

23th January 2018

Baiada Poultry Pty Ltd
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Attention: Dean Kent
By Email: dean.kent@baiada.com.au

Concept Process Design Report for Wastewater Treatment Plant, Advanced Water Treatment Plant,

Dear Dean,

Baiada Poultry Pty Ltd (“Baiada”) is proposing to construct a poultry processing plant in Tamworth, NSW.

Baiada is aware of the potential difficulty in securing a suitable water supply for this facility due to increasing water scarcity in the region. As such they are looking to employ an advanced water treatment to recover a portion of their wastewater for re-use. The recovery of this water for reuse via membrane technology will produce a concentrate stream which will need to be discharged off site.

Hydroflux Industrial Pty Ltd (“Hydroflux”) has developed a concept design for this facility.

The scope of this document includes:

- Calculations confirming the capacity of the treatment plant
- A description of the flow and wastewater quality expected
- High-level design and description of the overall process
- Basic block diagram and mass balance of the process
- Estimated energy usage requirements of the process
- Basic Layout of the plant showing land required and elevations

This draft report describes a concept design for a wastewater treatment plant (WWTP) and advanced water treatment plant (AWTP). This document is provided to support Baiada’s application for regulatory approval.

Please contact me if you have any queries.

Best Regards,

Andrew Miley | Director
Hydroflux Industrial

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2019

PROJECT PROPOSAL



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1 Summary

- The system is designed based on the staged production of processing up to 3 million birds per week.
- Based on current estimates and processing technology, the facility will require up to 8 million litres of potable water per day.
- The Advanced Water Treatment Plant is designed to treat up to 8 million litres of water per day and allow recovery of up to 6 million litres (75%) for use as potable water.
- Reuse of wastewater will have a significant impact on the water supply.
- The AWTP will generate a concentrate stream produced by the final process stages of disinfection and salt reduction.
- The Total Dissolved Solids (TDS) concentration at maximum recovery of water (ie 75%) will be approximately 5500 mg/L, which at the maximum design flow (8 ML/day), equates to 11,000 Kg TDS per day in 2 ML of water.
- The TDS mass discharged from the site will be same regardless of the flow treated in the AWTP.
- The advanced water treatment plant (AWTP) process is proven and has been operating successfully at two poultry processing plants in Australia for over 10 years

1.1 Attachments

HY2989-P000-C	WWTP, AWTP PROCESS DRAWING
Hy2989-G001-C	WWTP, AWTP GENERAL ARRANGEMENT

2 Expected Influent

Baiada owns and operates a poultry processing facility with similar characteristics as those proposed in this concept design. The data available from his existing facility will be used to estimate the conceptual process design.

The average influent wastewater data from the Hanwood site is as follows:

Influent Waste Water Quality Data		
Average since 2017		
pH	6.59	units
Electrical Conductivity	1925	µS/cm
Chemical Oxygen Demand	3964	mg/L
Chemical Oxygen Demand (filtered)	1418	mg/L
Total Suspended Solids	1293	mg/L
Total Nitrogen	209	mg/L
Total Phosphorous	32	mg/L
Biological Oxygen Demand	2377	mg/L
Total Dissolved Solids	1167	mg/L

Additionally, the wastewater flows and the number of birds over this period has been recorded:

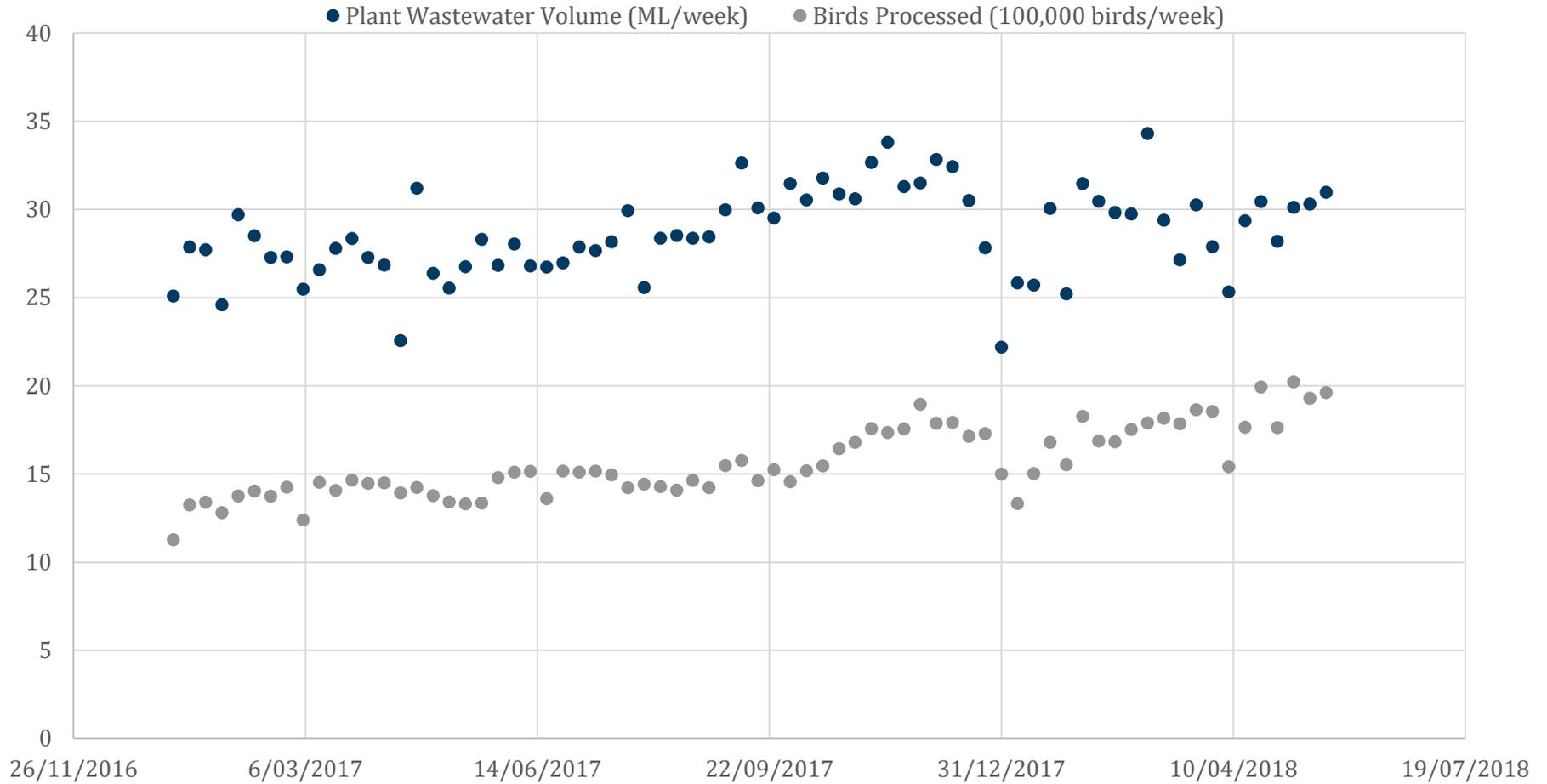
Influent Water Volume Data		
Average since 2017		
Incoming Water	23.51	ML/week
Birds Processed	1562165	birds/ week

From these figures, we can determine a mass loading and wastewater volume per bird processed:

Specific Wastewater Load per Bird Processed		
Average since 2017		
Chemical Oxygen Demand	60.38	g / bird
Chemical Oxygen Demand (filtered)	21.6	g / bird
Total Suspended Solids	19.7	g / bird
Total Nitrogen	3.18	g / bird
Total Phosphorous	0.49	g / bird
Biological Oxygen Demand	36.21	g / bird
Total Dissolved Solids	17.78	g / bird
Water Use	15.23	L / bird

The proposed facility will have the capacity for 3 million birds per week, as such we estimate the total water usage at 45.69 ML /week. However, the system will be designed for an average daily flow of 8 ML/day to provide contingency for a weekly flow of 56 ML/week.

Wastewater Volume and Number of Birds Processed January 2017 - May 2018



3 Conceptual Process Design

3.1 Summary

This concept design is for a Wastewater Treatment Plant (WWTP) followed by Advanced Water Treatment Plant (AWTP).

The wastewater from the poultry processing facility will first be treated in a conventional manner, with primary and secondary treatment processes. This will reduce the concentrations of primary solids, biodegradable nutrients, and anaerobic treatment will provide a source of biogas which may be used to co-generation and or heating. The proposed technology is a Covered Anaerobic Lagoon (CAL) to reduce COD, followed by a Sequencing Batch Reactor (SBR) designed to remove residual COD and reduce Nitrogen to target levels.

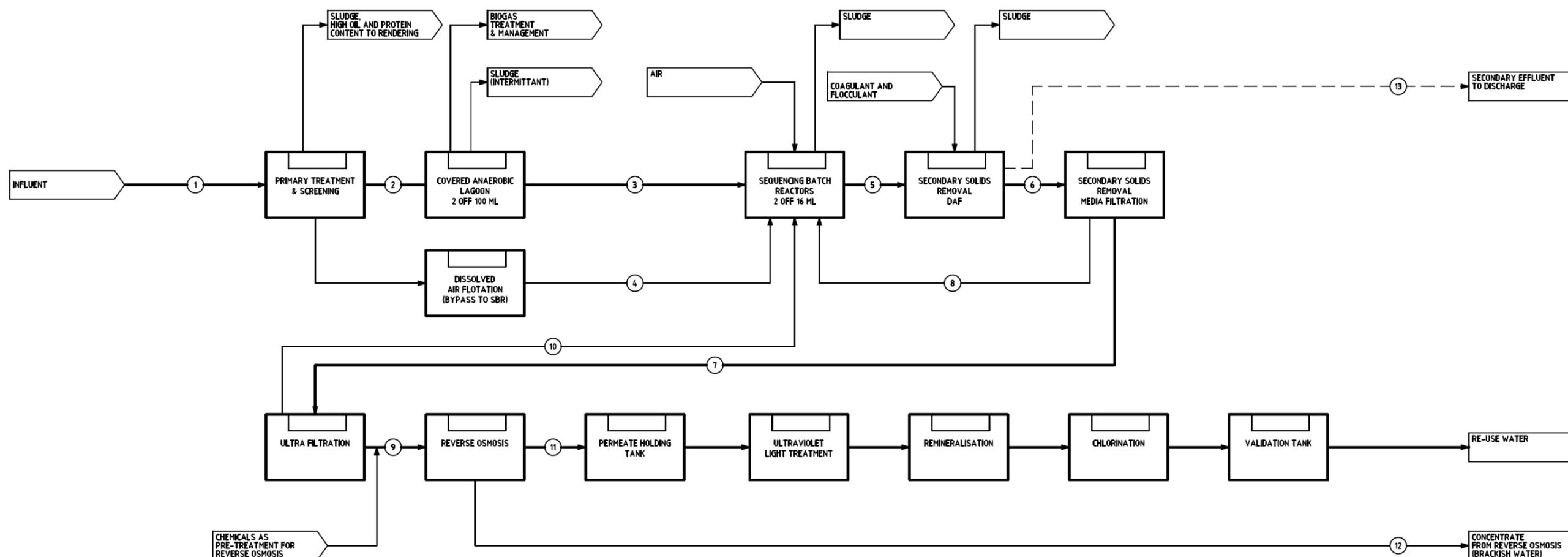
This is then to be followed by a secondary solids removal and tertiary treatment step. The secondary solids removal is required to remove the suspended solids generated during biological treatment. The tertiary treatment step is pre-treatment for the AWTP and is provided to remove residual solids and colloidal particles. These combined stages will consist of coagulation, flocculation, dissolved air flotation (DAF), multi-media filtration (MMF) and ultra-filtration (UF). A portion of this effluent may then be suitable for discharge depending on the volume of wastewater intended to be recovered for re-use. The coagulation stage will also be used to precipitate phosphorus to achieve target levels in the effluent.

The tertiary effluent intended for re-use will then be treated by low-pressure Reverse Osmosis (RO) to reduce the levels of dissolved solids. Following additional treatment, the RO permeate will be suitable for re-use. Additional treatment will consist of: chlorination, ultraviolet light and remineralisation. This system will be designed to meet and exceed the re-use water quality standards including the log reduction values (LVR) of pathogens, as laid out in:

- NSW Food Authority – Water Reuse Guideline – May 2008
- NSW Government – Management of private recycle water schemes – May 2008
- NSW Department of Primary Industries – Recycled Water Management Systems – May 2015
- Australian Government – NHMRC – NRMCC – Australian Drinking Water Guidelines 6 - 2011

A RO concentrate stream will also be produced, this stream will have a high concentration of dissolved salts, and is intended to be discharged to sewer.

3.2 Process Flow Diagram



o Table 1 - Concept Design Mass Balance

Stream Description	Stream #	Volumetric Flow m ³ /day	COD mg/L	BOD mg/L	TN mg/L	TKN mg/L	TP mg/L	TSS mg/L	TDS mg/L
Raw Influent	1	8,000	3,970.0	2,380.0	210.0	210.0	40.0	1,300.0	1,400.0
CAL Feed	2	6,500	3,970.0	2,380.0	210.0	210.0	40.0	1,300.0	1,400.0
CAL Effluent	3	6,500	794.0	476.0	210.0	210.0	40.0	500.0	1,400.0
CAL Bypass to SBR	4	1,500	3,176.0	1,904.0	210.0	210.0	40.0	1,040.0	1,400.0
SBR Influent	3,4,6,8	9,750	1,043.8	618.2	175.2	174.1	32.9	522.9	1,400.0
SBR Effluent	5	9,750	50.0	20.0	20.0	14.0	26.9	200.0	1,400.0
DAF Effluent	6	9,750	~30.0	~10.0	~16.0	~10.0	~0.5	~30.0	1,400.0
MMF Effluent	7	8,750	~10.0	~5.0	~16.0	~10.0	~0.5	~5.0	1,400.0
MMF Backwash	8	1,000	~205.0	~53.8	~16.0	~10.0	~0.5	~248.8	1,400.0
UF Effluent	9	8,000	~5.0	~2.5	~16.0	~10.0	~0.5	~0.5	1,400.0
UF Backwash	10	750	~63.3	~31.7	~16.0	~10.0	~0.5	~53.0	1,400.0
RO Permeate	11	6,000	-	-	-	-	-	-	50.0
RO Concentrate	12	2,000	<300	<60	<75	<50	<10	<30	~5,450.0
Secondary Effluent Discharge	13	UP TO 50% OF INFLUENT FLOW	<50	<20	<20	<15	<5	<30	~1,400.0

Notes: The impact of pH correction and other chemical addition has not accounted for in this mass balance.

3.3 Primary Treatment

The balancing tanks will ensure that the flows are hydraulically managed from the processing facility, this will serve to equalise the effluent concentrations and mitigate swings in pH that may be caused by clean in place (CIP) waste streams.

The primary treatment shall be designed to protect downstream processes from solids, and fats oil and grease (FOG). Large solids may cause mechanical issues with downstream processes, and FOG can upset the biological process when introduced in high concentrations.

3.3.1 Balance Tank

Objectives of this process unit:

- Ensure the flow from the plant can be adequately pumped to the WWTP
- Provide a balancing volume, such that spikes in pH and concentration may be effectively mitigated

Our recommendation is for a balance tank with a minimum hydraulic capacity of 600m³. This allows for 85 minutes of hydraulic retention time. This should be adequate for balancing pump flows to primary treatment. The downstream anaerobic treatment process shall be designed to provide additional surge capacity, negating the need for this to be a requirement of the balance tank.

3.3.2 Screening

Objectives of this process unit:

- Protect downstream equipment from large solids.

Coarse screening should be provided to protect downstream equipment, such as pumps and instruments. At a minimum, this should include screening to < 3mm. Hydroflux proposes an automatic bar screen or drum screen (or similar) for this purpose.

3.3.3 Primary Dissolved Air Flotation

Objectives of this process unit:

- Reduce levels of FOG for a bypass stream to be used as a carbon source in the aerobic treatment.
- Recover valuable proteins, fats and oils for rendering.

A dissolved air flotation (DAF) unit, creates a stream of microbubbles which attach to solids and FOG, causing them to float. This allows for the separation of solids and FOG from a wastewater stream.

This DAF is intended to run with limited chemicals, to avoid degradation of the float sludge for rendering. As such the for concept design an influent hydraulic loading rate of between 4-6 m³/m².hr has been selected.

Hydroflux recommends that the DAF be sized to meet one-quarter of the average influent flow. This will allow for a sufficient stream of carbon feed for the aerobic treatment system. The carbon feed source is required to adequately denitrify the wastewater. Denitrification is the process of reducing nitrate and nitrite to nitrogen gas. It uses the carbon feed as an electron donor and is the last stage of the nitrogen removal process.

Aerobic treatment systems are generally not tolerant to moderate levels of FOG, typically aerobic reactors will start to be adversely impacted when fed wastewaters with a higher concentration than 30 mg/L. The FOG will interfere with the aeration processes and thus starve the biomass of the required oxygen.

Table 2 - Concept design calculations: Primary Dissolved Air Flotation

Parameters	Value	Units
Influent Bypass to SBR Design Flow	2,000	m ³ /day
Design Flow	83.3	m ³ /h
Design Influent Hydraulic Loading	4	m ³ /m ² .h
Required Surface Area	20.8	m ²
Design Solids and FOG Concentration	4000	mg/L
Solids Loading	333.3	kg/h
Design Air:Solids Ratio	0.01	kg Air/kg Solids
Required Air Flow	3.33	kg Air/hr
Air Solubility @ 450kPa, 20°C	95.9	g/m ³
Nominal Saturator Efficiency	80%	
Required Recycle Flow	43.4	m ³ /h
Actual Hydraulic Loading	6.1	m ³ /m ² .h

3.3.4 Balance tank for carbon source bypass stream

A balance tank will be required to store the bypass stream, such that it can be delivered to the SBR at the required flowrate. A tank of 350 m³ is required assuming that one-quarter of the volume is bypassed and there are two SBRs with three daily cycles.

3.4 Secondary Treatment

Secondary treatment is required to remove the soluble nutrients and organics. Poultry processing wastewater is readily biodegradable and has a high concentration of organic compounds, as such, it is ideally suited to anaerobic treatment processes. Anaerobic treatment processes require less energy to operate in comparison to aerobic treatment and can also generate biogas which can be utilised as an energy source.

Where land is readily available, the most economical type of anaerobic treatment process is the covered anaerobic lagoon (CAL). In Australia, both the peak bodies for both red meat and pork industry recommend CALs for the treatment of both rendering and processing wastes.

The limitation of anaerobic treatment processes is that they are not able to remove more than 80-90% of the BOD/COD present in the wastewater, and they are not suited for nutrient removal, i.e. nitrogen and phosphorus. As such, a follow up aerobic treatment step is required.

Hydroflux recommends a sequencing batch reactor (SBR) for this purpose. The SBR can be designed as an aerated lagoon, to minimise capital costs associated with large above ground tanks.

3.4.1 Anaerobic Treatment - Covered Anaerobic Lagoon

Design Objective for this process unit:

- Remove 80-90% of the COD present in the influent
- Provide a surge volume for process flexibility
- Provide long-term sludge storage (3.5 years capacity)
- Safely produce and manage biogas

3.4.1.1 Description

A CAL (Covered Anaerobic Lagoon) consists of: a clay-lined lagoon meeting EPA standard with an impermeable liner (typically HDPE), cover (also HDPE), inlet and outlet pipework, biogas collection and discharge pipework, inspection ports, biogas safety release valve, weighting and stormwater removal, and an optional sludge removal system.

Hydroflux proposes two (2) CALs should be connected in parallel to allow for maintenance and desludging of each CAL without major disruption to the treatment plant.

Each CAL shall have a volume of 100 ML, length of 270m, width of 90m, and depth of 6m (inclusive of 0.5m freeboard).

The CALs have been designed with the capacity to hold sludge for up to 3.5 years. The intended operation would include a rotating schedule of sludge removal in each CAL. The selected CAL would be taken offline, with the cover removed and submersible dredge used for desludging.

3.4.1.2 Design Comment

The proposed design has an OLR (Organic Loading Rate) of 0.08 kg BOD/m³.day and a HRT (Hydraulic Retention Time) of 29.7 days. This meets the latest recommendations of the CSIRO, with guidelines for an OLR of 0.05-0.08 kg BOD/m³.day and a HRT of 20 – 40 days.

3.4.1.3 Biogas Handling and Production

The biogas production is estimated at 12,700 m³/day or 274,000 MJ/day, when treating the full flow of the influent, however up to 20% of this flow may be required as a carbon feed bypass to the SBR. The biogas production is 10,300 m³/day or 223,000 MJ/day as per the following calculation, when treating 81.25% of the average influent flow.

A biogas flare will be installed for gas handling. The flare should be designed with a peaking factor of two (2) times the average biogas production. Flare should be designed for a capacity of 1100 Nm³/hr of biogas continuously.

This system at a minimum will require knockout pots, centrifugal biogas blower, flow control valves, ignition system, methane analyser, pressure transducer, and flame arrestor safety valves. This CAL is intended to be operated as a positive pressure system, with the biogas stored under the cover of the CAL, as such no external biogas storage will be required.

Once the CAL has been commissioned the biogas can be analysed and the feasibility of re-use assessed. The gas can be re-used in a boiler or a cogeneration engine. Typically, a hydrogen sulphide scrubber is required before the biogas is suitable for re-use applications. Additionally, an additional positive displacement blower and chiller will also be required to achieve the correct pressures and temperatures for reuse requirements.

Table 3 – Concept design calculations: Covered Anaerobic Lagoons

Parameters	Value	Units
CAL Design Basis		
Estimated COD Removal	80%	-
Influent Flowrate	6,500	m ³ /day
TS Concentration	2,460	mg/L
TS Load	15,990	kg/day
COD Concentration	3,964	mg/L
COD Load	25,766	kg/day
COD Removed	20,613	kg/day
BOD Concentration	2,377	mg/L
BOD Load	15,451	kg/day
Minimum Treatment Volume		
Design Organic Loading Rate	0.2	kg COD/m ³ .day
Minimum Treatment Volume	128,830	m ³
	128.8	ML
Sludge Storage		
Specific Sludge Production	0.00202	m ³ /kg TS added
Daily Sludge Production	32.3	m ³ Sludge/day
Yearly Sludge Accumulation	11,789	m ³ /year
Sludge Storage Required	3.50	years
Volume Required	41,263	m ³
	41.3	ML
Total Required Volume		
Surge Volume	3.5	days
	22.8	ML
Total Volume	192.84	ML
Overall Hydraulic Retention Time	29.7	days
Overall Organic Loading Rate	0.134	kg COD/m ³ .day
	0.080	kg BOD/m ³ .day
Number of Lagoons	2	
Required Lagoon Volume	97	ML
Biogas Production		
Biogas Yield	0.5	m ³ biogas / kg COD
Biogas Production	10,306	m ³ biogas/day
Biogas Energy Content	6.0	kWh / m ³
Energy Production	61,838	kWh / day
	223,000	MJ / day

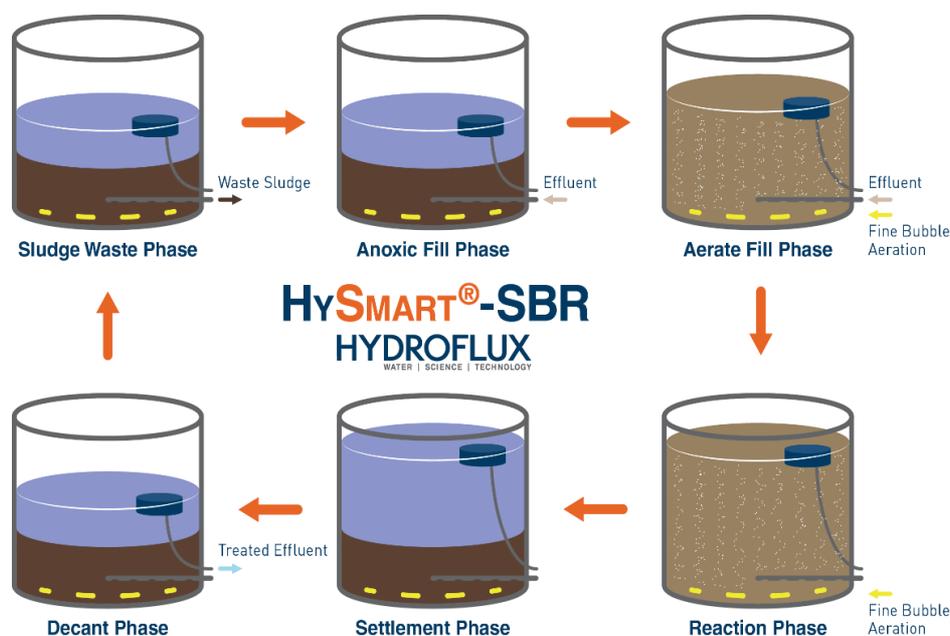
3.4.2 Aerobic Treatment – Sequencing Batch Reactor

Design Objective for this process unit:

- Remove residual organic carbon compounds
- Nutrient removal of nitrogen compounds
- Retain secondary solids

The sequencing batch reactor (SBR) is an activated sludge treatment process. Activated sludge processes are a suspended growth biological treatment process which relies on settling to retain the suspended biomass in the system. The SBR is a cyclic process involving the following stages:

- Anoxic Fill Phase – wastewater from the CAL and bypass wastewater from the primary DAF are introduced into the SBR. The introduced organics in the feed water and the oxidised nitrogen pre-existing in the SBR will be consumed by bacteria under the Anoxic conditions. This process is termed Denitrification and is necessary to achieve the total nitrogen removal.
- Aerate Fill Phase – the wastewater is then aerated, allowing for both heterotrophic and autotrophic bacteria to grow. The heterotrophs are responsible for the removal of residual organics, and the autotrophs are responsible for the oxidation of ammonia to nitrite and nitrate. The autotrophic process described above is termed Nitrification.
- Reaction Phase – the wastewater is aerated until the reaction started in the aerated fill phase is completed.
- Settlement Phase – the aeration stops, and the activated sludge flocs settle to the bottom of the SBR. Above the settled activated sludge, a clear water layer begins to form.
- Decant Phase – The clear water layer is decanted from the SBR.
- Sludge Waste Phase – Each new cycle creates additional biological sludge which needs to be removed to maintain optimal conditions. This waste activated sludge (WAS) is discharged from the SBR.
-



○ Figure 1 - Typical Cycle of SBR

Waste Activated Sludge (WAS) can be either returned to CAL for digestion and biogas production, or it could potentially be dewatered using a screw press (or other similar equipment). More complicated cycles can be implemented to further optimise the performance of the SBR, however, these would be considered during the detail design stage of the project.

Two design cases have been considered:

Case 1. As per mass balance, includes estimate of media filter and UF backwash streams, and CAL bypass stream. In order to achieve a correct C:N ratio for denitrification.

Table 4 - Concept design: SBR Design Case 1

Parameters	Inlet	Outlet	Unit
Volumetric Flow	9,710		m ³ /day
COD	1,043.8	50.0	mg/L
TN	175.1	15.0	mg/L
TKN	174.1	9.0	mg/L
NH4-N	153.7	2.3	mg/L
NO2-N	1.0	1.0	mg/L
NO3-N	5.0	5.0	mg/L
TP	33.0	27.0	mg/L
PO4-P	29.7	23.7	mg/L
TS	1,925.0	1,600.0	mg/L

Case 2. CAL effluent (assumed 80% COD removal) without accounting for any: backwash water and bypass stream.

Table 5 - Concept design – SBR Design Case 2

Parameters	Inlet	Outlet	Unit
Volumetric Flow	8000		m ³ /day
COD	794.0	50.0	mg/L
TN	210.0	15.0	mg/L
TKN	210.0	9.0	mg/L
NH4-N	204.8	2.3	mg/L
NO2	0.0	1.0	mg/L
NO3	0.0	5.0	mg/L
TP	40.0	26.8	mg/L
PO4-P	36.0	23.5	mg/L
TS	2,700.0	1,600.0	mg/L

○

Table 6 - Concept design calculations: Sequencing Batch Reactor

Parameters	Case 1	Case 2	Units
Influent Flow to SBR	9,710	8,000	m ³ /day
Design Influent COD Concentration	1,044	793	mg/L
Design COD Loading	10,135	7,700	kg/day
Design Influent TKN Loading	174	210	mg/L
Design TKN Loading	1,691	1,680	kg/day
COD Specific Oxygen Demand	1.3	1.3	kg O ₂ / kg COD
TKN Specific Oxygen Demand	4.3	4.3	kg O ₂ / kg TKN
COD Oxygen Demand	13,176	10,010	kg O ₂ /day
TKN Oxygen Demand	7,269	7,269	kg O ₂ /day
Assumed Aeration Efficiency	1.4	1.4	kg O ₂ /kWh
Total Oxygen Demand	20,445	17,279	kg O ₂ /day
Total Aeration Energy Required	14,604	12,342	kWh/day
Reactor Volume			
SBR Reactors	2	2	-
Treatment Cycles per Reactor	3	3	1/day
Fill Volume	15.0%	15.0%	
Batch Fill Volume	1,618	1,333	m ³
Reactor Volume	10,789	8,889	m ³
Total Reactor Volume	21,578	17,778	m ³
Volume Contingency	50.0%	50.0%	
Design Total Reactor Volume	32,367	26,667	m ³
Design Reactor Volume	16,183	13,333	m ³
Mixed Liquor Suspended Solids	3,000	3,000	mg/L
Food to Micro-organism Ratio	0.10	0.10	kg COD/kg MLSS.day
Hydraulic Retention Time	3.33	3.33	days
Blower Indicative Sizing			
Daily Aeration Hours	12	12	h/day
Rated Blower Power Per Reactor	608	514	kW
Total Blower Rated Power	1,217	1,029	kW

3.4.3 Clear Wells

Design Objective for this process unit:

- Balance flow out of the SBR
- Allow for effective gravity flow from SBR
- Balance flow to the AWTP

Clears wells are a cost-effective way to balance the flow out of the SBR, allowing for gravity flow from the SBR and providing a large buffering volume for the flow to the AWTP.

The concept design at this stage is for two (2) 5 ML clear well lagoons to be constructed next to SBR lagoons. These will also help to clarify the effluent from the SBR prior to secondary solids removal.

3.5 Secondary Solids Removal

Secondary solids removal is required to remove the residual biological solids, generated during secondary treatment. In addition, chemical precipitation of phosphorus and solid removal is required to meet the target total phosphorus (TP) requirements.

3.5.1 Coagulation and Flocculation

Design Objective for this process unit:

- Precipitate and remove total phosphorus to target levels
- Coagulate and Flocculate residual solids for removal in the DAF and MMF

The addition of an inorganic coagulant (typically Alum.) will be used for phosphorus removal and the coagulation of residual secondary solids. This will be followed up by flocculation with polymer dosing. The pH of this process will need to be controlled to adequately precipitate phosphorus. As such pH correction will also be required.

A reaction tank with mixing will be required to effectively coagulate and flocculate the secondary effluent. This will typically be paired with the DAF system.

3.5.2 Secondary Dissolved Air Flotation

Design Objective for this process unit:

- Remove coagulated and flocculated solids, thereby reducing total suspended solids (TSS) and TS (total solids) concentrations
 - TSS in treated water of less than 50 mg/L suitable for granular filtration.
- Reduce concentrations of total organic carbon (TOC)
- General improvement of water quality prior to AWTP

The proposed equipment for this purpose is three (3) DAF units each with a capacity to treat a flow of 145 m³/hr. The required surface area of each DAF unit is 22.2 m². As the expected solids load on this DAF unit is expected to be relatively low, a nominal recycle flow of 20% has been selected to ensure correct mixing in the contact zone.

Table 7 - Concept design calculations: Secondary Dissolved Air Flotation

Parameters	Value	Units
Average Influent Flow	8000	m ³ /d
	333.3	m ³ /h
Allowance for MMF and UF Backwash	30%	
Design Flow	433.3	m ³ /h
Number of DAF units	3	
DAF Design Flow	144.4	m ³ /h
Design Influent Hydraulic Loading	6.5	m ³ /m ² .h
Required Surface Area	22.2	m ²
Minimum Required Recycle Flow	20%	
Required Recycle Flow	28.9	m ³ /h
Actual Hydraulic Loading	7.8	m ³ /m ² .h

3.6 Pre-treatment and Reverse Osmosis

Pre-treatment is a requirement prior to reverse osmosis systems, to reduce the concentrations of contaminants that would otherwise cause fouling of the membranes. The extent of the pre-treatment is dependent on the intended water recovery. For concept design, the pre-treatment is designed with the assumption of 70-80% recovery in the reverse osmosis (RO) system.

3.6.1 Granular Media Filtration

Objectives of this process unit:

- Total Suspended Solids (TSS) in effluent reduced to less than 5 mg/L
- Contingent solids removal following DAF process upset
- Reduce the frequency of UF backwashing and chemical cleaning

The proposed design includes twelve (12) granular media filter vessels, each with an internal diameter of 2.2m. A dual-media (anthracite and sand) or multi-media (anthracite, sand and garnet) configuration is suggested for the concept design.

Feed pumps for the media filters should be managed on flow control, with turbidity and pressure used as a process variable. The filters will need to be equipped with a backwash facility and the downstream UF feed tank needs to have sufficient capacity to allow for the backwashing of the media filter vessels, without significant impact to upstream or downstream processes. The backwash will be triggered by either differential pressure or a timer. The backwash stream will be sent to a holding tank, where it will be pumped back to the SBR.

Table 8 - Concept design calculations: Granular Media Filtration

Parameters	Value	Units
Average Influent Flow	8000	m ³ /d
	333.3	m ³ /h
Backwash and Downtime Contingency	35%	
Design Flow	450.0	m ³ /h
Downflow Velocity	10	m/h
Total Required Vessel Area	45.00	m ²
Number of Vessels	12	
Vessel Area	3.75	m ²
Inner Diameter of Vessel	2.19	m
Flow per Vessel	37.5	m ³ /h
Nominal Vessel Diameter	2.2	m
Nominal Vessel Area	3.80	m ²
Actual Design Velocity	9.9	m/s
Backwash Velocity	40	m/h
Backwash Duration	8	min
Backwash Flowrate per Vessel	150.0	m ³ /h
Backwash Volume per Vessel	20.0	m ³
Backwash Balance Vessel Requirement	50%	of Filters
Suggested Backwash Volume	120.0	m ³
Selected Backwash Balance Tank	150.0	m ³
Retention for UF Feed	27.0	min

3.6.2 Ultrafiltration

Objectives of this process unit:

- Remove colloidal solids
- Remove colour and turbidity
- Remove residual TOC
- Improve performance of downstream RO system

The ultrafiltration systems will require feed pumps with flow and pressure control, backwash system including provision for chemical assisted backwashes and air scouring. Additionally, the system will include provision for clean in place chemical treatment which is required to maintain membrane performance. The flux and trans-membrane pressure (TMP) will be monitored to ensure correct control can be achieved.

The backwash stream will be sent to a backwash holding tank and transferred back to the SBR. The downstream RO feed tank needs to be sized sufficiently to allow for UF system backwashes, without impacting upstream or downstream processes.

Cartridge filters (150 – 300 μm) should be installed prior to the ultrafiltration to protect the membranes from any an upstream process upset, i.e. the potential for media loss from the media filter. The downstream reverse osmosis feed tank will need to be sized to meet the UF backwash requirements, a capacity of 150 m^3 is proposed for the concept design.

Table 9 – Concept design calculations: Ultrafiltration

Parameters	Value	Units
Average Influent Flow	8000	m^3/d
	333.3	m^3/h
Backwash and Downtime Contingency	15%	
Design Flow	383.3	m^3/h
Filtrate Flux Range	40 - 90	$\text{L}/\text{m}^2.\text{h}$
Design Filtrate Flux	60	$\text{L}/\text{m}^2.\text{h}$
Element Area	77	m^2
Flow per Element	4620	L/h
	4.62	m^3/h
Calc. Filter Elements	83.0	Elements
Elements per Skid	18	Elements / Skid
Skids Required	4.6	-
Nominal Skids Required	5.0	-
Elements Nominal	90	Elements

3.7 Reverse Osmosis and post

Objectives of this process unit:

- Contribute to log removal of pathogens for re-use water.
- Concentrate stream produced at TDS concentrations greater than 5,000 mg/L TDS
- Reduce TDS concentrations in permeate to less than 100 mg/L
- Recover up to 75% of input wastewater

This system will use brackish water RO membranes, which typically allow for concentrate TDS concentrations of up to 10,000 – 12,000 mg/L. The feed water is sent to pressure vessels containing semi-permeable reverse osmosis membrane elements. The membranes allow the passage of the water molecule but reject a portion of the dissolved solids. This creates a concentrate stream and a permeate stream (treated water). This separation is driven by the pressure gradient generated by the feed pumps.

The achievable level of recovery will depend on the ionic balance of the feedwater and may be limited by the presence of sparingly soluble salts and other potential foulants including silica. pH correction and antiscalants may be required to maximise the water recovery in this stage.

Balance tanks are required for the feed water, permeate and concentrate streams, such that the dynamics of the system can be adjusted without knock-on effects throughout the process.

3.7.1 Permeate Treatment

The permeate from reverse osmosis will require additional treatment prior to reuse. This is required to satisfy the log reduction of pathogens, ensuring the water will exceed the applicable guidelines.

- Table 10 - Concept design calculations: Log Reduction Values of Pathogens

Process	Protozoa Log Reduction	Virus Log Reduction	Bacteria Log Reduction
Ultra-filtration	3	2.5	3
Reverse Osmosis	5	4	5
Ultraviolet disinfection	3	3	3
Chlorination (min 30 mins)	2	2	2
Total	13	11.5	13

3.7.2 Ultraviolet Light Treatment

Objectives of this process unit:

- Achieve 3 log reductions of protozoa, viruses and bacteria

Ultraviolet light is an effective way to achieve disinfection of water, it is well suited to permeate and distillate treatment due to the favourable UV transmittance of the water source. The UV dosage required for disinfection is linked to the turbidity and colour of the water, as such a relatively low dosage is required for this application.

3.7.3 Remineralisation

Objectives of this process unit:

- Add Hardness and Alkalinity to the water.

Hardness and alkalinity are added to mitigate the potential for corrosion in pipes and equipment in contact with re-use water.

Remineralisation filters containing calcite are used for this purpose. The permeate will require the addition of carbon dioxide gas prior to introduction to the remineralisation filter.

3.7.4 Chlorination

Objectives of this process unit:

- Achieve target log removal of protozoa, viruses and bacteria
- Provide free chlorine residual for ongoing disinfection of water

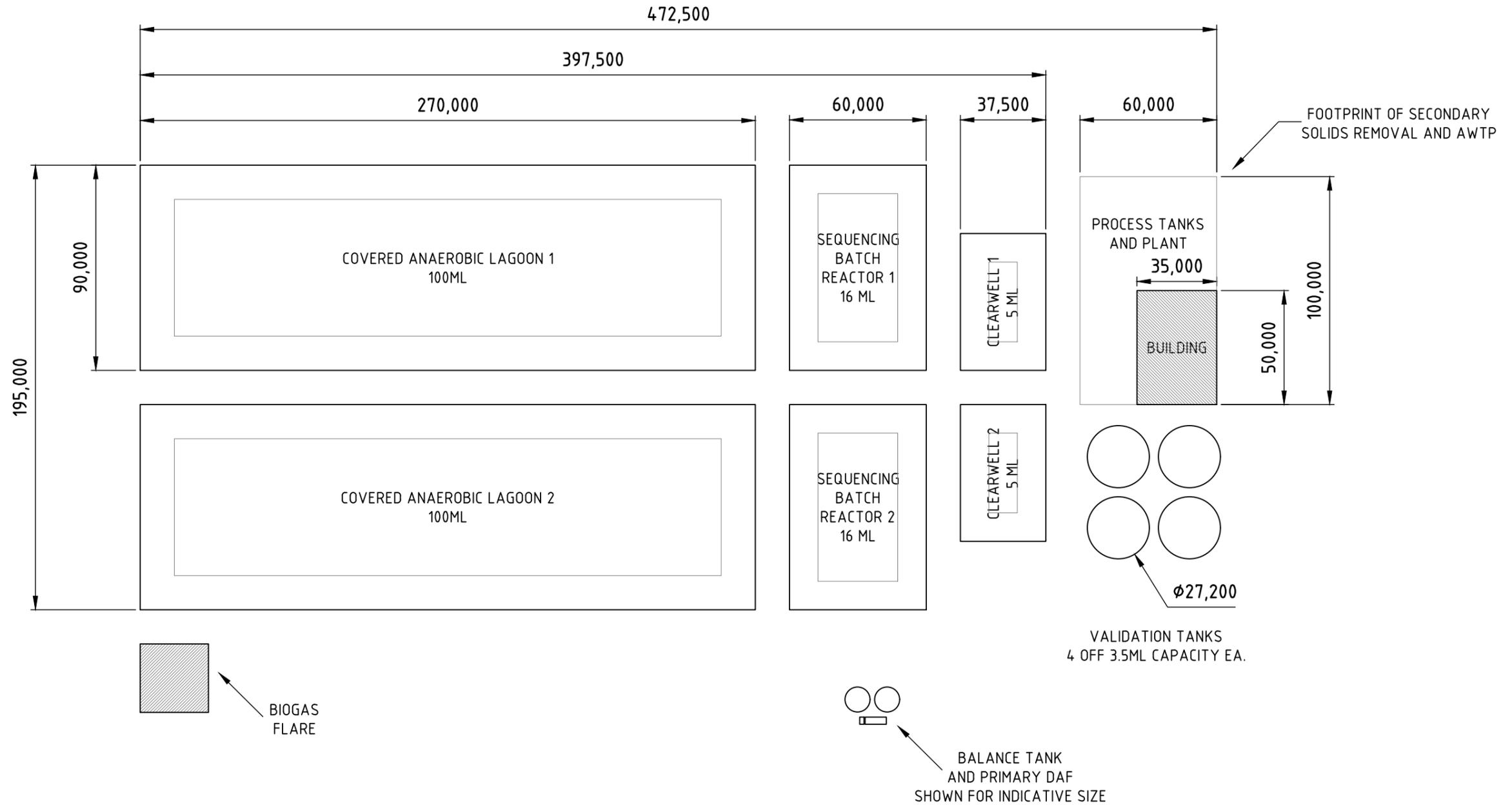
4 Estimated Energy Usage

The following table contains estimates for the energy usage of the plant.

Table 11 - Concept Design - Estimated Energy Usage

Flow	Power kW	Energy		Cost	
		kWh/day	\$ @ \$0.2/kWh	\$/Year	
Primary Dissolved Air Flotation	19.0	456	\$91	\$33,288	
Sequencing Batch Reactor	616.5	14,797	\$2,959	\$1,080,147	
Secondary Dissolved Air Flotation	57.0	1,368	\$274	\$99,864	
Granular Media Filtration	81.3	1,950	\$390	\$142,350	
Ultrafiltration	145.8	3,500	\$700	\$255,500	
Reverse Osmosis	833.3	20,000	\$4,000	\$1,460,000	
Remineralisation Filters	78.3	1,880	\$376	\$137,244	
Transfer Pump Allowance	200.0	4,800	\$960	\$350,400	
Total	1,812.3	48,751	\$9,750	\$3,558,793	

Notes: There are several components including: UV and screening which have not been considered in detail. As such this estimate does not include the energy usage for these components. This estimate should only be considered as a guide, actual energy usage is subject to detailed design.



NOTE:
 UPDATED CAL DESIGN BASED ON FLOW TO CAL OF 6500 kL/DAY @ 2377 mg/L BOD
 3.5 DAYS SURGE VOLUME AND 3.5 YEARS SLUDGE CAPACITY
 OVERALL HYDRAULIC RETENTION OF 32.5 days
 ORGANIC LOADING OF 0.77 kg BOD / m³

**DRAWING STATUS
 FOR INFORMATION**

REV	DATE	DESCRIPTION	DRN	CHK	APP	DOCUMENT STATUS	Hydroflux Industrial Pty Ltd	HYDROFLUX industrial	BAIADA OAKBURN	DRAWN:	SCALE:
C	17/12/2018	DESIGN FLOW & REQUIREMENT CHANGE	J.W	A.M		UNLESS THIS DOCUMENT BEARS A RED STAMP IT IS UNCONTROLLED AND MAY NOT BE THE LATEST ISSUE. VERIFY STATUS BEFORE USE.	ABN: 86 163 374 338		HY2989	J.W 26/10/2018	NTS
B	13/12/2018	UPDATE TO CAL DESIGN CAPACITY	J.W	A.M		COPYRIGHT	Level 26, 44 Market Street		WWTP, AWTP	A.M 19/11/2018	1 OF 1
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