Final Report

Wastewater Treatment Concept Design

Front End Engineering (FEED) – Integrated Bio-resource Recovery Facility – Stage 1

Project Code
2023-1028

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Date Submitted
27/06/2023

Published by
AMPC

Date Published
27/06/2023

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1.0 Executive Summary

Bindaree Food Group is one of Australia's leading red meat processing companies, employing more than 1,000 staff. The Inverell processing Facility, located in New South Wales, is operational 260 days per year and operates 24 hours during weekdays. Currently, the average heads of cattle processed per year are equivalent to 166,816. The expansion planned for 10 years aims to process up to 399,984 head of cattle, more than double the current production.

Bindaree Food Group (BFG) Inverell facility is looking to adopt an innovative way to their wastewater management. Aiming to improve the removal of nitrogen and phosphorus in the effluent to maintain an effective nutrient balance on irrigation of crops and use recycled water for further applications. In recent years, environmental regulation has become increasingly stricter, regarding the amount of water that can be disposed of via irrigation and the nutrients loading (nitrogen and phosphorus). Besides, using recycled water for specific irrigation applications limits recycled water use.

Unlocking the potential for recycling water for further applications represents the opportunity for BFG to increase production along with abiding by environmental regulations. Of particular interest, the raw water used in the BFG process is currently supplied by the local council. The existing water supply is limited by the current water supply network infrastructure to a flow rate of 26.6 L/s, which represents a total of 840 ML of water per year.

It is known that Bindaree's current wastewater treatment plant (WWTP) is designed for the removal of organic matter, but not nutrients. The innovative front-end engineering design (FEED) for an Integrated Bio-Resource Recovery Facility tailored specifically to BFG's processing plant considers the removal of nutrients (nitrogen and phosphorus) and other compounds from wastewater, ensuring compliance with permissible limits for irrigation and further applications such as cattle wash (other than final wash). Following a series of technical assessments, including sampling campaigns and Biowin modelling, the conclusion was that to achieve compliance with the regulation and water quality requirements for further applications other than irrigation, a new WWTP is required.

This Final Report presents the outcomes of the Front-End Engineering Design (FEED), Bindaree's Integrated Bio-resource Recovery Facility Stage 1 – WWTP. It encompasses the BFG effluent assessment, the new WWTP concept design (including layouts and process flow diagrams) and the detailed system implementation cost estimate with a list of preferred suppliers. In this concept, the treated water produced in the wastewater treatment plant aimed the remove of oil & grease, solids and organic matter, nitrogen and phosphorus.

The concept design technology selection was based on the requested applications for recycled water such as irrigation and cattle wash (other the final wash). Thus, the wastewater treatment plant does not include tertiary treatment equipment apart from chlorination.

The total capital expenditure (CAPEX) based on a +/- 30% cost estimate for the first two modules (to cater for current treatment needs) of the proposed WWTP is $6.6M. The further investment regarding the third module of the WWTP (to allow for future expansion on production) is planned to occur in the long term. A modular treatment design was proposed due to process flexibility and equipment redundancy.

Based on the technical and economic outcomes presented in this report, the implementation of the new wastewater treatment plant will result on:

- Further application for the Inverell recycled water.
- State-of-the-art wastewater treatment plant.
- Potential for valuable resources recovery (nitrogen and phosphorus as fertilisers).

- Potential for less carbon footprint (biogas production from the anaerobic digestion of the solid streams).
- Reduce dependence on an external supplier.

2.0 Introduction

Abattoir wastewater is a rich source of valuable nutrients, energy, and water. When well-managed, resource recovery can be achieved, along with robust environmental compliance. Implementing a state-of-the-art wastewater treatment facility at Bindaree Food Group Inverell production site will future proof the company's operation in terms of environmental compliance, aligned with the concepts of circular economy and resource recovery.

In this context, the concept design proposed for this project has taken into consideration the production of recycled water compliant with low exposure quality. The facility's wastewater stream is processed in a modular wastewater treatment plant, aiming for the removal of oil & grease, solids and organic matter, nitrogen and phosphorous. For the technology selection, specific applications of irrigation and cattle wash were considered to determine the recycled water quality requirements. Which is achieved through pre, primary, secondary, and tertiary water treatment stages. To source information for the project, it was undertaken a site visit, desktop review of relevant documentation and communication via phone calls and emails with the BFG engineering team. The scope of the project comprises:

Wastewater Characterisation (liquid Stream): A sampling campaign of the BFG save-all stream, derived from the combined red and green streams, was required. The samples were sent to an accredited laboratory to select parameters to be analysed for the characterisation of the wastewater. The available data allowed the WWTP design calculations to achieve the treated wastewater quality required.

Concept Design: A series of process and hydraulics calculations were carried out in Microsoft Excel followed by BioWin modelling software. This resulted in a preliminary basis of design to be used for the equipment specification list. The BioWin model was used to validate the process design assumptions and process sensitivity. Its sensitivity analysis was carried out using a methodical step-by-step process. The initial BioWin inputs were based on the assumptions and outputs of the Excel process design calculations. One parameter was altered at a time, with the selection of the final chosen value being used as an input in the subsequent sensitivity analysis parameter, and so on. The resulting effluent quality was the output of both process calculations and Biowin modelling.

Cost Estimate: A meticulous methodology that encompassed issuing requests for quotations (RFQs) to selected suppliers to obtain the WWTP equipment cost. Cost estimation methods were employed to consider various factors such as contractors' preliminaries, project contingency and civil works. These were accurately assessed to into consideration the project's overall capital expenditure (CAPEX).

This Final Report presents the outcomes of the Front-End Engineering Design (FEED), Bindaree's Integrated Bio-resource Recovery Facility Stage 1 – WWTP. The design was conceived based on the concepts of approaching resource recovery and a circular economy.

3.0 Project Objectives

This project aims to develop a front-end engineering design of a wastewater treatment plant. The concept to be used in the design considers engineered biological reactors for adequate management of wastewater originated from the abattoir processing plant.

This design is for a new optimised and modular wastewater treatment plant with medium level of automation, due to less stringent monitoring requirements. It was focused on attending to current wastewater disposal issues faced by the facility and expanding its application. Design upgrades of the existing infrastructure were not considered. The current infrastructure can remain operating until the full installation of the new WWTP. A pipeline connection can be placed to diverge the wastewater to the new WWTP. After that, the existing infrastructure can be decommissioned.

The new plant design is considering aspects such as nutrients (N, P) and other compounds removal from wastewater, with the possibility of irrigation and cattle wash (other the final wash). The result of this project, including the cost estimates for the plants, will then be used by Bindaree Food Group for the decision-making process for further stages of the plant implementation. These results will also support the Environmental Licensing application process.

The overarching objective of this project is to prepare a front-end engineering design for an integrated wastewater plant for better wastewater management in the facility. The final report can be used for the licensing application, decision making process, procurement related to this and further stages of the system implementation. The objectives to be achieved include:

- Waste and wastewater audit and characterisation (quantities and quality).
- Development of a design of an integrated bio-resource wastewater recovery facility for the Bindaree Food Group (BFG) processing plant in Inverell, NSW.
- Preparation of an equipment list to be used in the procurement stages.
- Development of a cost estimate for the wastewater treatment plant implementation.

4.0 Methodology

To undertake the design of the integrated facility and cover all aspects required for a successful and concise outcome, the project comprised Bindaree's Food Group wastewater characterisation and wastewater treatment plant design. The methodology followed for the project delivery is described below:

- Site Assessment: the site assessment included a desktop review of existing documentation, gap-analysis, site visit for assessing the site constraints/conditions, identification of available areas for system implementation, new processes requirements (why current infrastructure cannot perform proposed work), evaluation of the existing infrastructure and equipment to be maintained.
- Wastewater Characterisation (liquid Stream): A sampling campaign of the BFG save-all stream, derived from the combined red and green streams, was required. The samples were sent to an accredited laboratory to select parameters be analysed for the characterisation of the wastewater. The available data allowed the WWTP design calculations to achieve the treated wastewater quality required. The Environmental License was assessed for wastewater irrigation limitations. Nutrients and mass balance were calculated, and these were used to assess the need for outsourcing carbon from an external source.
- Wastewater uses, demand & off-take potential: the water source/quality and availability were confirmed via client consultation. The Guideline for recycling water in Australia was assessed and opportunities for water reuse on-site were evaluated. The treated effluent quality was established based on the requirements of the environmental regulator and water reuse possibility, ensuring full compliance with the design.
- Wastewater Treatment Plant Equipment Selection and Concept Design: following the basis of design, the wastewater flow rates, and components balance were calculated. The inlet wastewater quality suitability,

including the equipment selection and process requirements were detailed. The system hydraulics/pumping requirements were defined, including hydraulic calculations for equipment, piping and interconnection (using an Excel spreadsheet) to develop the process design of the wastewater treatment plant. Based on this process, a BioWin model was used to validate the process design assumptions and verify its sensibility. The resulting effluent quality was estimated during the process calculations. The technical drafting of the WWTP was undertaken.

- Preparation of an equipment list for the wastewater treatment plant: The equipment list included the equipment design conditions and basic specifications. One to three preferred suppliers were suggested for each piece of equipment. Two specific suppliers were listed to quote the full WWTP system, as they complete turnkey projects. The equipment suppliers were selected based on existing and long-term relationships from work carried out for other WWTP projects for the red meat industry. The suppliers listed are reliable, provide high-quality equipment, engage with innovative solutions and support technical queries.
- Cost estimate of the Wastewater Treatment Plant: The cost estimate accounted for costs beyond the equipment. The estimation methodology also encompassed civil, pipe, and electrical works. A systematic approach was employed to evaluate the materials, labour, and associated expenses required for these components of the construction process. This methodology ensured that all relevant factors were considered, resulting in a more accurate cost estimate.

5.0 Project Outcomes

5. 1 Site Assessment

The site is located at 7307 Gwydir Highway, Inverell NSW. The facility is operational 260 days per year and typically operates 24 hours during weekdays. Currently, the average heads of cattle processed per year are equivalent to 166,816 representing a production equivalent to 43,368 t.HSWC per year.

BFG has indicated the WWTP area (Figure 1) as a potential site for the implementation of the new wastewater treatment plant. The area is a green field site with approximately 10,000 m^2, which is located close to the existing wastewater treatment plant. Topographical and geotechnical surveys are recommended to be undertaken at the proposed site.

Figure 1. Area available for the new WWTP implementation.

5.1.1 Existing Structure

The current production of wastewater is treated by a DAF and a series of ponds. When treated it used for irrigation purposes. The DAF performance is still being optimised, and a chemical dosing system is planned to be introduced soon. The ponds include a sequence of anaerobic/aerobic systems, as per the diagram below (Figure 2):

Figure 2. Schematic diagram of the existing pond's system at the BFG site.

5.1.2 Irrigation Area

The irrigation area is composed of 320 ha of adjacent Land. Currently, there is an irrigation network that irrigates the treated wastewater in the adjacent land close to the property. The irrigation network will remain in place as an alternative for water disposal when the water is not recycled/reused in the facility.

5.1.2.1 Current Loads/Permits Limitation

The current Environment Protection License #809 does not state a limit for nutrients application, however, the concentration of nutrients from effluents and solids including total phosphorous, total nitrogen, potassium, and others, have to be calculated and monitored/recorded as part of the licensing requirements. A baseline of 70 kg per hectare per year of Total Nitrogen was used based on the optimal uptake for crop performance.

5.1.3 Water Source

The raw water used in the process is currently supplied by the local council. The existing water supply is limited by the current water supply network infrastructure to a flow rate of 26.6 L/s, which represents a total of 840 ML of water per year. Considering the current yearly water usage of 596,360 kL, BFG has anecdotally reported that even currently, some days they experience a shortage of water supply just to maintain their current operations. The water supply can be increased as per facility demand. It is expected that the water demand required for future expansion will exceed the existing supply restrictions.

5.1.4 Design flow rate definition

The water usage data was assessed for the last three years, and the production over the years was recorded (Table 1). The water usage has varied between 540 to 570 ML from 2020 to 2022, while the production varied between 64,695 to 51,230 t.HSCW per year. Even with production decreasing from 2020 to 2022, there was a water usage increase of around 5% over the three years. After discussing it with the technical team from Bindaree Group, that was stated that part of the water is used for cleaning purposes and this amount is the same every production day. Thus, the average annual water usage is 557,120 kL, which represents 1,526 kL per day.

Table 1. Annual production and water usage.

Year	Water Usage (KL per year)	Facility Production (t.HSCW per year)
2020	540,000	64,695
2021	562,000	62,366
2022	569,360	51,230
Averages	**557,120**	**59,430**

The existing wastewater treatment plant is not equipped with flow meters and the wastewater production couldn't be monitored. Typically, 85% of the water used in the facility becomes wastewater (AMPC, 2017b); using the national averages of water usage (7.92 kL/t.HSCW) and wastewater production (6.5 kL/t.HSCW) the ratio is 82%. As a safety factor for the design, it was adopted 90% conversion of water into wastewater. For the prediction of future wastewater production, the water usage was based on the year 2022 and the expected consumption was forecast for the next 10 years (Table 2).

Table 2. Water usage projection and estimated wastewater production.

Timeline	Facility Production (t.HSWC per year)	Equivalent No. of heads (heads/week)	*Water usage (kL/year)	**Wastewater production (kL/year)
Current	43,368	3,208	481,154	433,038
2 years	62,400	4,615	692,308	623,077
5 years	78,000	5,769	865,385	778,846
10 years	104,000	7,692	1,153,846	1,038,462

*Assuming 3 kL of water used per head.
**Assuming up to 90% of the water used is converted into wastewater.

As part of the expansion plans of the facility, BFG is considering future potential projects that would require additional water usage, including the implementation of new freezers, intestine cleaning process and others. Of particular interest, regarding the 10-year expansion, the water usage of 1,153,846 kL/year will exceed the current maximum water supply capacity (26.6 L/s or 840 ML per year). This reinforces the importance of an innovative WWTP capable to treat and recycle wastewater on-site.

Assuming the 10-year expansion wastewater production, 70 kL of wastewater per day from the green wastewater washdown and a safety factor of an additional 10%, the WWTP design flowrate was projected (Table 3).

Table 3. Flowrate Projections to be Used in the WWTP Design

Flowrate Estimate for Design	Value	Unit	Value	Unit
Wastewater production annual (10 years projection)	1,038,462	kL/year	2,845	kL/day
Greenwash down wastewater (current)	25,550	kL/year	70	kL/day
Combined Wastewater production volume	1,064,012	kL/year	2,915	kL/day
Total wastewater production volume (with 10% safety)	***1,170,413***	***kL/year***	***3,207***	***kL/day***

Envisaging the production increase accompanied by the implementation of water-saving techniques and water reuse possibilities, it is recommended that the implementation of a wastewater treatment system occurs in modules allowing flexibility for the expansion of the WWTP as production increases over the years. It is recommended the implementation of three modules of 840 kL per day, coping with the current wastewater production while considering an increase in 50% of wastewater production over the next two to five years; that means a treatment plant with an installed capacity of 2,520 kL per day. A fourth module could be implemented once the wastewater treatment plant reaches above 90% of its capacity, preparing the processing facility to have a final capacity for treatment of up to 3,360 kL of wastewater per day; equivalent to approximately 1,226 ML per year (Table 4).

Table 4. Proposed treatment capacity stages.

Individual module capacity (kL/day)	Total capacity (kL/day)	Individual capacity (kL/year)	Total capacity (kL/year)
840	840	306,600	306,600
840	1,680	306,600	613,200
840	2,520	306,600	919,800
840	**3,360**	306,600	**1,226,400**

5.2 Wastewater Characterisation

5.2.1 Wastewater Characteristics

The average wastewater quality characteristics are shown Table 5. It includes the Save-All stream (combined red and green stream prior to the existing anaerobic pond) samples provided by BFG. The full wastewater analysis results of combined red and green streams are in Appendix 1.

Table 5. Wastewater quality characteristics.

Parameter	Average	Load	Minimum	Maximum
BOD	**6,360 mg/L**	16,040 kg/d	975 mg/L	14,830 mg/L
COD[a]	**9,090 mg/L**	22,900 kg/d	1,390 mg/L	21,190 mg/L
TKN	**350 mg/L**	880 kg/d	180 mg/L	590 mg/L
TP	**50 mg/L**	120 kg/d	21 mg/L	71 mg/L
Flowrate	**2,520 kL/d**	-	540[c] kL/d	3,024[b] kL/d

a COD results of the save-all stream were not available. The COD here is based on a factor derived from the red stream only samples of BFG relationship of COD to BOD, then applied to the BOD of the combined save-all stream
b Peak flowrate based on 120% of inflow
c Minimum flowrate was estimated using the minimum flowrates seen at another red meat processing facility

The COD ratio is higher than optimal for biological nutrient removal. It is assumed that a large portion of the COD in the wastewater will realistically be part of the fat, oil and grease content. Therefore, it is assumed that approximately 50% of the total COD will be removed in the primary DAF system when the correct chemical dosing is applied. After that, the C:N:P ratios are expected to be more suitable for effective biological nutrient removal.

The average of the wastewater analysis is of moderate strength, with individual analysis with peak values in the high strength category, as per the categorisation proposed in the Digital Tool (AMPC, 2022) – refer to Table 17.

Table 6. Effluent strength categorisation.

Parameter	Unit	Low strength	Moderate Strength	High Strength
TSS	mg/L	< 1,350	1,350 – 5,000	> 5,000
BOD	mg/L	< 1,500	1,500 – 5,500	> 5,500
COD	mg/L	< 3,064	3,064 – 11,215	> 11,215
TN	mg/L	< 180	180 – 360	> 360
TP	mg/L	< 35	35 – 62.5	> 62.5

5.2.2 Primary DAF Effluent Characteristics

Bindaree Food Group has claimed that the Primary DAF was not operating as expected. The effluent characteristics before and after the DAF made available by BFG shows that the equipment is not operating to achieve claimed levels of removal for TSS (50%) and O&G (80%), consequently no reduction of pollutant load is observed. This is due lack of coagulant/flocculant dosing. The next section explains the analysis made to conclude the correct amount of chemicals that need to be dosed for expected TSS and O&G removal.

5.2.2.1 Primary DAF Effluent Jar Test

The DAF effluent jar test was accomplished to define the amount of dosing chemicals required in the primary dissolved air flotation equipment to improve the effluent quality. Samples from before primary DAF (red stream) and before grit separator (green stream) were collected by Bindaree Food Group and analysed by Tessele Consultants Team for the Jar Test experiment.

To perform the tests, a six paddles Jar Tester was used to stir six 1 litre glass beakers with sample simultaneously. A composite sample based on the current flow of the red and green streams was prepared and flocculated using Tanfloc SG 20% w/v and the cationic polymer EM640CT containing 41% of active content. After a preliminary test, the dosing range from 0 to 0.6 mL of Tanfloc SG 20% and 0.01 mL of EM640CT in 1 L of the sample was selected based on the initial turbidity results measured. After assessing the dosing rate capable to remove 75% of initial turbidity, replicates were prepared and sent to a laboratory for a comprehensive chemical analysis.

As expected, the final turbidity decreased with the addition of Tanfloc SG, with a sharper drop when dosing 0.3 and 0.4 L/kL resulting in turbidity removals of 49% and 76% respectively and removing up to 93% when dosing 0.6 L/kL. The targeted 75% of turbidity removal occurred with 0.4 L/kL

It is important to notice that an optimal flocculation step can significantly reduce the amount of BOD and COD entering the secondary treatment which for most scenarios in the red meat industry is desired due to commonly higher levels of carbon in the wastewater causing an unbalance in the nutrients needed for the biological treatment to work properly. After evaluating the removals, replicates of the sample containing 0.4 L/kL of Tanfloc were prepared and sent to a certified laboratory to collect detailed chemical analysis where the results are shown in Table 19 along with the data provided by BFG.

Table 7. Results of Jar Test, before and after flocculation, using Tanfloc SG.

Parameter	UOM	Before	After
BOD	mg/L	5,068	1,400
COD	mg O_2/L	7,240	3,900
TSS	mg/L	4,712	740
VSS	mg/L	-	720
TN	mg/L	249.2	300
TKN	mg/L	249.2	300
Ammonia as N	mg/L	31.6	22
Nitrate as N	mg/L	<0.005	0.049

Nitrite as N	mg/L	0.2	<0.005
TP	mg/L	22	41
Phosphate as P	mg/L	15.7	28
Ca	mg/L	8.3	6
Mg	mg/L	5.6	8.3
pH	pH unit	5.8	6.5
Alkalinity	mg/L	232.6	460

When comparing the obtained data, all parameters, apart from the target variables (BOD, COD and TSS), Phosphorous and Alkalinity are within the range of the average history data. The main explanation of why the last two are out of range is the usage of cleaning products based on phosphates which usually contain higher alkalinity, which helps to neutralise fatty acids. Due to that, we can consider the sample tested representative of the usual wastewater from BFG.

The tests have demonstrated a high performance of Tanfloc SG in terms of turbidity removal in wastewater up to 93%. We recommend a dosing of 0.4 L/kL of Tanfloc 20% w/v and 0.01 L/kL of EM640CT 41% active content. This is the minimal dosing to keep average solids removal over 75% during the day and estimated BOD and COD removal of around 50%, which is a desirable removal to improve the water treatment performance.

It is important to notice that the test should be re-assessed for further studies and confirmation of biological parameters (BOD and COD) since the present experiment focused on TSS removal and estimated BOD and COD values. That is due to the data being taken only before the Primary DAF (red stream) and grit removal (green stream). To refine the jar test experiment, data from before and after Primary DAF should be analysed.

5.1.3 Treated effluent quality target.

Assuming the treated wastewater will be used for irrigation and cattle wash (other than final wash), the treated final effluent quality requirements according to the Australian Guideline for Water Recycling (Environment Protection and Heritage Council et al 2006) and the Water Reuse Guideline from NSW Food Authority are shown in Table 8.

Table 8. Treated final effluent quality requirements.

Parameter	Unit	Non-potable water for irrigation
Soluble BOD	mg/L	20
TSS	mg/L	30
TDS	ppm	N/A
pH	---	6.5 - 8.5
Turbidity	NTU	<5
UV dose (mJ per cm2)	-	*

Residual chlorine	mg/L	*
E.coli	cfu per 100 mL	<10
Virus	log reduction	6
Protozoa	log reduction	5
Bacteria	log reduction	5
TN	mg/L	<19**
TP	mg/L	<1.4***

*Minimum disinfection that aims to demonstrate reliability to consistently achieve microbial quality. It is recommended to add a 2 mg/L chlorination dose.

**TN concentration estimated based on calculation for 70kg TN/hectare provided by BFG.

***TP concentration estimated based on a calculation of TN compared to another red meat processing facility, and using the ratio of TN/TN for both sites, then applying the factor to TP for BFG for an estimated allowable concentration of TP allowed.

5.1.4 Recycled Water Reuse Opportunities and Applicable Regulations

The Australian Meat Processor Corporation (AMPC) has developed a Guideline for Water Recycling and Reuse in Red Meat Processing (AMPC, 2017a). The document outlines the criteria and requirements for water recycling in meat processing facilities in Australia, as summarised in the following paragraphs.

Water availability in Australia is limited and there is a push for the industry to demonstrate best practices in water consumption subject, including water reuse. Recycling water is a trend and is already a reality in some Australian red meat processing facilities. Stringent food safety regulations and impacts of a food poisoning incident indicate that potential use of this water includes cleaning and sanitation purposes (limiting the reuse of water to around 30%). Fit-for-purpose investigations and further treatment, including Reverse Osmosis (RO) can make possible an increase in water consumption to almost totality (AMPC, 2021a).

According to AQIS Meat Notice No: 2008/06 – The Efficient Use of Water in Export Establishments (DAFF, 2008), meat processors establishments can use potable recycled water for any potable processing purpose on the establishment apart from a direct ingredient in meat products or use it for drinking. Selling the recycled water will require the approval of the relevant domestic authorities.

Regarding non-potable recycled water applications in the red meat processing industry, Table 9 shows the potential uses divided by required AQIS approval.

Table 9. Applications for non-potable recycled water in the red meat processing industry by required AQIS approval.

(i) Applications that require AQIS risk assessment through HACCP*.	(ii) Applications that don't require special approval just a reference in the water procedures within the Approved Arrangement.
• Steam production (other than steam used or to be used in direct or indirect contact with meat and meat products), fire control, the cleaning of yards, the washing of animals (other than the final wash) and other similar purposes not connected with meat and meat products;	• Irrigation, watering gardens, flushing toilets, washing down external areas.

*HACCP: Hazard Analysis Critical Control Point.

It is relevant to say that not requiring an AQIS HACCP does not mean that the water quality for the specific application is inferior to a water application which needs AQIS HACCP application.

Besides attending to the Australian market, BFG exports its products to China and the European Union. For export registered establishments any applications that use recycled or reused water should be directed to AQIS On Plant Supervisor if one is stationed at the establishment or Area Technical Manager if there isn't an AQIS On Plant Supervisor. AQIS will inform the relevant state food safety authority of the proposal to ensure any concerns of the local authority is identified and addressed.

5.2 Concept Design

The wastewater treatment plant concept design has used the future design average flow rate of 2,520 kL/day as a basis for biological reactions and physical/chemical separation processes. A peak of 3,024 kL/day (120% of the expected future average daily flowrate) was assumed to calculate hydraulic components in the process. The treatment process sequence was designed based on a combination of unit operations, aiming to achieve the removal of contaminants, as described in Figure 3.

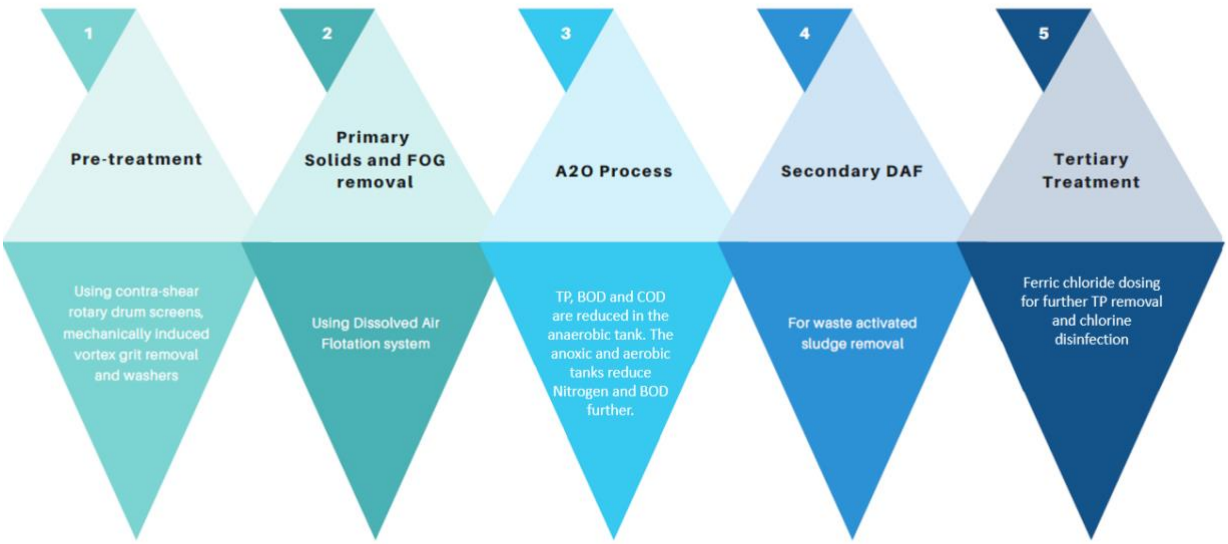

Figure 3. Summary of steps considered in the WWTP concept design.

The following sections describe the specifications of individual equipment and processes. Refer to Appendix 2, Technical Drawings:

- 2023-1028-AMPC-CP-DW-001-REV.C
- 2023-1028-AMPC-CP-DW-002-REV.C
- 2023-1028-AMPC-CP-DW-003-REV.C
- 2023-1028-AMPC-CP-DW-004-REV.C

The effluent treatment plant is design to equalise the screened daily effluent flow using the equalisation tanks, and then continuously operate at balanced flowrate. The plant is designed in three modules of same capacity running in parallel. The modules can work completely independent from each other which increases process robustness and reliability. The design conditions and basic specifications of the equipment used in the concept design is described below.

5.2.1 Pre-treatment

Screening

Three rotary drum screens were selected as it is known to be highly suitable for red meat processing wastewater, which is high in fat, oil and grease. The screening step must be robust to avoid solids going to the wastewater treatment plant. The design considers three rotary screens (contra-shear) operating in parallel with aperture sizes of 0.75mm; typically used in the red meat industry at apertures of 0.5 - 1.0 mm, as recommended by screen suppliers.

The chosen aperture size of 0.75mm will benefit the efficiency of downstream processes such as the DAF unit (reducing chemical consumption). The screened wastewater from the Save-all Pit flows by gravity to the grit removal system. The screens are designed for an estimated peak flow of 302 kL/h (120% of the average daily design flowrate, back calculated over an assumed 10 hours of operation) and a Total Solids concentration of approximately 5,200 mg/L. The expected efficiency of removal of suspended solids is 30%. The Contra Shear units require regular maintenance and inspection – the recommended screen is a new generation of Contra Shear with easy access for maintenance, that can be made in-situ without stopping operations. Table 10 summarises the screens' specifications.

Table 10. Screening specifications.

Tags	Design Conditions	Preliminary Specifications
RS.001A RS.001B RS.001C	Peak flowrate design = 3,024 kL/day total Peak flowrate design = 1,008 kL/day per screen Operational hours = 10 hours Design flow: 300 kL/h total Design flow: 100kL/h per screen	Fine screens Aperture = 0.75 mm screening Material = SS 304 Channel details to be specified with screen manufacturer

Solids originating from the rotary screen will be collected in skip bins and transported to the future biogas plant in Bindaree site for energy recovery. Alternatively, if opting for a fully automated system, a screw conveyor will transport the solids to the biogas plant (to be defined in the detailed design stage).

Grit removal

Three grit mechanically induced vortex tanks and two grit classifiers were selected for grit removal in the WWTP, because of their consistent removal efficiency over varying flowrates. The grit removal step must be robust to avoid grit transferring further downstream in the process. The design considers three mechanically induced vortex tanks operating in parallel, which consist of inlet and outlet baffles plus rotating paddles in the centre chamber to maintain the required circulation to remove grit for all flowrates. Grit slurry collected in the centre hopper is pumped out to grit classifiers for organic solids removal before the cleaned grit is deposited into skip bins. The de-gritted wastewater from the grit tanks flows by gravity to the transfer pumping station TK.001. The grit tanks are designed for an estimated peak flow of 302 kL/h (120% of the average daily design flowrate, back calculated over an assumed 10 hours of operation). Table 11 summarises the grit removal equipment specifications.

Table 11. Grit removal equipment specifications.

Tags	Design conditions	Basic Specifications
GS.001A GS.001B GS.001C	Peak flowrate design = 3,024 kL/day total Peak flowrate design = 1,008 kL/day per grit tank Operational hours = 10 hours Design flow: 300 kL/h total Design flow: 100kL/h per grit tank Duty/Duty/Duty	Volume per tank: ~1 m3 for a 30s detention times Material = SS 304 Details to be specified with grit tank manufacturer
GW.001A GW.001B	Peak flowrate design = 41 kL/day total Peak flowrate design = 21 kL/day per grit classifier/washer Operational hours = 10 hours Design flow: 4 kL/h total Design flow: 2 kL/h per grit washer Duty/Duty-Standby	Specifications per grit washer: Width: 2.3 m Total Height: 3.1 m Discharge Height: 2.5 m Inlet DN: 80 Outlet DN: 150 Installed Mixer Power: 0.37 kW Drive Power: 1.1 kW Material = SS 304

Transfer pumping station (TK.001)

Screened and de-gritted wastewater flows by gravity to the pumping station TK.001 and is pumped to the equalisation tanks via a set of submersible pumps, (3 duty and 3 standby). The wastewater will be pumped to a flow splitter prior to entering the equalisation tanks. The specifications for the transfer pumping station and pump sets are presented in Table 12.

Table 12. Transfer pumping station specification.

Tags	Design Conditions	Preliminary Specifications
TK.001	Peak flowrate design = 3,024 kL/day Operational hours = 10 hours peak and 14 hours non-peak 1-2 minutes holding capacity	Diameter = 1.8 m Depth = 3 m Operational depth assumed = 1.5 m Operational volume = 3.8 kL
P.001A P.001B P.001C P.001D P.001E P.001F	Pump set (total flows) Peak flowrates (total) = 300 kL/h Average flowrates (total) = 252 kL/h Duty/Duty/Duty/Standby/Standby/Standby Pump number of starts and operational settings to be confirmed with supplier and electrical engineers	Flow range total = 20 to 400 kL/h Flow range per pump = 20 to 140kL/hr Operating in parallel on VSDs to maintain a level setpoint Pump power and head to be confirmed during detailed design, based on site location and elevations

Equalisation tanks

Fluctuations in the influent-wastewater flow and quality are common in a variety of situations and industries. Flow equalisation is used to overcome operational problems caused by flow variations, improve treatment performance downstream, and minimise costs and the size of subsequent treatment steps. It also serves to minimise the temperature of the wastewater. Three parallel balancing tanks will be used for flow equalisation achieving the required average hourly flow, calculated for subsequent treatment stages. The tanks are mixed and slightly aerated to avoid anaerobic processes starting early, minimising odour emissions. The equalisation tanks also offer the opportunity for pH analysis and adjustment if required.

Three tanks (TK.002A, TK.002B and TK.002C) will be installed after the transfer pumping station (TK.001). At the inlet to the equalisation tanks, there will be a flow splitter to divide the combined wastewater into three streams for subsequent parallel treatment in trains 1, 2 and 3.

The equalisation tanks are designed for 1.5 days hydraulic retention time (HRT) of the future wastewater daily peak flowrate, which includes a 20% safety factor of the average flowrate (3024 kL/day). This the minimum recommended HRT to balance weekdays/weekend flowrates to cope with flow variation throughout weekdays (day and night shifts) and to balance reduced flow on the weekends, without compromising downstream process performance and avoiding excessive capital expenditure and/or operational inefficiencies of the treatment system. For the assessed red meat processing facility operating five days a week, at an average weekday wastewater flow of 2,520 kL/day, the equalisation tanks will have HRT = 1.8 days. The required operational tank volume will be 1,512 kL per tank, which will balance the wastewater produced on weekdays and weekends. From the equalisation tanks, the wastewater will be fed continuously to the WWTP with an average flow rate of 105 kL per hour (recommended operational capacity - which will be divided into three modules of 35 kL/h each). Over the course of the week, the equalisation tanks will build up the water level, and deplete during weekends, when the influent flow rate is significantly reduced.

Coarse bubble diffusers will be installed at the equalisation tanks to prevent the occurrence of anaerobic process, keep solids in suspension, and maintain the effluent homogenised and oxygenated. The dissipated power is equivalent to 10W per kL of tank volume. With a 50% safety factor for the air distribution system, a 90kW blower will deliver air to a coarse bubble diffuser at both tanks' bottoms. Table 17 summarises the equalisation tanks' specifications.

Table 13. Equalisation tanks specifications.

Tags	Design conditions	Basic Specifications
TK.002A TK.002B TK.002C	Total balancing volume = 4,536 kL Balancing volume per tank 1,512 kL Operational hours = 24 hours Minimum Holding Capacity = 1.5 days	Specifications per tank: Diameter: 15.4 Total Height: 8.5 m Operational Height: 8.2 m Operational Volume: 1,512 kL Material Glass Fused Steel with epoxy coating – covered top Coarse bubble diffuser shared between all tanks = 90 kW blower

After the equalisation tanks, the three subsequent treatment trains are designed to operate independently in parallel, with an average flow rate of 35 kL/h per train over 24 hours, 7 days a week. A transfer pump is required to direct equalised wastewater flow to the next stages of treatment. External pump sets (ranging from 16 kL/h for current flows to 42 kL/h for expected maximum flows for future production, per pump) will be positioned at the outlet of each tank and will be responsible for transporting the wastewater to the DAF.001. These pumps have the role of regulating flow, bringing stability to the process.

5.2.2 Primary treatment

Primary DAF

The dissolved air flotation (DAF) system uses fine air bubbles to separate fats and suspended solids via flotation, with the assistance of coagulants and flocculants. The DAF system also removes BOD and nutrients that are contained within the solid fraction of the wastewater. The process is reliable, has a relatively small footprint and an adjustable chemical dosing system. It can typically recover more than 90% of fat and is expected to remove a *minimum* of 70% total solids from this part of the process.

It has been assumed that approximately 75% TS removal will occur here, as the high TSS loading of BFG's wastewater will require good DAF performance. This can be achieved by optimising chemical dosing (section 5.2.2.1) and operator supervision. During further detailed design, higher CAPEX alternatives can be assessed.

One DAF unit (DAF.001) will be located downstream of the equalisation tanks and will receive balanced wastewater transferred via pumps. The DAF systems act as the primary treatment for BOD, TSS, Oil and Grease, Nitrogen and Phosphorous, reducing the loads directed to the Biological Nutrient Removal. The equipment will have mixing and flocculation, an air saturation system and a chemical storage and dosing system. The flocculation time was estimated from 1 to 2 minutes based on jar-testing at similar plants and based on manufacturers' recommendation. A recirculation pump will feed reclaimed effluent (from the end of the treatment process) to the air saturation system, varying from 10 to 30% of the recirculation rates for optimisation of operational conditions. The primary sludge removed by the DAF has been estimated at ~ 330kL/d at approximately 2 - 4% solids content. This sludge will be sent to the anaerobic digesters if the Biogas Plant is implemented.

The DAF system will make use of the existing DAF unit on-site, which has enough capacity in terms of hydraulic surface loading rate, particularly when considering the planned addition of chemical dosing to achieve performance targets. The solids loading rate of the DAF unit used for this application is determined to be suitable for the existing DAF unit to handle, particularly when considering the addition of chemical dosing. With critical improvements such as chemical dosing, feed temperature optimisation and the use of final reclaimed effluent for use in the saturation vessel, the existing DAF unit is expected to handle the future load of 105m3/hr. As a contingency, after commissioning the WWTP with current loads and flowrates at approximately 50m3/hr, operational optimisation can occur and any additional DAF requirements, if needed, can be defined ahead of the future 105m3/hr flowrates. However, note that because the existing DAF system is just one unit, it will not have redundancy if downtime is needed on the unit.

Primary DAF - Dosing requirements

The DAF system demands use of chemicals coagulate/flocculate the wastewater and achieve efficient removal rates of suspended solids. Chemicals will be delivered in IBC containers and placed in bunded areas, then connected to allocated dosing pumps. The chemicals dose rates were evaluated via jar testing for coagulation and flocculation as mentioned in section 5.2.2.1 of this report. Thus, for the primary DAF it is expected that Tanfloc 20% w/v may be dosed at a rate of 0.4 L/ kL and EM640CT 41% active content polymer at a rate of 0.01 L/ kL. Provision for pH adjustment using acid or alkaline solution has been included.

The chemical house will have designated bunded areas for the receival of premixed chemicals – recommended to be supplied in IBCs. Further design stages will detail the chemical house and maturation requirements for polymer mixing and preparation.

There will be a Primary DAF sludge pit, TK.006, to collect the DAF skimmed and bottom purged sludge from all primary DAF unit. This will have a short retention time of approximately 2-3 minutes to avoid causing anaerobic conditions and sedimentation in the pit. From here, the sludge will be pumped to the Biogas Plant (if implemented), or to the sludge handling system. Table 19 summarises the DAF specifications.

Table 14. Primary DAF design parameters.

Tags	Design conditions	Basic Specifications
DAF.001A	Inlet average flow rate = 105 kL/h Inlet peak flow rate = 126 kL/h Hydraulic Flocculation time = 1 to 2 min Recirculation rate = 10 - 30% Application rate/Hydraulic Surface Loading Rate = 2.7 – 3.3 m/h for average and peak flows respectively Solids Loading Rate = 8.7 to 10.4 kg/m2.h for average and peak flows respectively Average flow rate design = 137 kL/h (including recirculation) Minimum surface area required = 50 m^2	The following specifications are for the existing DAF unit which will be utilised: Flotation Length: 14.4 m Total Height: 3.7 m Flotation Width: 3.5 m Material: Stainless Steel
Chemical dosing	Flocculant dosing Polymer dosing Ph adjustment (acid) Ph adjustment (base)	Two dosing pumps allocated for each chemical required, per train – in duty/standby configuration for each train (Pump range from 0 to 200 L/hr)
TK.006	Inlet average flowrate of DAF sludge = 13kL/h	Total Depth: 1.3 m

	Inlet peak flowrate of DAF sludge = 16kL/h Hydraulic retention time = 2-3 minutes 2 pumps (1 duty 1 standby)	Diameter: 1.8 m Operational volume: 0.5 m^3 Actual tank volume: 3.3 m^3 Freeboard: 1.1m Material: Concrete

Distribution chamber (TK.003)

After the DAF system the primary effluent will flow by gravity to be merged into a distribution chamber (sump). The distribution chamber will allow operational flexibility with a maximum of 15 min HRT of the averaged flow rate. The distribution chamber is designed to operate over 24 hours 7 days a week at average flow rate of 105 kL/hour with the ability to receive additional 7 kL/h of filtrate liquid from dewatering processes (from biofertiliser dewatering, if Biogas Plant is implemented). Six submerged pump-sets (in a duty/standby configuration for each of the three trains) will pump primary effluent from the distribution box to the Anaerobic Tanks (R.001A, R.001B and R.001C) at the average design flowrate of 35 kL/h per module. The pump set is designed to handle a range from 16 kL/h for current flows to 42 kL/h for expected maximum flows for future production, per pump. Table 20 presents the details of the primary effluent distribution chamber.

Table 15. Primary effluent distribution chamber.

Tags	Design conditions	Basic Specifications
TK.003	Inlet flow rate, from DAF = 105 kL/h Additional 7 kL/h Design flow rate = 112 kL/h Maximum holding capacity = 15 min	Total Height: 4.0 m Diameter: 3.6 m Operational volume: 28 m^3 Actual tank volume: 41 m^3 Freeboard: 1.3m Material: Concrete
Pump set P.002A P.002B P.002C P.002D P.002E P.002F	Flow rate = 16 to 42 kL/h per pump Duty/Duty/Duty/Standby/Standby/Standby	6 x submersible pumps

5.2.3 Secondary treatment

A2O reactor is one of the variations of the activated sludge process composed of anaerobic, anoxic and aerobic zones. It offers a high level of operational flexibility (Metcalf & Eddy, 1991), and removes BOD, SS, nitrogen and phosphorous. The proposed reactor will be designed in three modular stages:

- Anaerobic process (biological phosphorus removal and some COD reduction)
- Anoxic process for pre-denitrification (conversion of nitrate into gaseous nitrogen)

- Aerobic process for nitrification (oxidation of ammonia to nitrite and nitrate)

The system has two recirculation lines:

- Activated sludge return line from the secondary DAF to the anaerobic zone;
- Recirculation of mixed liquor from the aerobic zone back into the anoxic zone to optimise denitrification/nitrification.

Anaerobic bioreactors – biological phosphorus removal

After fats, oils and grease and primary suspended solids are removed via the primary DAF system, the primary effluent is directed to the anaerobic reactors. The first stage (anaerobic zone) of the biological nutrient removal process is included for biological phosphorus removal and some level of COD reduction. The anaerobic tanks reduce the concentrated COD/BOD further to achieve the optimum C:N:P wastewater ratio required (acceptable range ranges from ~100:10:1 to ~100:5:1) for the aerobic zone of the biological nutrient removal process. This stage also reduces the need for chemical phosphorus removal downstream, reducing associated operational costs and reducing heavy metals in the sludge product, enabling better reuse options.

Return activated sludge, containing the required micro-organisms for biological nutrient removal, is circulated to the head of the anaerobic bioreactors. A total operational volume of 240 kL is required, to allow for flexible operations which can adopt an appropriate HRT of 2 hours (7 days operation) and a RAS ratio of 20-100% of the influent. Three 80 kL operational volume glass fused steel anaerobic reactors with epoxy coating are proposed to provide some level of redundancy, with the ability to provide ~67% treatment capacity during any maintenance activities. Each circular reactor will have a height of 5.7 m and a diameter of 4.5 m. To maintain suspension of solids and homogenous anaerobic conditions throughout, each reactor will have a submersible mixer to promote energy inputs from 0.25 to 1 W/kL per tank, controlled via VSD of the submersible mixer. The VSD can be used to optimise the mixer operation pattern. Table 16 summarises the Anaerobic reactors design.

Table 16. Anaerobic reactors design.

Tags	Design conditions	Basic Specifications
R.001A R.001B R.001C	Anaerobic Reactor primary effluent in = 120kL/h Anaerobic Reactor flowrate in (per reactor) = 40kL/h Average HRT = 2h Operational hours = 24 hours	Diameter: 4.5 m Total Height: 5.7 m Operational Height: 5.1 m Operational Volume: 80 kL Freeboard: 0.5 m Material Glass Fused Steel with epoxy coating – open top Top entry submerged mixer with VSD – mixer power 0.9 kW

Anoxic bioreactors – pre-denitrification

An anoxic zone is required for denitrification. Here, nitrates produced from the aerobic stage are recirculated and undergo anoxic treatment. A total volume of 2,640 kL is required. Three 880 kL operational volume glass fused steel tanks with Epoxy Coating are proposed for the anoxic bioreactors required for the pre-denitrification stage, resulting in a HRT of 6 hours. Three tanks were designed with same dimensions: 14.5 m diameter and 5.7 m height. To maintain mixing and anoxic conditions in the tank, two submerged mixers with 1kW of power each were assumed for each tank to supply 1 W/m3. The power output will be controlled via VSD for the submersible mixers. The VSD can be used to optimise the mixer operational pattern. Table 17 summarises the Anoxic reactors design.

Table 17: Anoxic reactors design

Tags	Design conditions	Basic Specifications
R.002A R.002B R.002C	Operational hours = 24 hours	Specifications per tank: Diameter: 14.5 m Total Height: 5.7 m Operational Height: 5.4 m Operational Volume: 880 kL Freeboard: 0.3 m Material Glass Fused Steel with epoxy coating – open top Top entry submerged mixer with VSD – mixer power = 2 x 1 kW per tank

Aerobic bioreactors - nitrification

The aerobic zone is responsible for most of the soluble BOD removal and for the nitrification process. Three open circular glass fused steel tank with Epoxy Coating, each with 1,158 kL operational volume, are recommended. This results in a total operational volume of 3,474 kL. Which can adopt an appropriate HRT of 8 hours. Each tank shall have dimensions as follows: 17 m diameter and 5.7 m height are required. The tanks will include aeration (diffusers) to meet the oxygen required for nitrification and BOD removal. Each tank will comprise of three segments, separated by baffles, to optimise aeration and denitrification recycles. From here, the mixed liquor will be pumped from the aerobic reactors to the secondary DAF tanks. The aeration requirement is ~24,000 kg of O2 per day. The power requirements vary based on the type of diffusers adopted. The aeration system adopted is composed by air diffusers installed at the bottom of the tank (assuming diffusers standard oxygen transfer efficiency of 4.5% per m of submersion) and four blowers (3 duty, 1 standby) with 220kW of power each with capacity to deliver a total of ~620,000Nm3 air/ day in an aerobic reactor of 5.1m operational depth. Table 17 summarises the Aerobic reactors design.

Table 18. Aerobic reactors design.

Tags	Design conditions	Basic Specifications
R.003A R.003B R.003C	Refer to Appendix 1 – Basis of Design. Operational hours = 24 hours	Specifications per tank: Diameter: 17 m Total Height: 5.7 m Operational Height: 5.1 m Operational Volume: 1,158 kL Freeboard: 0.6 m Material Glass Fused Steel with epoxy coating – open top Segmented with baffle curtains Equipped with bottom air diffusors connected to blower system

Air diffusors	Air flow rate per diffusers = 4.5 Nm^3/h Diffuser density in the tank = up to 6 diffusers per square meter	Disc Diameter = 229 mm Disc Material = EPDM Total number of diffusers ~6,000
Blowers	Air flow rate = 620,000 Nm^3/day	4 blowers with 260 kW each (3 duty +1 stand-by)

BNR Recirculation and RAS pumps

The biological nutrient removal process requires recirculation of nitrified mixed liquor and recirculation of activated sludge (RAS). The internal recirculation of mixed liquor, starting at the end of the aerobic stage and returning to the start of the anoxic stage, requires flexibility in flowrates which can vary from 1 up to 6 times the volume of plant inlet flowrate. The RAS varies from 0.5 to 1.0 times the plant inlet flowrate and is returned from the secondary DAF system to the start of the anaerobic zone. There will be two RAS pumps per train and two recirculation pumps per train. The pumps will be per treatment train and specifications for each recirculation line and pump sets are detailed in Table 19.

Table 19: Internal Recirculation Pumps and RAS Pumps Design

Tags	Design conditions	Basic Specifications
IN-Recirc from R.003A to R.002A IN-Recirc. R.003B to R.002B IN-Recirc. R.003C to R.002C	Average design flowrate = 315 kL/h total (for the design of 3x recirculation rate) Average design flowrate per pump = 105kL/h Range from 22 kL/h to 756 kL/h total Range per pump = 7 kL/h to 252 kL/h Recirculation from 1 to 6 times influent 3 pipelines total (pumps running in parallel)	Number of pumps: 6 (3 duty + 3 standby; 1 duty and 1 standby are dedicated to each train)
RAS from DAF.002A to R.001A RAS from DAF.002B to R.001B RAS from DAF.002C to R.001C	Average design flow rate = 105 kL/h total Average design flow rate per pump = 35 kL/h total Range per pump = 3 kL/h to 42 kL/h RAS from 50 to 100% 3 pipelines total (pumps running in parallel)	Number of pumps: 6 (3 duty + 3 standby; 1 duty and 1 standby are dedicated to each train)

Secondary DAF

A secondary DAF system is proposed to separate, thicken and remove activated sludge produced in the bioreactors. There will be three DAF units operating in parallel; one for each train. The process has a smaller footprint when compared to a conventional secondary clarifier, which utilises gravity for sludge settling. Additionally, it eliminates the issue of floating sludge during warmer months, filamentous issues that can arise during operational and seasonal variations and allows for higher variability and loading rates for the footprint than traditional clarifiers. A chemical dosing skid will include coagulant and polymer dosing all via a static mixer. A recirculation pump will feed treated wastewater for the air recirculation system.

Part of the thickened sludge, the Return Activated Sludge (RAS), is recirculated to the anoxic reactor (0.5 to 1.0 of the inlet flow rate), and the Excess Activated Sludge (EAS) will be dewatered and sent to the biogas plant (if the Biogas Plant is implemented). An activated sludge generation rate of ~270 kL /day is estimated, assuming a DAF outlet concentration (for mass balance, not dewatered) of ~2-4% TS. The clarified effluent will be transferred by gravity to a common buffer tank (TK.004) preceding the advanced treatment stage. Table 20 summarises the parameters for the secondary DAF design.

The secondary DAF system demands use of chemicals, such as polymer, to flocculate the wastewater and achieve efficient removal rates of suspended solids. Chemicals will be delivered in IBC containers and placed in bunded areas, then connected to allocated dosing pumps. The chemical house will have designated bunded areas for receival of premixed chemicals – recommended to be supplied in IBCs. Further design stages will detail the chemical house and maturation requirements for polymer mixing and preparation. Each treatment train will have a dedicated set of dosing pumps.

There will be a secondary DAF sludge pit, TK.007, to collect the DAF skimmed and bottom purged sludge from all secondary DAF units. This will have a short retention time of approximately 2-3 minutes to avoid causing anaerobic conditions and sedimentation in the pit. From here, the sludge will be pumped to the Biogas Plant (if implemented), or to the sludge handling system. Table 20 summarises the Secondary DAF system design.

Table 20: Secondary DAF system design.

Tags	Design conditions	Basic Specifications
DAF.002A DAF.002B DAF.002C	Design conditions per DAF unit: Inlet average flow rate per DAF = 78 kL/h Recirculation rate = 10 - 30% Application rate/Hydraulic Surface Loading Rate = 4.6 – 5.5 m/h Solids Loading Rate = 13.2 - 15.8 kg/m2.h Average flow rate design = 100 kL/h (including recirculation) Minimum surface area required per DAF unit = 22 m^2	Length: 10.0 m Total Height: 2.5 m Width: 2.2 m Material: Stainless Steel
Chemical dosing	Polymer dosing	Two dosing pumps allocated per train – in duty/standby configuration (Pump range from 0 to 200 L/hr)
TK.007	Inlet average flowrate of DAF (and UF backwash) sludge = 16kL/h Inlet peak flowrate of DAF sludge = 19kL/h Hydraulic retention time = 2-3 minutes 2 pumps (1 duty 1 standby)	Total Depth: 1.3 m Diameter: 1.8 m Operational volume: 0.7 m^3 Actual tank volume: 3.3 m^3 Freeboard: 1.1m

		Material: Concrete

5.2.4 Tertiary treatment

Buffer tank and chemical dosing (TK.004)

One buffer tank, upstream of the ceramic membrane filters, allows for any dosing of any chemical additives required for further phosphorus removal, which is a contingency phosphorus removal system to supplement the UASB and activated sludge process. The TK.004 will have 25 to 30 minutes of holding capacity (for peak and average flow respectively) and an operational volume of 56kL, receiving a total an average of 2,634m3/day at this section of the plant. Here, any remaining phosphorous will be removed by chemical precipitation with ferric chloride (or other metallic coagulant), mixed via an in-line static mixer. Table 21 presents the details of the buffer tank and chemical dosing design.

Table 21: Buffer Tank and Chemical Dosing Design

Tags	Design conditions	Basic Specifications
TK.004	Total operational volume = 2,634 kL/day Operational volume = 56 kL Operational hours = 24 hours Holding Capacity = 25 – 30 minutes; design can be tuned pending on specific water reuse requirements	Diameter = 4.5 m Height = 4.5 m Operational Volume: 56 kL Actual Tank Volume: 72 kL Freeboard: 1.0 m Material Concrete; spaced with baffles
	Ferric Dosing	Provision for up to 1.4kL/day of 44% Ferric Chloride Solution (contingency alternative to anaerobic tank)
	Sodium Hydroxide dosing	TBD by supplier during detailed design process
	Chlorine liquid (for biofouling prevention)	0.5ppm – 1.14 ppm

Chlorination - disinfection (DI.001)

Sodium Hypochlorite will be dosed after the TK.004 to maintain up to 2.0 mg/L of chlorine residual in the water. Sodium Hypochlorite will be dosed via dosing pumps and injected with a static mixer installed in-line; the storage tanks right after the chlorine dosage are designed to allow a minimum of 30 minutes of contact time, resulting in a CT of up to 60 mg.min/L, which is a conservative approach for <0.2 NTU, pH <7.5 and temperature <15˚C (AASI, 2017).

5.2.5 Sludge handling

The current design assumes that the biogas plant will be implemented, which includes anaerobic digestion of sludge. The liquid digestate can be applied to land directly in NSW, if certain conditions have been met or processed further into a high-value, solid biofertiliser product. However, if the decision is made to implement only the WWTP in isolation, an allowance should be made for sludge handling. In this case, mechanical dewatering equipment should be installed to dewater combined sludge from the following sources shown in Table 22.

Table 22. Sludge streams.

Sludge streams	Sludge quantities
Raw primary sludge and fats oils and grease from the primary DAF units	~330 kL/d at 3% TS
Activated sludge generated in the BNR and removed via the secondary DAF units	~283 kL/d at 3% TS
Total sludge quantity for dewatering and disposal	**~613kL/d at 3% TS**

Three centrifuges (or alternatively large screw presses) can be installed to mechanically dewater combined sludge from the primary DAF, BNR purge and secondary DAF resulting in ~613kL/d at 3%TS. The sludge pits from the primary and secondary DAF units will pump thickened sludge to the sludge blending tank, from where the centrifuge feed pumps will pump feed into the centrifuges. The centrifuges are responsible for concentrating the sludge to ~22%TS prior to offsite disposal (Table 23). This will reduce the quantity of sludge to be transported for disposal or offsite further processing to approximately 85m3/d. The equipment allows hydraulic loads of up to 10kL/hour and dry solids loads up to 500kg/hour, which is adequate for the WWTP sludge dewatering purposes. Excess water will be returned to wastewater equalisation tanks via a pressurised pipeline. The centrifuges will have a polymer dosing system to improve the dewatering process.

Table 23. Sludge handling specifications.

Tags	Design conditions	Basic Specifications
TK.008	Sludge blending tank operational volume = 200kL Residence time = 6.5 hours	Diameter: 6.8 m Total Height: 5.7 m Operational Height: 5.5 m Actual Tank Volume: 207 kL Freeboard: 0.2 m
LSS feed pumps	Average total design flowrate = 123 kL/h Average design flowrate per pump = 50kL/h Range from 22 kL/h to 148 kL/h total Range per pump = 7 kL/h to 50 kL/h	Pumps with VSDs Number of pumps: 4 (3 duty + 1 standby; 1 duty is dedicated to each train with 1 standby on the shelf to share between the trains)
LSS.001A LSS.001B LSS.001C	Average hydraulic loading = 730kL/d total Average hydraulic loading per centrifuge = 243kL/d =10kL/h Solids content of influent = 2.5%TS Dry solids loading per centrifuge = 6t/d total	Dimensions per centrifuge: Length = 2.98m Width = 0.94 m Height = 0.89 m

Tags	Design conditions	Basic Specifications
	= 260kg/h Operation = 24h	
Dosing point within unit	Polymer Dosing	Polymer to be adjusted during operation dosing volume TBC with centrifuge supplier
Skip bin	Sludge skip bin	Volume sufficient to store waste from primary DAFs, UASB reactors purge, secondary DAFs and filtration systems for minimum of 10 hours.

The concept design was modelled in Biowin (Figure 4), to ensure the treated water quality will still be compliant with the regulations.

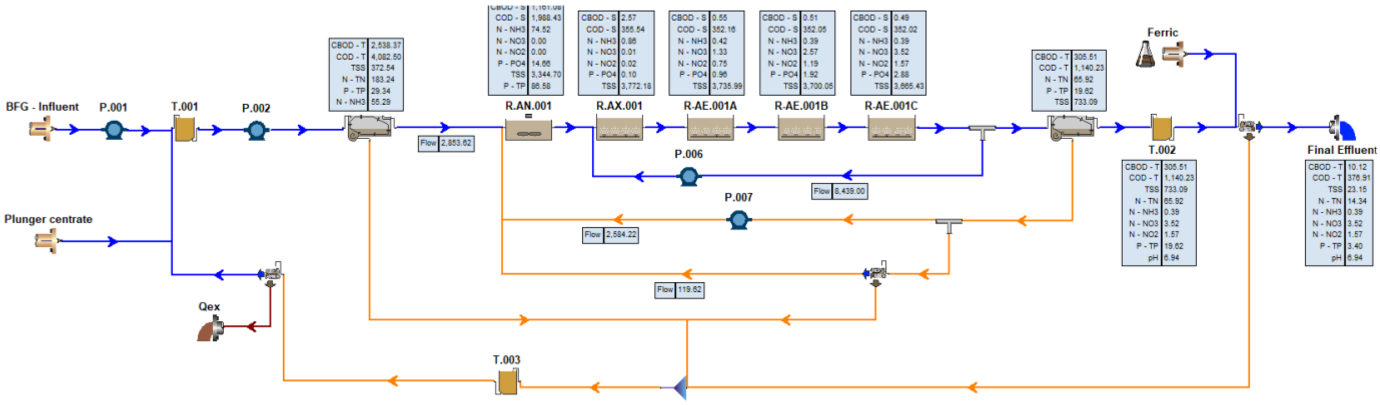

Figure 4. Concept design simulated in Biowin model.

Table 24 shows the resulting treated effluent quality, compared to the required by the Australian Guidelines for Water Recycling (AGWR) parameters, considering the recycled water use for irrigation and cattle wash (other than final), as requested by Bindaree Food Group.

Table 24. Wastewater treatment plant – Final Effluent quality and regulatory requirements.

Item	Design Value	AGWR * (mg/L)
BOD (mg/L)	10	<20
SS (mg/L)	23	<30
Nitrogen (mg/L)	14	-
Phosphorus (mg/L)	3	-

*Water quality objectives for Commercial food crops.

5.3 Cost Estimate

The total capital expenditure (CAPEX) based on a +/- 30% cost estimate for the first two modules (to cater for current treatment needs) of the proposed WWTP is $6.6M. The further investment regarding the third module of the WWTP (to allow for future expansion on production) is planned to occur in the long term. A modular treatment design was proposed due to process flexibility and equipment redundancy.

Table 25 shows three options presenting the investment necessary to build 3 and 2 modules of the specific WWTP. Option 1 includes a full tertiary treatment (with ultrafiltration, UV and chlorine disinfection) which would be necessary if the recycled water was used for high-exposure applications such as toilet flush and garden use. Option 2 was detailed in item 5.2 of this report and considers only chlorination as a disinfection step since it is sufficient for the required applications of irrigation and cattle wash (other than final). Option 3 comprises only primary and secondary treatment and its recycled wastewater application is limited to irrigation. The detailed breakdown of equipment costs and reference suppliers as well as the site implementation costs for the proposed concept design option (option 2) are presented in Appendix 3 and 4, respectively.

Table 25. Summary of the Cost Estimate for the WWTP implementation.

	Total (Thousands of AU$)					
	Option 1* Including Full Tertiary Treatment		Option 2 Including Only Chlorination		Option 3 Without Tertiary Treatment	
Description	**3 Modules**	**2 Modules**	**3 Modules**	**2 Modules**	**3 Modules**	**2 Modules**
Contract Preliminaries WWTP (13%)	1,985	1,323	1,087	724	1,084	722
Design and Project Management WWTP (6%)	1,103	735	502	334	500	334
Wastewater Treatment Plant Breakdown	11,026	7,351	8,361	5,574	8,336	5,557
Civil Works	574	383	574	383	574	383
Amenities Lab/Control Room	163	109	163	109	163	109
Equipment Supply	9,693	6,462	7,028	4,685	7,002	4,669
Pipework	217	144	217	144	217	144
Electrical	379	253	379	253	379	253
Total for full implementation of the Wastewater Treatment Plant	**14,113**	**9,409**	**9,949**	**6,633**	**9,920**	**6,613**

* Contract Preliminaries and Design and Project Management were assumed as 18% and 10%, respectively, due to higher level of automation and more stringent monitoring requirements.

6.0 Discussion

Not applicable.

7.0 Conclusions / Recommendations

The proposed wastewater treatment plant concept design has taken into consideration the production of recycled water compliant with low exposure quality for the required specific applications of irrigation and cattle wash (other than final). The proposed process technology is an innovative concept in Australia red meat industry resulting in positive economic and environmental outcomes.

This design is for a new optimised and modular wastewater treatment plant with high flexibility of process control, focusing on attending to current wastewater disposal issues faced by the Bindaree Food Group Inverell facility. Design upgrades of the existing infrastructure will not be considered and the decommissioning of such infrastructure, existing ponds, was purposed after the implementation of new designed WWTP.

The new plant design is considering aspects such as nutrients (N, P) and other compounds removal from wastewater, with the possibility of irrigation and cattle wash (other than final), within compliance. The result of this project, including the cost estimates for the WWTP, will then be used by Bindaree Food Group for the decision-making process for further stages of the plant implementation. These results will also support the Environmental Licensing application process.

After careful evaluation, prioritising project affordability and the required recycled water applications, it was suggested to pursue only two modules of the WWTP with chlorination as tertiary treatment. It will cope with current wastewater flow treatment needs and required recycled wastewater applications. However, it is recommended to reassess the cost estimate for the third module before future WWTP expansion. Market fluctuations and potential higher expenses beyond initial projections should be considered.

8.0 Bibliography

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9.0 Appendices

9.1 Appendix 1 – Full wastewater analysis of combined red and green streams

Table 26. Full wastewater analysis of combined red and green streams.

		Samples														
Parameter	**UOM**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Ave**	**Min**	**Max**
pH	pH Units	5.7	5.9	6.6	5.6	5.6	7.0	6.2	6.7	7.5	6.8	6.4	6.5	**6.4**	5.6	7.5
Conductivity (EC)	dS/m	1	1	2	1	1	2	1	2	2	1	1	1	**1**	1	2
TDSalts	mg/L	787	684	1,223	894	907	1,373	802	1,015	1,533	762	635	878	**958**	635	1,533
TD Solids	mg/L	850	715	2,480	3,150	2,650	1,590	757	1,110	955	1,550	733	1,230	**1,481**	715	3,150
TSS	mg/L	5,880	2,510	5,120	7,740	9,050	2,214	2,171	3,050	1,505	4,667	3,880	2,190	**4,165**	1,505	9,050
BOD	mg/L	6,610	4,320	975	12,815	14,833	5,010	7,475	3,820	2,230	7,300	6,960	4,020	**6,364**	975	14,833
O&G	mg/L	3,597	2,627	4,626	5,172	5,358	10,148	4,757	2,098	1,505	2,291	2,476	1,546	**3,850**	1,505	10,148
TP	mg/L	21	27	52	51	54	66	40	44	72	44	34	60	**48**	21	72
TN	mg/L	485	218	417	588	535	253	259	424	254	319	283	182	**351**	182	588
Ammonia	mg/L	53	36	82	6	6	126	38	96	181	26	46	36	**61**	6	181
Sodium	mg/L	126	120	190	132	145	182	104	140	188	112	114	180	**144**	104	190
Potassium	mg/L	45	39	96	43	48	87	52	54	104	60	41	63	**61**	39	104
Calcium	mg/L	20	30	24	50	60	50	50	28	76	34	29	41	**41**	20	76

		Samples														
Parameter	**UOM**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Ave**	**Min**	**Max**
Magnesium	mg/L	8	9	11	8	9	14	8	10	20	11	8	10	**11**	8	20
Sodium Absorption Ratio (SAR)	mg/L	6	5	8	5	5	6	4	6	5	4	5	7	**5**	4	8
Chloride	mg/L	142	135	253	88	121	124	61.9	78	216	31	178	82	**126**	31	253

9.2 Appendix 2 – Technical Drawings

2023-1028-AMPC-CP-DW-004-REV.C.pdf 2023-1028-AMPC-CP-DW-003-REV.C.pdf 2023-1028-AMPC-CP-DW-002-REV.C.pdf 2023-1028-AMPC-CP-DW-001-REV.C.pdf

9.3 Appendix 3 – Equipment Cost Breakdown and Reference Suppliers

Table 27. Equipment Cost Breakdown and Reference Suppliers.

Item	Drawing Label	Equipment	Qty.	Reference Supplier	Price $/unit	Total Cost	Comments	Other Suppliers
1. Pre-Treatment						**$1,884,622**		
1.1	RS1A RS1B RS1C	Rotary Screen	3	Aqseptence Group	$76,180	$228,540	Delivery and services are not included.	FRC: $262,670 - 3 rotary drum screens. Delivery and services are not included. Hydroflux: $632,640 - 3 rotary drum screens. EXW Sydney.
1.2	GS1A GS1B GS1C	Grit Screens	3	Aqseptence Group	$62,983	$188,949	Delivery and services are not included.	
1.3	GW1A GW1B	Grit Washers	2	Aqseptence Group	$66,333	$132,666	Delivery and services are not included.	FRC: $133,370 - 2 grit washers. Delivery and services are not included.
1.4	TK1	Pumping Station	1	Xylem	$289,990	$289,990	Delivery and services are not included.	

1.5	P1A P1B P1C P1D P1E P1F	Transfer Pumps to Equalisation Tanks	6	Xylem	$20,500	$123,000	Delivery and services are not included.	Caprari: $89,079 - 6 submersible pumps. EXW Adelaide. Services are not included. Qmax Pumps: $60,060 - 6 submersible pumps. Delivery and services are not included.
1.6	TK2A TK2B TK2C	Equalisation Tanks	3	CST	$164,354	$493,062	CIF Sydney Port. Services are not included.	Boerger: $937,848 - 3 Equalisation Tanks without roof. CIF Sydney Port. Services are not included.
1.7	TK2A TK2B TK2C	Coarse bubble diffusor	3	Xylem	$98,000	$294,000	DDP Inverell. Services are not included.	Hydroflux: $425,241 - Diffusors. EXW Sydney. Services are not included.
1.8	TK2A TK2B TK2C	Blower Supply Aerator	3	Robuschi	$44,805	$134,415	EXW Melbourne. Services are not included.	Xylem: $405,000 - 3 Blowers. DDP Inverell. Services are not included.
2. Primary Treatment						**$663,000**		
2.1	DAF1	Transfer Pumps to Primary DAF	2	Xylem	$20,500	$41,000	Delivery and services are not included.	
2.2	DAF1	Static Mixer Before Primary DAF	1		$5,000	$5,000		
2.3	DAF1	Primary DAF Chemical Dosing Pumps	8	Dynapumps	$9,020	$72,160	DPP Inverell. Services are not included.	Hydroflux: $157,820 - 4 chemical dosing systems with 2 pumps each. EXW Sydney. Services are not included.
2.4	TK6	Pumping Station (Sludge)	1	Xylem	$239,000	$239,000	Delivery and services are not included.	
2.5	TK6	Sludge Pumps	2	Xylem	$4,440	$8,880	Delivery and services are not included.	
2.6	TK3	Pumping Station	1	Xylem	$254,000	$254,000	Delivery and services are not included.	Qmax Pumps: $245,480 - Pumping Station. Delivery and services are not included.
2.7	P2A P2B P2C P2D P2E P2F	Transfer Pumps to Anaerobic Reactors	6	Xylem	$7,160	$42,960	Delivery and services are not included.	Qmax Pumps: $54,864 - 6 Pumps. Delivery and services are not included.
3. Secondary Treatment						**$3,203,431.67**		
3.01	R1A R1B R1C	Anaerobic Reactors	3	CST	$16,101.68	$48,305.04	CIF Port Sydney. Services are not included.	Boerger: $289,176 - 3 Anaerobic Tanks. CIF Sydney Port. Services are not included.

3.02	R1A R1B R1C	Submerged mixers	3	Xylem	$14,200	$42,600	DPP Inverell. Services are not included.	Boerger: $54,657.36 - 3 Submerged Mixers. CIF Sydney Port. Services are not included.
3.03	R2A R2B R2C	Anoxic Reactors	3	CST	$68,985.68	$206,957.04	CIF Port Sydney. Services are not included.	Boerger: $648,982 - 3 Anoxic Tanks. CIF Sydney Port. Services are not included.
3.04	R2A R2B R2C	Submerged mixers	3	Xylem	$27,966.67	$83,900	DPP Inverell. Services are not included.	Boerger: $57,075.12 - 3 Submerged Mixers. CIF Sydney Port. Services are not included.
3.05	R3A R3B R3C	Aerobic Reactors	3	CST	$59,428.53	$178,285.59	CIF Port Sydney. Services are not included.	Boerger: $949,749 - 3 Aerobic Tanks. CIF Sydney Port. Services are not included.
3.06	R3A R3B R3C	Fine Bubbles Diffusors	3	Xylem	$168,333.33	$505,000	DPP Inverell. Services are not included.	Hydroflux: $501,372 - Diffusors. EXW Sydney. Services are not included.
3.07	R3A R3B R3C	Blower Supply Aerator	4	Robuschi	$109,401	$437,604	EXW Melbourne. Services are not included.	Xylem: $754,000 - 4 Blowers. DDP Inverell. Services are not included.
3.08	R3A R3B R3C	Internal Recirculation Pumps	6	Xylem	$16,960	$101,760	Delivery and services are not included.	Caprari: $ 98,693.58 - 6 submersible pumps. EXW Adelaide. Services are not included. Qmax Pumps: $60,060 - 6 submersible pumps. Delivery and services are not included. Boerger: $123,411.96 - 6 submersible pumps. CIF Sydney Port. Services are not included.
3.09	R3A R3B R3C	RAS Pumps	6	Xylem	$11,280	$67,680	Delivery and services are not included.	Caprari: $ 55,315.26 - 6 submersible pumps. EXW Adelaide. Services are not included. Qmax Pumps: $36,960 - 6 submersible pumps. Delivery and services are not included. Boerger: $75,434.16 - 6 submersible pumps. CIF Sydney Port. Services are not included.
3.1	DAF2A DAF2B DAF2C	Transfer Pumps to Secondary DAF	6	Xylem	$7,160	$42,960	Delivery and services are not included.	
3.11	DAF2A DAF2B DAF2C	Static Mixer Before Secondary DAF	3		$5,000	$15,000		

3.12	DAF2A DAF2B DAF2C	Secondary DAF	3	FRC	$380,486.67	$1,141,460	Delivery and services are not included.	Hydroflux: $810,000 - 3 Secondary DAFs. EXW Sydney. Services are not included.
3.13	DAF2A DAF2B DAF2C	Polymer preparation system	1	IFS	$48,000	$48,000	Delivery and services are not included.	Flottweg: $58,519.50. CIF Sydney Port. Services are not included. Hydroflux: $218,184. EXW Sydney. Services are not included.
3.14	DAF2A DAF2B DAF2C	Secondary DAF Polymer dosing Pumps	4	Dynapumps	$9,020	$36,080	DPP Inverell. Services are not included.	Hydroflux: $118,365 - 3 chemical dosing systems with 2 pumps each. EXW Sydney. Services are not included.
3.15	TK7	Pumping Station (Sludge)	1	Xylem	$239,000	$239,000	Delivery and services are not included.	
3.16	TK7	Sludge Pumps	2	Xylem	$4,420	$8,840	Delivery and services are not included.	
4. Tertiary Treatment						**$546,560.00**		
4.01	TK4	Pumping Station	1	Xylem	$254,000	$254,000	Delivery and services are not included.	Qmax Pumps: $330,480 - Pumping Station. Delivery and services are not included.
4.02	TK4	Transfer Pumps to Ultrafiltration	6	Xylem	$12,080	$72,480	Delivery and services are not included.	
4.03	TK4	Static Mixers TK4	3		$2,500	$7,500		
4.04	TK4	Chemical Dosing Pumps TK4	12	Dynapumps	$9,020	$108,240		
4.05	DI1	Static Mixer before Chlorination Disinfection DI1	1		$5,000	$5,000	Delivery and services are not included.	
4.06	DI1	Chlorination Disinfection	1	Ixom	$20,000	$20,000	Delivery and services are not included.	
4.07	TK5	Treated Water Storage Tank	1	CST	$84,340	$84,340	CIF Port Sydney. Services are not included.	Boerger: $312,616 - 3 Treated Water Storage Tanks. CIF Sydney Port. Services are not included.
5 Sludge Handling						**$725,252**		
5.1	TK8	Sludge Blending Tank	1	CST	$51,552	$51,552	CIF Port Sydney. Services are not included.	

5.2	LSS1A LSS1B LSS1C	Centrifuge Feed Pumps	4	IFS	$11,000	$44,000	Delivery and services are not included.	Flottweg: $49,747.38 - 3 Centrifuge Feed Pumps. CIF Sydney Port. Services are not included.
5.3	LSS1A LSS1B LSS1C	Centrifuge	3	IFS	$185,900	$557,700	Delivery and services are not included.	Flottweg: $661,441.20 - Centrifuges including polymer dosing pumps. CIF Sydney Port. Services are not included. Hydroflux: $914,763 - Centrifuges. EXW Sydney. Services are not included.
5.4	LSS1A LSS1B LSS1C	Polymer preparation system	1	IFS	$48,000	$48,000	Delivery and services are not included.	Flottweg: $58,519.50. CIF Sydney Port. Services are not included. Hydroflux: $218,184. EXW Sydney. Services are not included.
5.5	LSS1A LSS1B LSS1C	Polymer dosing pumps	4	IFS	$6,000	$24,000	Delivery and services are not included.	Dynapumps: $36,080 - 4 Polymer dosing pumps. DPP Inverell. Services are not included.
5.6	Sludge skip bin	Sludge skip bin	Not included	Not included	0	0	Not included	Not included
Total Cost						**$7,022,865.67**		

9.4 Appendix 4 – Site Implementation Costs

Table 28. Site Implementation Costs.

Item No.	Item Description	Option 1 Qty.	Option 2 Qty.	Unit	Rate	Option 1 Amount (AU$)	Option 2 Amount (AU$)
WASTEWATER TREATMENT PLANT							
PRELIMINARIES							
1	Contractors preliminaries including supervision, safety, insurances, etc (allow 13%)			Item		1,086,909.00	724,606.00
2	Design and project management (6%)			Item		501,651.00	334,434.00
					TOTAL WWTP	***8,360,835.00***	***5,573,890.00***
CIVIL WORKS						**574,279.00**	**382,853.00**

3	Strip topsoil, remove minor rubbish items, etc in preparation for new works (measured over compound area)	15,210.00	10,140.00	m2	6.00	91,260.00	60,840.00
4	Oversite fill to make up levels and form substrate for new works	4,563.00	3,042.00	m3	25.00	114,075.00	76,050.00
5	200 Compacted crushed limestone and subgrade to access roads	4,095.00	2,730.00	m2	70.00	286,650.00	191,100.00
6	150 thick reinforced concrete base to receive equipment, pumps, etc including 150 crushed limestone base	536.25	357.50	m2	370.00	198,412.50	132,275.00
7	Chemical loading areas	100.00	66.67	m2	500.00	50,000.00	33,333.33
8	Allow for drainage swales			Item		20,000.00	13,333.33
9	Allow for water supply to the site			Item		10,000.00	6,666.67
10	Allow for electrical supply to the site			Item		50,000.00	33,333.33
AMENITIES LAB/ CONTROL ROOM						***162,750.00***	***108,500.00***
11	Building works for new facility to include amenities, Lab and control room	70.00		m2	1,500.00	75,000.00	50,000.00
12	Air supply house	58.50		m2	3,000.00	87,750.00	58,500.00
EQUIPMENT						**7,027,866.00**	**4,685,244.00**
13	Rotary Screen	3.00	2.00	No.	76,180.00	228,540.00	152,360.00
14	Grit Screens	3.00	2.00	No.	62,983.00	188,949.00	125,966.00
15	Grit Washers	2.00	2.00	No.	66,333.00	132,666.00	88,444.00
16	Pumping Station	1.00	1.00	No.	289,990.00	289,990.00	193,326.67
17	Transfer Pumps to Equalisation Tanks	6.00	4.00	No.	20,500.00	123,000.00	82,000.00
18	Equalisation Tanks	3.00	2.00	No.	164,354.00	493,062.00	328,708.00
19	Coarse bubble diffuser	3.00	2.00	No.	98,000.00	294,000.00	196,000.00
20	Blower Supply Aerator	3.00	2.00	No.	44,805.00	134,415.00	89,610.00
21	Transfer Pumps to Primary DAF	2.00	2.00	No.	20,500.00	41,000.00	27,333.33
22	Static Mixer Before Primary DAF	1.00	1.00	No.	5,000.00	5,000.00	3,333.33
23	Primary DAF Chemical Dosing Pumps	8.00	6.00	No.	9,020.00	72,160.00	48,106.67
24	Pumping Station (Sludge)	1.00	1.00	No.	239,000.00	239,000.00	159,333.33
25	Sludge Pumps	2.00	2.00	No.	4,440.00	8,880.00	5,920.00
26	Pumping Station	1.00	1.00	No.	254,000.00	254,000.00	169,333.33

27	Transfer Pumps to Anaerobic Reactors	6.00	4.00	No.	7,160.00	42,960.00	28,640.00
28	Anaerobic Reactors	3.00	2.00	No.	28,753.00	48,305.04	32,203.36
29	Submerged mixers	3.00	2.00	No.	14,200.00	42,600.00	28,400.00
30	Anoxic Reactors	3.00	2.00	No.	77,512.00	206,957.04	137,971.36
31	Submerged mixers	3.00	2.00	No.	27,966.67	83,900.00	55,933.33
32	Aerobic Reactors	3.00	2.00	No.	94,331.00	178,285.59	118,857.06
33	Fine Bubbles Diffusors	3.00	2.00	No.	168,333.33	505,000.00	336,666.67
34	Blower Supply Aerator	4.00	3.00	No.	109,401.00	437,604.00	291,736.00
35	Internal Recirculation Pumps	6.00	4.00	No.	16,960.00	101,760.00	67,840.00
36	RAS Pumps	6.00	4.00	No.	11,280.00	67,680.00	45,120.00
37	Transfer Pumps to Secondary DAF	6.00	4.00	No.	7,160.00	42,960.00	28,640.00
38	Static Mixer Before Secondary DAF	3.00	2.00	No.	5,000.00	15,000.00	10,000.00
39	Secondary DAF	3.00	2.00	No.	380,486.67	1,141,460.00	760,973.33
40	Polymer preparation system	1.00	1.00	No.	48,000.00	48,000.00	32,000.00
41	Secondary DAF Polymer dosing Pumps	4.00	3.00	No.	9,020.00	36,080.00	24,053.33
42	Pumping Station (Sludge)	1.00	1.00	No.	239,000.00	239,000.00	159,333.33
43	Sludge Pumps	2.00	2.00	No.	4,420.00	8,840.00	5,893.33
44	Pumping Station	1.00	1.00	No.	254,000.00	254,000.00	169,333.33
45	Transfer Pumps to Ultrafiltration	6.00	4.00	No.	12,080.00	72,480.00	48,320.00
46	Static Mixers TK.004	3.00	2.00	No.	2,500.00	7,500.00	5,000.00
47	Chemical Dosing Pumps TK.004	12.00	9.00	No.	9,020.00	108,240.00	72,160.00
48	Static Mixer before Chlorination Disinfection DI.001	1.00	1.00	No.	5,000.00	5,000.00	3,333.33
49	Chlorination Disinfection	1.00	1.00	No.	20,000.00	20,000.00	20,000.00
50	Treated Water Storage Tank	1.00	1.00	No.	84,340.00	84,340.00	56,226.67
51	Sludge Blending Tank	1.00	1.00	No.	51,552.00	51,552.00	34,368.00
52	Centrifuge Feed Pumps	4.00	3.00	No.	11,000.00	44,000.00	29,333.33
53	Centrifuge	3.00	2.00	No.	185,900.00	557,700.00	371,800.00
54	Polymer preparation system	1.00	1.00	No.	48,000.00	48,000.00	32,000.00

55	Polymer dosing pumps	4.00	3.00	No.	6,000.00	24,000.00	16,000.00
PIPEWORK						***216,740.00***	***144,494.00***
PE100-SDR11 Pipework							
56	110 NB pipework in ground	100.00	66.67	m	72.00	7,200.00	4,800.00
57	125 NB pipework above ground	134.00	89.33	m	102.00	13,668.00	9,112.00
58	125 NB pipework in ground	435.00	290.00	m	88.00	38,280.00	25,520.00
59	125 NB pipework partial in and above ground	72.00	48.00	m	95.00	6,840.00	4,560.00
60	160 NB pipework above ground	3.00	2.00	m	137.00	411.00	274.00
61	160 NB pipework in ground	180.00	120.00	m	116.00	20,880.00	13,920.00
62	160 NB pipework partial in and above ground	33.00	22.00	m	127.00	4,191.00	2,794.00
63	160 NB pipework suspended	41.00	27.33	m	130.00	5,330.00	3,553.33
64	250 NB pipework in ground	150.00	100.00	m	210.00	31,500.00	21,000.00
65	250 NB pipework partial in and above ground	33.00	22.00	m	180.00	5,940.00	3,960.00
Other Pipework							
66	125 NB SCH40 SS pipework above ground	200.00	133.33	m	390.00	78,000.00	52,000.00
67	Dosing pipelines suspended	15.00	10.00	m	300.00	4,500.00	3,000.00
ELECTRICAL						***379,200.00***	***252,800.00***
68	Electrical, instrumentation and control	1.00	1.00	No	349,200.00	349,200.00	232,800.00
69	Builders work in connection			Item		30,000.00	20,000.00
SUBTOTAL						***9,949,395.00***	***6,632,930.00***
70	Subtotal					9,919,644.67	6,613,096.45
71	GST excluded						
WASTEWATER TREATMENT PLANT					***TOTAL***	***9,949,395.00***	***6,632,930.00***