse effectiveness by automatic measuring the pH of the filtrate via the installation of a Prominent DMT series pH analyser on each membrane train filtrate outlet pipeline.
- Return cell to normal operation.

During a MC the membranes remain fully submerged in mixed liquor. No neutralisation is required as the small amount of chlorine used in the MC is consumed by the mixed liquor.

**3.) Clean in Place (CIP)**

The MBR process is designed so that a CIP is typically required only once every 3 to 6 months of operation. During a CIP cycle, the mixed liquor is drained from the MOS cell, and the cell is flushed with filtrate before being filled again with dilute cleaning solution made up with clean water.

For biological systems using coagulant for phosphorus removal, both acid and chlorine cleaning solutions are typically used. In these systems, the Acid CIP cycle uses a blend of Citric Acid (0.5%). The chlorine CIP solution is made to a concentration of up to 1500 mg/l of free chlorine. A CIP cycle will usually be performed when;

- The filtration TMP reaches a pre-set maximum value.
- The total filtration time reaches a pre-set value.
- An operator starts the CIP cycle manually.

The MOS cell in the plant will be cleaned periodically. A CIP sequence is generally from around 6 hours in duration, and typically includes the following steps;

- Drain mixed liquor from the cell.
- Fill the cell with filtrate from the filtrate storage tank.
- Fill the cell with clean water and add the cleaning solution concentrate, recirculating the cleaning solution through the membranes with the filtrate pump and back into the cell for 45 minutes.
- Soak in the cleaning solution for 15 minutes
- Aeration – For an acid CIP, the membranes continue to soak for about 5 minutes with aeration on. For chlorine CIP, this step is skipped.

- Repeat the soak and aeration (for acid CIP) steps for a total soak period of about 3 hours.
- Drain the used cleaning solution from the cell and the membrane modules to the neutralisation tank (which is built into the fabricated reactors beside the digester chambers)
- If a dual (acid followed by chlorine) clean is in progress, refill the cell with clean water and chlorine concentrate and repeat the relevant steps as described above.
- After the cleaning solution has been drained, reverse flush the filtrate pipe work and membrane modules with filtered water.
- Fill the MOS cell with mixed liquor then continue mixed liquor recirculation with aeration on for 5 minutes.
- Start filtration, returning the first few minutes of filtrate production to the MOS cell.
- Return cell to normal operation.

During the CIP cycle the membrane modules are fully submerged in the cleaning solution. This process is performed in the MOS cell, providing operational simplicity by eliminating the need to remove the membranes to a separate location for cleaning. Filtrate from the MOS system will be delivered to a 750 m3 chlorine contact panel tank beside the MOS cell. The tank shall be fitted with a level transmitter and based upon tank level the treated effluent will be transferred from the tank to the final proposed re-use scheme via an automatic actuated ball valve.

### 2.3.7. Waste Activated Sludge

All activated sludge treatment systems produce waste sludge as BOD/COD is converted biologically. The volume of sludge is influenced by several factors including incoming nutrient loads, operating sludge age, and system F:M ratio. In addition, activated sludge treatment systems require a controlled sludge age to maintain effective and efficient operation and treatment of sewage. Sludge age control determines the system's ability to provide clean and clear effluent as well as important nutrient removal of Ammonia, Nitrates, Nitrite and Phosphorous.

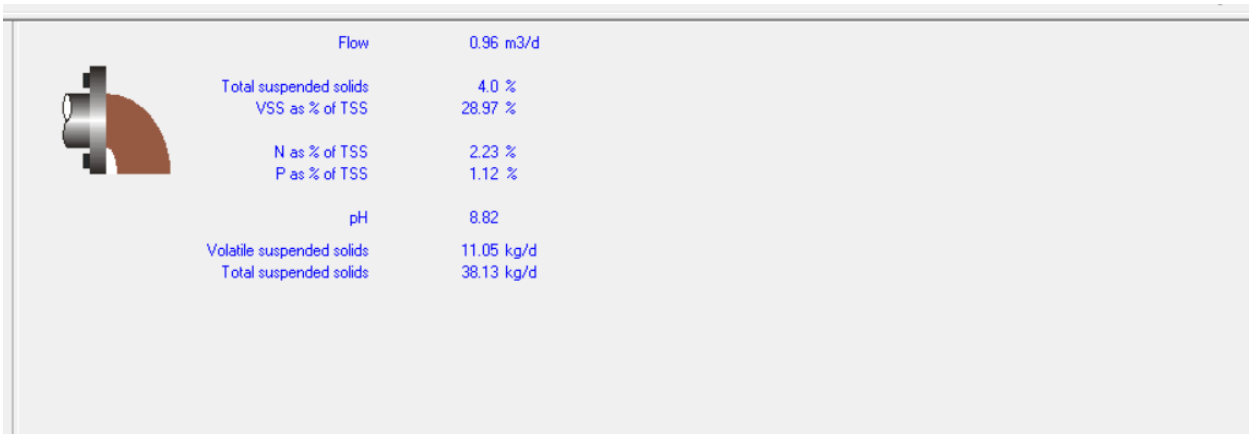
The sludge age of any system requires operator input to manage; however, we make it relatively easy in the way in which we automate this part of the system.

The central plant PLC receives a flow signal from the water meter on the outlet of the system – which it uses to count and log the total litres processed by the STP on any given day.

The sludge management platform works 24 hours in arrears – looking at the previous day's total processed volume from 7am to 7am. The HMI has an available set point for WAS stated as a percentage of daily volume to waste, with the plant usually needing to waste around 3%-5% of total daily flow back to the solids digester to maintain accurate MLSS stability and control sludge age within the system (all highly dictated by the influent quality and level of non-biodegradable solids, but close as a general rule).

The system will automatically pump activated sludge one or more times per day from the aerobic bioreactor to the waste sludge storage tank until the required volume of sludge wasting is achieved. The waste sludge storage tank shall be a 22.5$m^3$ SG1.5 industrial poly tank located beside the flow balance tank.

The operator can select daily percentage of raw influent Mode, Operator pre-set volume mode, and the number of cycles per day (up to three) to ensure lower impact on the balance system – with the time of day for each cycle to operate also programmable from the HMI. The specification of waste sludge which will be sent to this tank is:



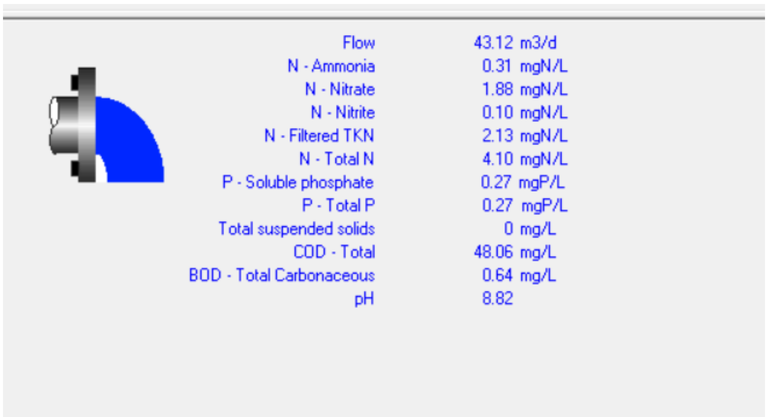
| | |
|---|---|
| Flow | 0.96 m3/d |
| Total suspended solids | 4.0 % |
| VSS as % of TSS | 28.97 % |
| N as % of TSS | 2.23 % |
| P as % of TSS | 1.12 % |
| pH | 8.82 |
| Volatile suspended solids | 11.05 kg/d |
| Total suspended solids | 38.13 kg/d |

**Equipment Specification:**

- 1 x Waste Sludge Tank (P&ID Ref: TK-007) 22.5kL LLDPE tank
- 1 x Sludge Pump (P&ID Ref: SP-002) 2.8kW -Design Capacity: 43.2 m3/h - Max. Head: 17.8 m
- 5 x 2m tube diffusers (P&ID Ref: DIF-004)

### 2.3.8. Permeate Pump

The permeate pump transfers permeate water from the MOS tank through the pressurised UV and to the permeate tank. The specification of permeate flow which will be sent to UV section is:



| | |
|---|---|
| Flow | 43.12 m3/d |
| N - Ammonia | 0.31 mgN/L |
| N - Nitrate | 1.88 mgN/L |
| N - Nitrite | 0.10 mgN/L |
| N - Filtered TKN | 2.13 mgN/L |
| N - Total N | 4.10 mgN/L |
| P - Soluble phosphate | 0.27 mgP/L |
| P - Total P | 0.27 mgP/L |
| Total suspended solids | 0 mg/L |
| COD - Total | 48.06 mg/L |
| BOD - Total Carbonaceous | 0.64 mg/L |
| pH | 8.82 |

As one can see, almost the required specification for treated water has been achieved but for pathogen reduction we will send this flow to UV reactor as mentioned following section.

Equipment Specifications:

- 1x Permeate pump + VSD (P&iD Ref: PP-003) 1.12kW -Centrifugal pump with 7.2 m3/hr @10m h capacity.

### 2.3.9. Pressurised UV Disinfection System

The proposed UV lamp is the latest generation of low-pressure high intensity mercury-indium amalgam lamps.
Thanks to a special amalgam dot in combination with gaseous mercury used by modern low-pressure lamps, the lamps UV output has been drastically increased resulting better overall efficiency.

The lamps are easy to replace and require no special tools, have easy connections, no need to drain the reactor and typically take 10 minutes to prepare and 2 minutes to change the lamps.
The UV system will be located inside the containerised plant room.

**UV Equipment Specification:**

- 1 x pressurised UV (P&ID Ref: UV-001)

| | |
|---|---|
| Flow: | 3 m3/h |
| UVT: | >77% UVT considered for the design. |
| Goal of treatment: | 40 mJ/cm2 ONORM validated system for:<br>- 0.5 log virus<br>- 4 log Crypto<br>- 4 log Bacteria |
| Environment: | -Control cabinet rated IP54 for indoor or under a roof installation<br>-Maximum ambient temperature of 40°C for the control cabinet |
| Specific requirements: | - Automatic Wiping<br>- UVI monitor<br>- UVT analyser |

**Inclusions:**

- UV reactor in S.S. 316L with drain valves
- Flow pacifier
- UV lamps
- Automatic cleaning system (Sleeves and UVI sensor)
- UV intensity monitor
- High temperature alarm switch
- EcoTouch controller with touch screen, including the equation of validation when appropriate.
- Control cabinet in painted steel rated IP54 for a maximum ambient temperature of 40°C (see below options)
- Portable UVT analyser (minimum flow 0.5m3/hr)

#### 2.3.9.1. Pathogen Log Reduction Overview

Log Reduction overview for Recycled Water re-use as per the Recommended Pathogen Log Reduction Values (LRVs)

| Process | Log reduction Value | | |
|---|---|---|---|
| | Bacteria | Virus | Cryptosporidium |
| MBR – Ultra-filtration | 3.0 | 2.5 | 3.0 |
| Chlorination Ct>15mg/L min | 4.0 | 4.0 | 0 |
| UV >40 mj/cm² | 4.0 | 0.5 | 4.0 |
| Total achieved LRVs | **11** | **7** | **7** |

| | | | |
|---|---|---|---|
| LRV requirement | 5.3 | 6.5 | 5.1 |

Treatment process meets LRV targets and multi barrier process requirements for recycled water re-use.

### 2.3.10. Permeate Tank

The proposed permeate tank receives treated effluent from the MOS chambre having passed through UV disinfection lamp. The tank will be located close to the plant room.

**Equipment Specifications:**

- 1 x 50kL LLDHE Permeate Tank (P&ID Ref: TK-006)
- 1 x Permeate discharge pump with VSD (P&ID Ref: P-004A) Duty/Standby configuration - 64.68 m3/hr @ 81.3mh – 18.5kW

#### 2.3.11. Residual Chlorine Analysing and Dosing System

To maintain residual disinfection on the treated effluent held in storage prior to discharge, a recirculation- based chlorine analysing, and dosing system will be installed to maintain a set level of chlorine in the water stored in the effluent storage tank. This will ensure that the effluent produced is guaranteed to achieve full disinfection prior to being released.
An end suction pump system shall constantly recirculate water through the chlorine contact tank at a stable flow rate. The pump shall be mounted on a fabricated HDG steel base and shall include fabricated Schedule 80 UPVC suction and discharge pipe work including isolation valves for the pump. On the discharge of the recirculation pump system, a sample line off-take will deliver a sample through a probe holder containing a flow switch, pH, turbidity and chlorine residual probe. A chlorine analyser receives the signals from the flow switch and probes, and controls chlorine dosing pump to deliver chlorine into the return line to the tank. A chlorine set point programmed into the control system enables the system to maintain the required level of chlorine to guarantee residual disinfection of the Treated Effluent.
Treated effluent water shall be available for delivery to the nominated discharge or re-use scheme via a flanged discharge connection on the plant battery limit.

**Equipment Specifications:**

- 1 x Recirculation Pumps with VSD (P&ID Ref: P-004A) Duty/Standby configuration - 64.68 m3/hr @ 81.3mh – 18.5kW
- 1 x NaOCl Dosing pump with VSD (P&ID Ref: PK-008) 7.5L/hr with Max Operating Pressure 16 Bar
- pH, Turbidity and chlorine probes and analyser/controller
- 150L LDPE chemical dosing tank and HDPE bund

#### 2.3.12. Heating System

We have allowed for a heating system in TK-002 (Anoxic tank A) to heat and turn over the tank water to avoid freezing during the colder season and maintain a sufficient level of biomass activity.
The system will be flange mounted for ease of maintenance and repairs.
During the warmer months, the heater can be simply shut off.

**Equipment specifications:**

- 6 x U shaped 220v 6111w heating elements, low watt density
- Polished Incoloy 825 element sheath for chemical resistance
- Central temperature sensing probe/support tube in 316SS
- 5 x 3/4 Baffles in 316SS (Element support discs)
- 100mm Standoff in 316SS (Uninsulated)
- Terminal enclosure mounting plate in 316SS.
- 316SS Terminal enclosure.
- IP68 cable entry/exit gland.

### 2.3.13. Additional Chemical Dosing Systems

The proposed system incorporates fully automated chemical dosing systems to provide several duties within the treatment process. These include the following;

- Carbon dosing to provide additional supplementary BOD to sustain biomass during low-capacity system operation and periods of low hydraulic throughput, and to balance the BOB/COD to Ammonia ratio needed to achieve efficient nitrification and ammonia conversion.
- pH correction and alkalinity buffering via liquid Caustic.
- Aluminium Sulphate dosing for increased Phosphorus removal capacity
- Liquid chlorine dosing to provide residual disinfection.

For all chemicals, the chemical storage tanks of sufficient capacity for several weeks of normal system operation will be included in the package. These storage tanks will require periodic refilling by plant operators and will include custom fabricated HDPE chemical containment bunding fit for purpose. The chemical dosing tanks and bunds shall be installed in the plant container in a segregated area complete with safety shower and positive ventilation.

All chemical dosing pumps shall be mounted on appropriately designed dosing skids, with duty only dosing pump configuration for each chemical in the system. As all the pumps are a common model, a boxed spare pump shall provide redundancy for the entire dosing system. The skids shall each incorporate all required pipe work and ancillary valving. The dosing pumps chosen for this project are all high quality Prominent or Grundfos chemical metering pumps.

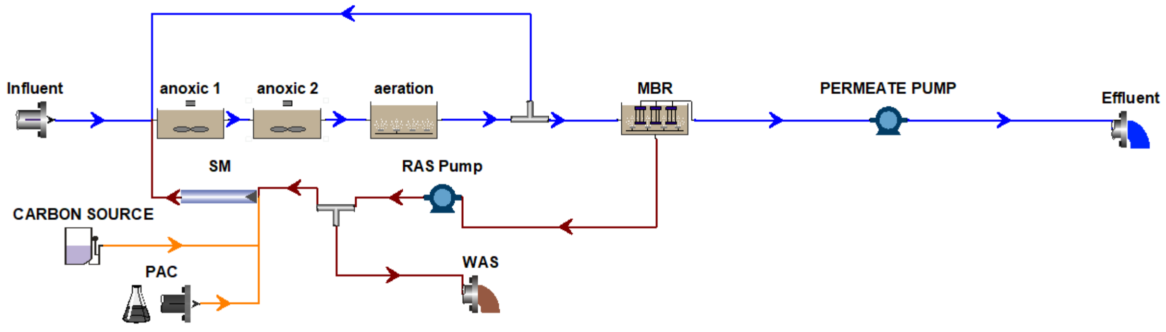
### 2.3.14. Control panel and System Controls

The entire system is controlled via a PLC, with the operator interface done through a panel mounted "touch screen".
A live display of the operating state of the STP is active most of the time on screen, showing tank levels and what phase the STP is currently operating in. A menu button on the bottom of the status screen allows access to the settings and alarm menu for the system, with the submenus available as follows:

- Active alarms
- Totaliser
- System settings
- Status display

Active alarms show any currently active alarm.
Totaliser shows the total processed volume in litres, as well as the total WAS volume sent to the digester. (7 days history with dates). System settings allow access to the system sequencing timers, DO target and phase control settings, and the WAS % of daily flow target adjustment. None of these can be accessed without a password to ensure that only authorised operations personnel have access to change system settings.
The control system includes OPTIONAL remote dial in facility to enable plant operators and service technicians to remotely view plant operation and adjust plant operational settings remotely as required. Plant alarms can also be sent to nominated mobile phones via text message if required.

## 2. Annexe A – BioWin Results




# Configuration information for all Bioreactor units

## Physical data

| Element name | Volume [m3] | Area [m2] | Depth [m] | # of diffusers |
|---|---|---|---|---|
| anoxic 1 | 11.4000 | 4.5600 | 2.500 | Un-aerated |
| anoxic 2 | 11.4000 | 4.5600 | 2.500 | Un-aerated |
| aeration | 22.8000 | 9.1200 | 2.500 | 22 |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| anoxic 1 | 0 |
| anoxic 2 | 0 |
| aeration | 2.0 |

| Element name | Average Temperature [deg. C] |
|---|---|
| aeration | 20.0 |

## Aeration equipment parameters

| Element name | k1 in C = k1(PC)^ 0.25 + k2 | k2 in C = k1(PC)^ 0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | Diffuser mounting height | Min. air flow rate per diffuser m3/hr (20C, 1 atm) | Max. air flow rate per diffuser m3/hr (20C, 1 atm) | 'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2 | 'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2 | 'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2 |
|---|---|---|---|---|---|---|---|---|---|---|
| anoxic 1 | 1.2400 | 0.8960 | 0.8880 | 0.0410 | 0.2500 | 0.5000 | 10.0000 | 3.0000 | 0 | 0 |
| anoxic 2 | 1.2400 | 0.8960 | 0.8880 | 0.0410 | 0.2500 | 0.5000 | 10.0000 | 3.0000 | 0 | 0 |
| aeration | 1.2400 | 0.8960 | 0.8880 | 0.0410 | 0.2500 | 0.5000 | 10.0000 | 3.0000 | 0 | 0 |

# Configuration information for all Bioreactor - MBR units

## Physical data

| Element name | Volume [m3] | Area [m2] | Depth [m] | # of diffusers | # of cassettes | Displaced volume / cassette [m3/cassette] | Membrane area / cassette [m2/cassette] | Total displaced volume [m3] | Membrane surface area [m2] |
|---|---|---|---|---|---|---|---|---|---|
| MBR | 22.8000 | 9.1200 | 2.500 | 18 | 2.00 | 1.690 | 200.00 | 3.38 | 400.00 |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| MBR | 0.7 |

| Element name | Split method | Average Split specification |
|---|---|---|
| MBR | Flowrate [Under] | 100.0008 |

| Element name | Average Temperature [deg. C] |
|---|---|
| MBR | 20.0 |

## Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | Diffuser mounting height | Min. air flow rate per diffuser m3/hr (20C, 1 atm) | Max. air flow rate per diffuser m3/hr (20C, 1 atm) | 'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2 | 'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2 | 'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2 |
|---|---|---|---|---|---|---|---|---|---|---|
| MBR | 0.0500 | 0.3800 | 1.0000 | 0.0500 | 0.2500 | 2.0000 | 50.0000 | 1.0000 | 0 | 0 |

| Element name | Surface pressure [kPa] | Fractional effective saturation depth (Fed) [-] |
|---|---|---|
| MBR | 101.3250 | 0.3000 |

| Element name | Supply gas CO2 content [vol. %] | Supply gas O2 [vol. %] | Off-gas CO2 [vol. %] | Off-gas O2 [vol. %] | Off-gas H2 [vol. %] | Off-gas NH3 [vol. %] | Off-gas CH4 [vol. %] | Off-gas N2O [vol. %] | Surface turbulence factor [-] |
|---|---|---|---|---|---|---|---|---|---|
| MBR | 0.0400 | 20.9500 | 1.2000 | 19.9000 | 0 | 0 | 0 | 0 | 2.0000 |

# Configuration information for all Input - Methanol units

## Operating data Average (flow/time weighted as required)

| Element name | CARBON SOURCE |
|---|---|
| Biomass - Ordinary heterotrophic [mgCOD/L] | 0 |
| Biomass - Methylotrophic [mgCOD/L] | 0 |
| Biomass - Ammonia oxidizing [mgCOD/L] | 0 |
| Biomass - Nitrite oxidizing [mgCOD/L] | 0 |
| Biomass - Anaerobic ammonia oxidizing [mgCOD/L] | 0 |
| Biomass - Phosphorus accumulating [mgCOD/L] | 0 |
| Biomass - Propionic acetogenic [mgCOD/L] | 0 |
| Biomass - Acetoclastic methanogenic [mgCOD/L] | 0 |
| Biomass - Hydrogenotrophic methanogenic [mgCOD/L] | 0 |
| Biomass - Endogenous products [mgCOD/L] | 0 |
| CODp - Slowly degradable particulate [mgCOD/L] | 0 |
| CODp - Slowly degradable colloidal [mgCOD/L] | 0 |
| CODp - Degradable external organics [mgCOD/L] | 0 |

| | |
|---|---|
| CODp - Undegradable non-cellulose [mgCOD/L] | 0 |
| CODp - Undegradable cellulose [mgCOD/L] | 0 |
| N - Particulate degradable organic [mgN/L] | 0 |
| P - Particulate degradable organic [mgP/L] | 0 |
| N - Particulate degradable external organics [mgN/L] | 0 |
| P - Particulate degradable external organics [mgP/L] | 0 |
| N - Particulate undegradable [mgN/L] | 0 |
| P - Particulate undegradable [mgP/L] | 0 |
| CODp - Stored PHA [mgCOD/L] | 0 |
| P - Releasable stored polyP [mgP/L] | 0 |
| P - Unreleasable stored polyP [mgP/L] | 0 |
| CODs - Complex readily degradable [mgCOD/L] | 0 |
| CODs - Acetate [mgCOD/L] | 0 |
| CODs - Propionate [mgCOD/L] | 0 |
| CODs - Methanol [mgCOD/L] | 1188000.00 |
| Gas - Dissolved hydrogen [mgCOD/L] | 0 |
| Gas - Dissolved methane [mg/L] | 0 |
| N - Ammonia [mgN/L] | 0 |
| N - Soluble degradable organic [mgN/L] | 0 |
| Gas - Dissolved nitrous oxide [mgN/L] | 0 |
| N - Nitrite [mgN/L] | 0 |
| N - Nitrate [mgN/L] | 0 |
| Gas - Dissolved nitrogen [mgN/L] | 0 |
| P - Soluble phosphate [mgP/L] | 0 |
| CODs - Undegradable [mgCOD/L] | 0 |
| N - Soluble undegradable organic [mgN/L] | 0 |
| Influent inorganic suspended solids [mgISS/L] | 0 |
| Precipitate - Struvite [mgISS/L] | 0 |
| Precipitate - Brushite [mgISS/L] | 0 |
| Precipitate - Hydroxy - apatite [mgISS/L] | 0 |
| Precipitate - Vivianite [mgISS/L] | 0 |
| HFO - High surface [mg/L] | 0 |
| HFO - Low surface [mg/L] | 0 |
| HFO - High with H2PO4- adsorbed [mg/L] | 0 |
| HFO - Low with H2PO4- adsorbed [mg/L] | 0 |
| HFO - Aged [mg/L] | 0 |
| HFO - Low with H+ adsorbed [mg/L] | 0 |
| HFO - High with H+ adsorbed [mg/L] | 0 |
| HAO - High surface [mg/L] | 0 |
| HAO - Low surface [mg/L] | 0 |
| HAO - High with H2PO4- adsorbed [mg/L] | 0 |
| HAO - Low with H2PO4- adsorbed [mg/L] | 0 |
| HAO - Aged [mg/L] | 0 |
| P - Bound on aged HMO [mgP/L] | 0 |
| Metal soluble - Magnesium [mg/L] | 0 |
| Metal soluble - Calcium [mg/L] | 0 |
| Metal soluble - Ferric [mg/L] | 0 |
| Metal soluble - Ferrous [mg/L] | 0 |
| Metal soluble - Aluminum [mg/L] | 0 |
| Other Cations (strong bases) [meq/L] | 0 |
| Other Anions (strong acids) [meq/L] | 0 |
| Gas - Dissolved total CO2 [mmol/L] | 0 |
| User defined - UD1 [mg/L] | 0 |
| User defined - UD2 [mg/L] | 0 |
| User defined - UD3 [mgVSS/L] | 0 |
| User defined - UD4 [mgISS/L] | 0 |
| Biomass - Sulfur oxidizing [mgCOD/L] | 0 |
| Biomass - Sulfur reducing propionic acetogenic [mgCOD/L] | 0 |
| Biomass - Sulfur reducing acetotrophic [mgCOD/L] | 0 |
| Biomass - Sulfur reducing hydrogenotrophic [mgCOD/L] | 0 |
| Gas - Dissolved total sulfides [mgS/L] | 0 |
| S - Soluble sulfate [mgS/L] | 0 |
| S - Particulate elemental sulfur [mgS/L] | 0 |
| Precipitate - Ferrous sulfide [mgISS/L] | 0 |
| CODp - Adsorbed hydrocarbon [mgCOD/L] | 0 |
| CODs - Degradable volatile ind. #1 [mgCOD/L] | 0 |
| CODs - Degradable volatile ind. #2 [mgCOD/L] | 0 |
| CODs - Degradable volatile ind. #3 [mgCOD/L] | 0 |
| CODs - Soluble hydrocarbon [mgCOD/L] | 0 |
| Gas - Dissolved oxygen [mg/L] | 0 |
| Flow | 0.025 |

# Configuration information for all Influent - COD units

## Operating data Average (flow/time weighted as required)

| Element name | Influent |
|---|---|
| Flow | 43.9999999999999 |
| COD - Total mgCOD/L | 900.00 |
| N - Total Kjeldahl Nitrogen mgN/L | 60.00 |
| P - Total P mgP/L | 10.00 |
| S - Total S mgS/L | 0 |
| N - Nitrate mgN/L | 0 |
| pH | 9.00 |
| Alkalinity mmol/L | 400.00 |
| ISS Total mgISS/L | 350.00 |
| Metal soluble - Calcium mg/L | 160.00 |
| Metal soluble - Magnesium mg/L | 20.00 |
| Gas - Dissolved oxygen mg/L | 0 |

| Element name | Influent |
|---|---|
| Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD] | 0.1600 |
| Fac - Acetate [gCOD/g of readily biodegradable COD] | 0.1500 |
| Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD] | 0.7500 |
| Fus - Unbiodegradable soluble [gCOD/g of total COD] | 0.0500 |
| Fup - Unbiodegradable particulate [gCOD/g of total COD] | 0.1300 |
| Fcel - Cellulose fraction of unbiodegradable particulate [gCOD/gCOD] | 0.5000 |
| Fna - Ammonia [gNH3-N/gTKN] | 0.6600 |
| Fnox - Particulate organic nitrogen [gN/g Organic N] | 0.5000 |
| Fnus - Soluble unbiodegradable TKN [gN/gTKN] | 0.0200 |
| FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD] | 0.0350 |
| Fpo4 - Phosphate [gPO4-P/gTP] | 0.5000 |
| FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD] | 0.0110 |
| Fsr - Reduced sulfur [H2S] [gS/gS] | 0.1500 |
| FZbh - Ordinary heterotrophic COD fraction [gCOD/g of total COD] | 0.0200 |
| FZbm - Methylotrophic COD fraction [gCOD/g of total COD] | 1.000E-4 |
| FZao - Ammonia oxidizing COD fraction [gCOD/g of total COD] | 1.000E-4 |
| FZno - Nitrite oxidizing COD fraction [gCOD/g of total COD] | 1.000E-4 |
| FZaao - Anaerobic ammonia oxidizing COD fraction [gCOD/g of total COD] | 1.000E-4 |
| FZppa - Phosphorus accumulating COD fraction [gCOD/g of total COD] | 1.000E-4 |
| FZpa - Propionic acetogenic COD fraction [gCOD/g of total COD] | 1.000E-4 |
| FZam - Acetoclastic methanogenic COD fraction [gCOD/g of total COD] | 1.000E-4 |
| FZhm - Hydrogenotrophic methanogenic COD fraction [gCOD/g of total COD] | 1.000E-4 |
| FZso - Sulfur oxidizing COD fraction [gCOD/g of total COD] | 1.000E-4 |
| FZsrpa - Sulfur reducing propionic acetogenic COD fraction [gCOD/g of total COD] | 1.000E-4 |
| FZsra - Sulfur reducing acetotrophic COD fraction [gCOD/g of total COD] | 1.000E-4 |
| FZsrh - Sulfur reducing hydrogenotrophic COD fraction [gCOD/g of total COD] | 1.000E-4 |
| FZe - Endogenous products COD fraction [gCOD/g of total COD] | 0 |

# Configuration information for all Pump units

## Operating data Average (flow/time weighted as required)

| Element name | Value/Average | |
|---|---|---|
| RAS Pump | Calculated | ----- |
| PERMEATE PUMP | Calculated | ----- |

## Pumping/piping parameters

| Element name | Static head | Pipe length (headloss calc.s) | Pipe inside diameter | K(fittings) - Total minor losses K | Pipe roughness | 'A' in overall pump efficiency = A + B*Q + C*(Q^2) | 'B' in overall pump efficiency = A + B*Q + C*(Q^2) | 'C' in overall pump efficiency = A + B*Q + C*(Q^2) |
|---|---|---|---|---|---|---|---|---|
| RAS Pump | 0.5000 | 30.0000 | 0.0500 | 4.9000 | 2.000E-4 | 0.8500 | 0 | 0 |
| PERMEATE PUMP | 0.5000 | 50.0000 | 0.0750 | 5.0000 | 2.000E-4 | 0.8500 | 0 | 0 |

# Configuration information for all Splitter units

## Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| WAS Split | Flowrate [Side] | 0.96 |
| Splitter3 | Flowrate [Side] | 144 |

# Configuration information for all Plug flow channel units

## Physical data

| Element name | Volume[m3] | Area[m2] | Depth[m] |
|---|---|---|---|
| SM | 5.625E-3 | 0.0750 | 0.075 |

## BioWin Album

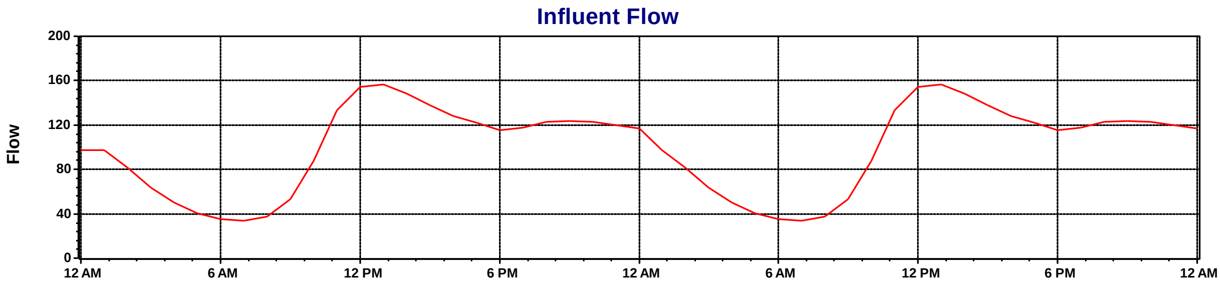
## Album page - Table #1

| Elements | COD - Total [mg/L] | COD - Total [kg/d] | BOD - Total Carbonaceous [mg/L] | BOD - Total Carbonaceous [kg/d] | Total suspended solids [mg/L] | Total suspended solids [kg/d] | Volatile suspended solids [mg/L] | Volatile suspended solids [kg/d] | N - Total Kjeldahl Nitrogen [mgN/L] | N - Total Kjeldahl Nitrogen [kgN/d] | P - Total P [mgP/L] | P - Total P [kgP/d] | N - Ammonia [mgN/L] | N - Ammonia [kgN/d] | N - Nitrate [mgN/L] | N - Nitrate [kgN/d] | N - Total N [mgN/L] | N - Total N [kgN/d] | P - Soluble phosphate [mgP/L] | P - Soluble phosphate [kgP/d] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Influent | 900.00 | 39.60 | 441.37 | 19.42 | 705.79 | 31.05 | 355.79 | 15.65 | 60.00 | 2.64 | 10.00 | 0.44 | 39.60 | 1.74 | 0 | 0 | 60.00 | 2.64 | 5.00 | 0.22 |
| anoxic 1 | 11883.07 | 3411.88 | 1626.15 | 466.90 | 27811.20 | 7985.17 | 8106.22 | 2327.46 | 626.14 | 179.78 | 311.84 | 89.54 | 7.50 | 2.15 | 0.00 | 0.00 | 626.14 | 179.78 | 2.63 | 0.76 |
| Effluent | 48.06 | 2.07 | 0.64 | 0.03 | 0 | 0 | 0 | 0 | 2.13 | 0.09 | 0.27 | 0.01 | 0.31 | 0.01 | 1.88 | 0.08 | 4.10 | 0.18 | 0.27 | 0.01 |

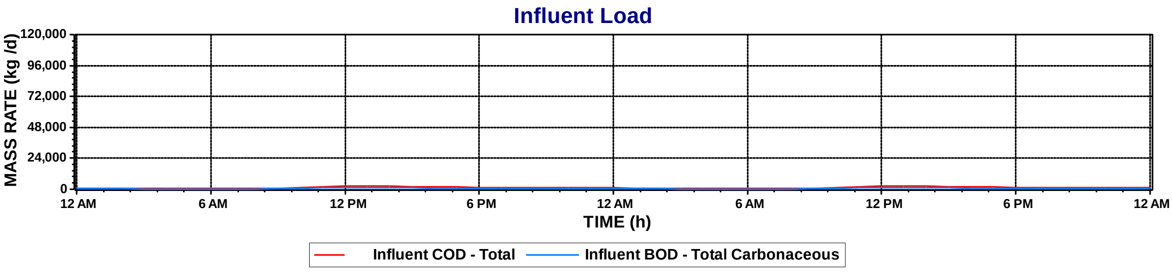
## Album page - Table #1

| Elements | COD - Total [kg /d] | BOD - Total Carbonaceous [kg /d] | Total suspended solids [kg /d] | Volatile suspended solids [kg /d] | N - Total Kjeldahl Nitrogen [kg N/d] | N - Total N [kg N/d] | P - Soluble PO4-P [kg P/d] | P - Total P [kg P/d] |
|---|---|---|---|---|---|---|---|---|
| Influent | 39.60 | 19.42 | 31.05 | 15.65 | 2.64 | 2.64 | 0.22 | 0.44 |
| anoxic 1 | 3411.88 | 466.90 | 7985.17 | 2327.46 | 179.78 | 179.78 | 0.76 | 89.54 |
| Effluent | 2.07 | 0.03 | 0 | 0 | 0.09 | 0.18 | 0.01 | 0.01 |
| WAS | 16.00 | 2.01 | 38.13 | 11.05 | 0.85 | 0.85 | 0.00 | 0.43 |

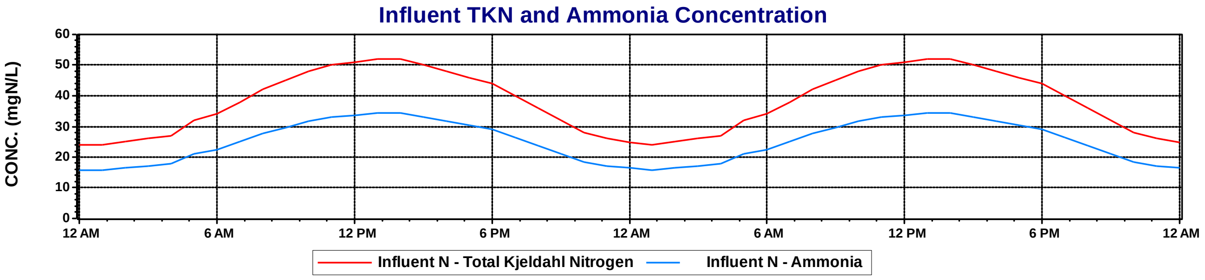
## Album page - Influent Flow / COD



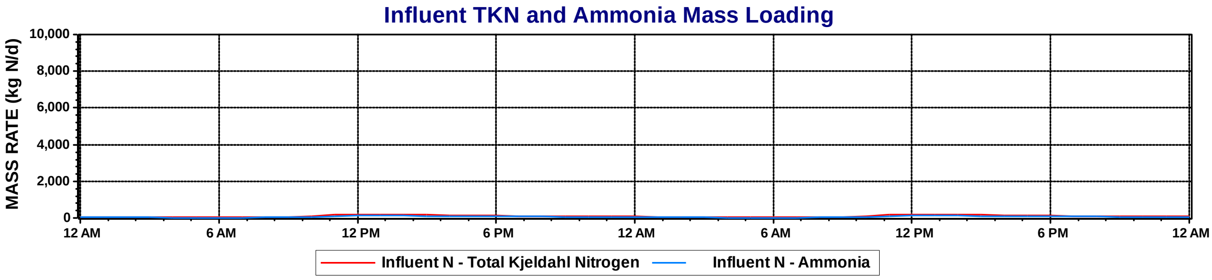

## Album page - Influent Flow / COD



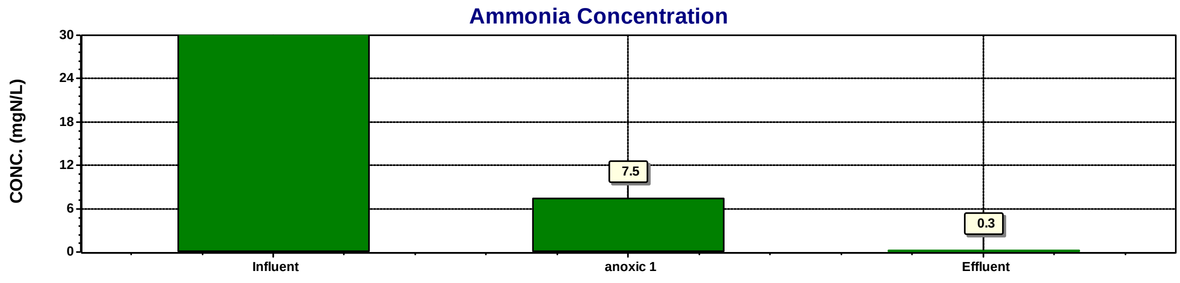

## Album page - Influent TKN / NH3



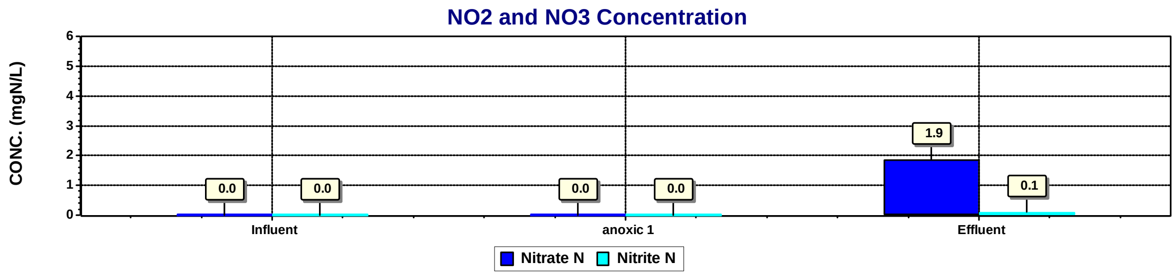

## Album page - Influent TKN / NH3



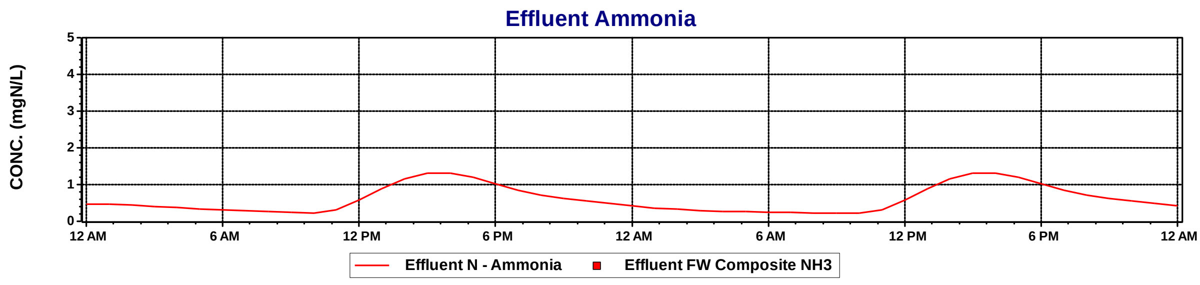
## Album page - Steady State Profiles



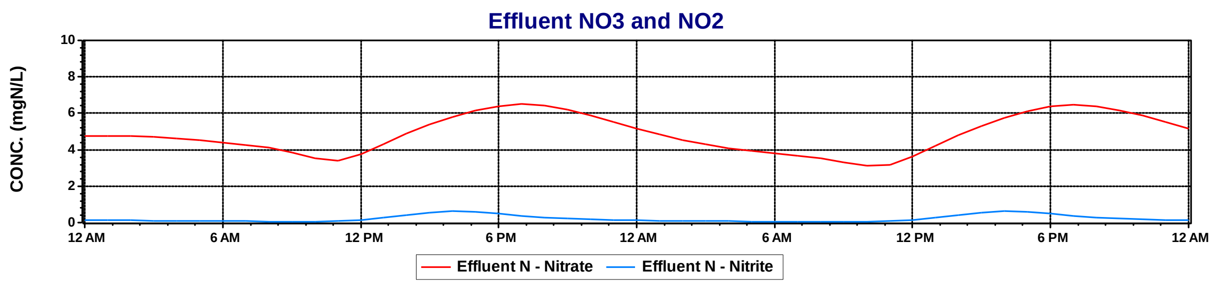

## Album page - Steady State Profiles



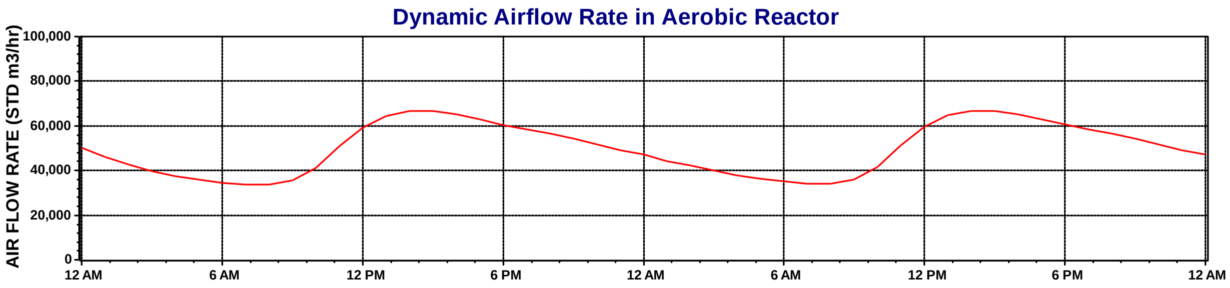

## Album page - Dynamic Effluent



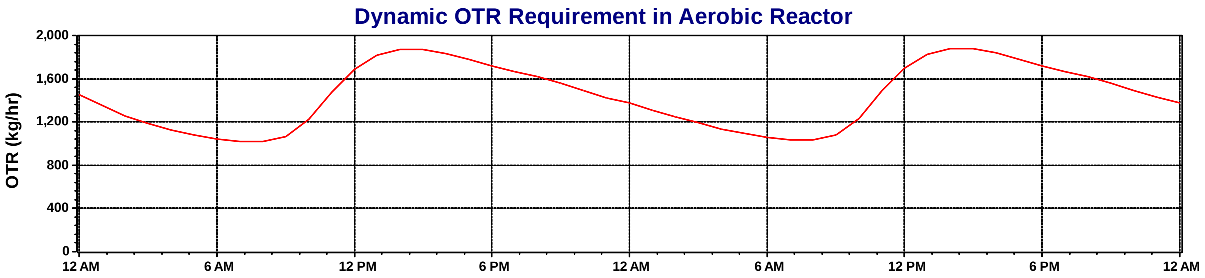

## Album page - Dynamic Effluent



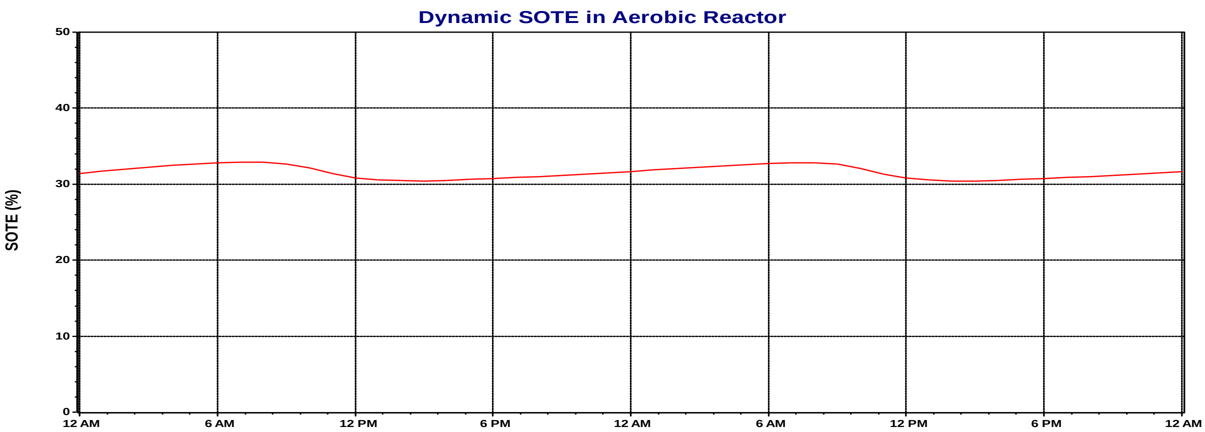
## Album page - Dyn Aeration




## Album page - Dyn Aeration




## Album page - SOTE




## Album page - Current Value Power