Concept and Viability Report

Professional Services: Upgrade of Bulk Sewers, Replacing of Small-Bore Sanitation System at Woodlands

Prepared for: Koukamma Local Municipality
8 November 2024
Client Reference No. DWS 22/23-058

SMEC INTERNAL REF. EC0047

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Document Control

Document Type	Concept and Viability Report
Project Title	Professional Services: Upgrade of Bulk Sewers, Replacing of Small-Bore Sanitation System at Woodlands
Project Number	EC0047
File Location	P:\EC0047 - Woodlands\3_Working\3-5_DivW\Reports\Inception Report.docx
Revision Number	00

Revision History

Revision No.	Date	Prepared By	Reviewed By	Approved for Issue By
[00]	8/11/2024	E. Du Toit	D. Sharp	J. Kampman

Issue Register

Distribution List	Date Issued	Number of Copies
Koukamma Local Municipality	8/11/2024	[00]
Add lines as needed		

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Abbreviations

Average Daily Dry Weather Flow	ADWF
Kilolitre	Kl
Local Municipality	LM
Peak Daily Dry Weather Flow	PDWF
Peak Wet Weather Flow	PWWF
Wastewater Treatment Works	WWTW

1. Introduction

1.1 Background

The Koukamma Local Municipality (LM) has commissioned SMEC South Africa for the design and implementation of the internal sewer reticulation, bulk sewer reticulation, and wastewater treatment works within the Woodlands Settlement.

This report contains a preliminary design and cost estimate of the proposed sewer reticulation and wastewater treatment works (WWTW).

1.2 Locality

The Woodlands Settlement is located approximately 15km southwest of Kareedouw Town and situated in the Koukamma LM jurisdiction in the Eastern Cape. Access to the Settlement is via the R102 National Road. Figure1-1 indicates the locality of the Woodlands Settlement

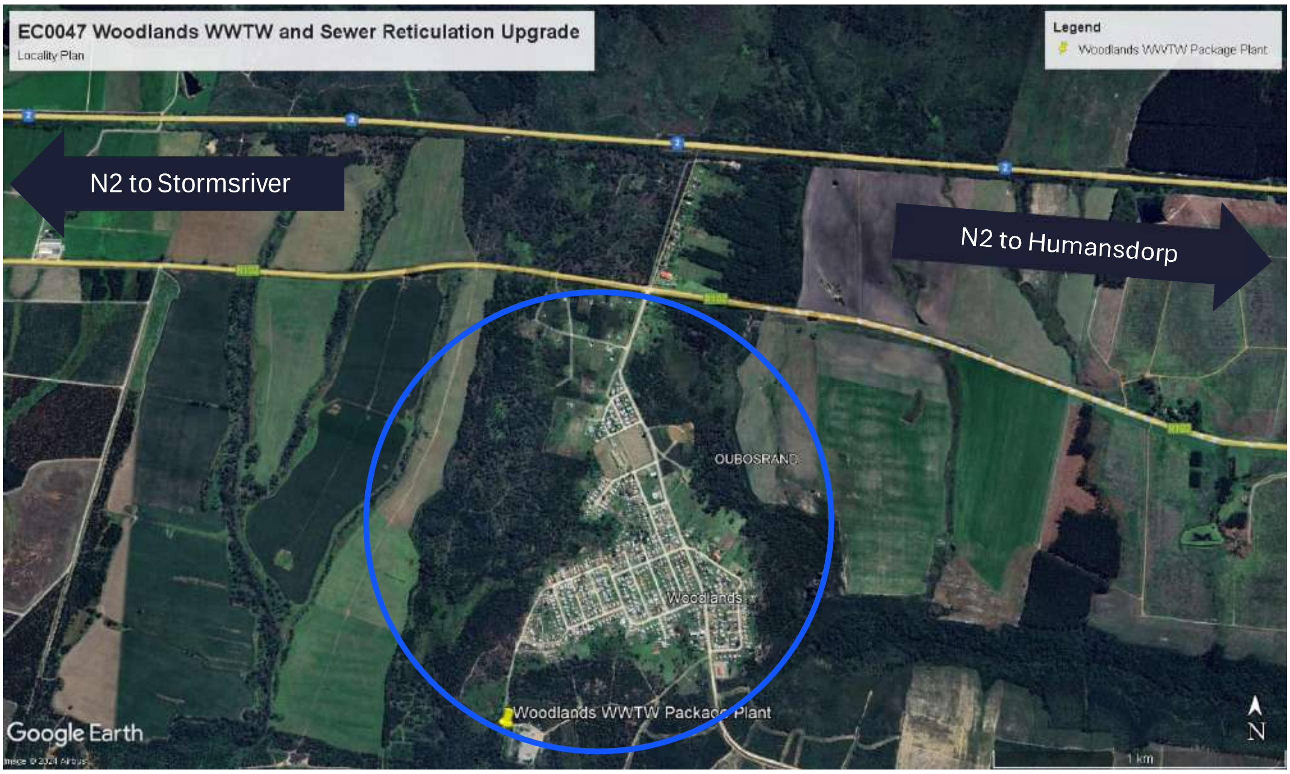


Figure 1-1: Woodlands Locality

1.3 Scope of Services

The scope of civil engineering service includes upgrading the bulk sewer network system and wastewater treatment works to accommodate future housing developments in the town. The following deliverables form part of the scope:

1. Provide Inception Report and preliminary programme (Submitted and approved).
2. Provide updated schedule of required surveys, geotechnical investigations and Occupation Health and Safety requirements, including any other additional investigations required, and conduct a RFQ and appointment process (In progress).
3. Preparation of all reports and submission of all applications that will need to comply with requirements as set out by the Department of Environmental Affairs and Development Planning (DEADP) (In Progress),
4. Concept and viability and Report (This report)
5. Detail Design and Report
6. Documentation & Procurement
7. Contract Administration
8. Construction Monitoring
9. Close-out report

1.4 Limitations and Assumptions

All information provided by the stakeholders, including the Koukamma LM, shall be assumed to be correct and verified by the relevant stakeholder. This includes, but is not limited to:

- GIS Information
- Operational Requirements
- Strategic Plans and future development figures
- Municipal policies or bylaws

The limitations in the designs are as follows:

- Limited Historical flow measurement data at the WWTW
- Water consumption figures not available

1.5 Terms of Reference

The following standard were used for the Preliminary Design:

1. The Neighbourhood Planning and Design Guidelines (2019)
2. Koukamma Municipality Integrated Development Plan 2023/24
3. Koukamma Municipality Spatial Development Framework 2023/24

1.6 Information Received

The following information was requested from the municipality and received on the date noted in the Table 1-1. This historical information informed the proposed network and treatment works design.

Table 1-1 Information Register

Information Received	Date Received
• Future Expansion Plans	10 September 2023
• Koukamma Integrated Development Plan (2023/2024)	13 March 2024
• Environmental Basic Impact Assessment for the Upgrading of Clarkson Sewage Network and WWTW (2019)	26 August 2024
• Tecroveer WWTW As Built Information	16 October 2024
• Site Evaluation Report: Woodlands, Storms River W, Coldstream, Sandrifts WWTW's (June 2012) • Water Use General Authorisation (2017) • Woodlands As-built Sewer Layout (1997) • WWTW Water Quality report (2021) • Woodlands Potable water treatment plant Report (2004) • Kou-Kamma Local Municipality Water Services Development Plan (2022-2023)	25 October 2024

2. Specialist Service Providers

2.1 Engineering & Land Survey

A Land Surveyor will be appointed to survey the proposed sewer bulk main route and the entire Woodlands sewer treatment works. This survey will determine the precise position of erf boundaries, existing services, and ground levels on site.

2.2 Environmental Impact Assessment

Blue Pebble was appointed on the 17th of October 2024 as the Environmental Assessment Practitioners (EAP) on the project. A site evaluation was conducted on the 24th of October 2024. and the following findings were made in terms of Listing Notice 1: GN No R327 of 2014:

- There are Wetlands near the Woodlands Settlement, near the proposed bulk pipeline route
- A Basic Assessment is required, due to the presence of wetlands on site
- Infilling or depositing materials on site more than $10m^3$ or removal/moving soil and other materials within 10 m^3 from a watercourse (wetlands) will require a Maintenance Management Plan
- The expansion of the existing WWTW may result in the requirement for a new permit or licence from the national/provincial legislations regulating the release of emissions, effluent, or pollution

A comprehensive screening report will be issued by the 15th of November 2024. The Environmental Screening Report will determine the necessary environmental applications. The application process will, in turn, affect the critical path of the project programme.

2.3 Geotechnical Engineer

A Geotechnical Engineer will be appointed to determine the ground water levels in the area, as well as the type of soil to be expected in the area.

3. Hydraulic Load

3.1 Demand Calculation Rationale

The hydraulic demand is calculated using the Neighbourhood Planning and Design Guidelines Part K and Part J (2019). This method determines the Average Daily Water Demand (AADD) and allocates a percentage of water use for discharge, known as the Average Daily Dry Weather Flow (ADWF).

Based on a visual site inspection, the area is primarily low-income housing, and the proposed developments will also be low-income housing. The area includes larger plots, possibly small holdings, though none are used for commercial farming. Therefore, they are treated as typical low-income housing.

For unknown proposed business and school footprints, an assumed floor space ratio of 40% was used, as per the Neighbourhood Planning and Design Guidelines (2019) Table K4.

A peak factor is applied to calculate expected peak flow during high-water usage times, typically between 6-8am and 6-8pm. A peak factor of 1.9 is used for all low-income dwellings, and 1.7 for business and institutional facilities (schools and community facilities) as per Table J.9.

After determining the Peak Daily Dry Weather Flow (PDWF), a stormwater ingress factor is applied. The general recommendation is 15%, according to the Human Settlements and Design Guidelines. However, due to the number of small ponds and wetlands along the bulk sewer main, a 20% allowance is made.

For future growth, the proposed developments sufficiently account for sizing the pipes to accommodate future needs.

3.2 Existing Hydraulic Load

There was difficulty in determining drainage zones for the existing developments, this the demands are calculated per type of development and grouped together.

The following assumptions were made when calculating the existing demand:

- All Erven is residential unless specified otherwise on GIS (Google Earth)
- Allowance is made for one Community facility

An estimation of the existing sewage generation is indicated in Table 3-1 below:

Table 3-1 Existing Hydraulic Load

Development Type	Total Units	Average Daily Dry Weather Flow (ADWF) (Kl/day)	Peak Daily Dry Weather Flow (PDWF) (Kl/day)	Peak Wet Weather Flow (PWWF) (Kl/day)
Low-Income housing	381	157.16	345.76	397.44
Small Holdings	31	24.80	54.56	63.07
Community Facilities	1	22.66	31.72	36.29
Educational Facilities	1	51.14	71.59	82.08
	Totals	255.76	503.63	615.17

For a more accurate estimation of the existing sewage generation, it would be best to use flow readings provided by the local Municipality.

Refer to Appendix A for all hydraulic load calculations and design assumptions.

Figure 3-1 indicates the sewer drainage zone pre-development.

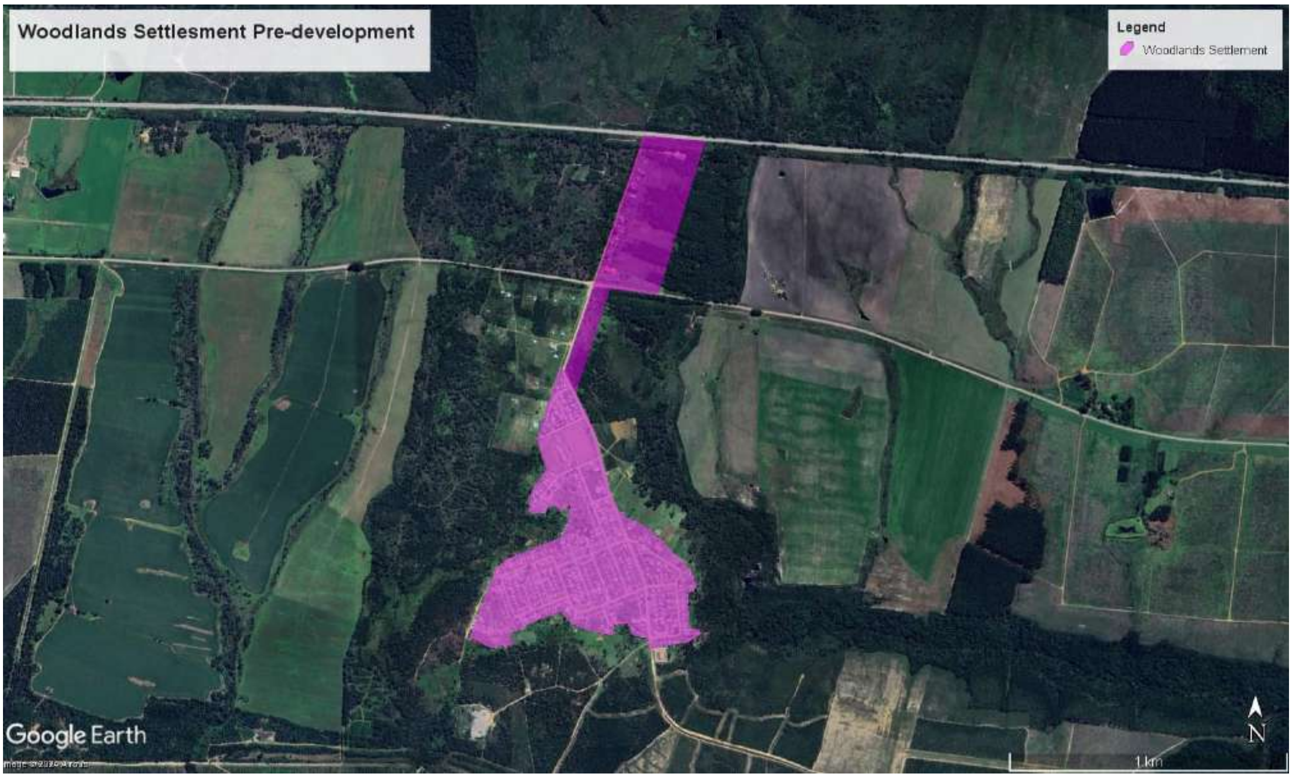


Figure 3-1 Sewerage Drainage zone Pre-Development

3.3 Future Hydraulic Load

Given that the connection points to the Bulk Main are within the designer's control, the entire development has been divided into zones based on their connection points. Please refer to Appendix B for the drainage zone layout and their respective connection points to the Bulk Main.

The future Hydraulic load indicated in Table 3-2 below.

Table 3-2 Future Hydraulic Load

Development Type	Total Units	Average Daily Dry Weather Flow (ADWF) (Kl/day)	Peak Daily Dry Weather Flow (PDWF) (Kl/day)	Peak Wet Weather Flow (PWWF) (Kl/day)
Zone 1				
Low Income Housing	94	35.72	67.87	79.49
Business		2.47	4.20	5.18
Educational Facilities		14.55	24.73	29.38
	Sub-Total	52.74	96.8	114.05
Zone 2				
Low Income Housing	571	216.98	412.83	494.208
Business		4.10	6.97	8.64
Educational Facilities		23.34	39.67	47.52
	Sub-Total	244.42	459.47	550.368
Zone 3				
Low Income Housing	15	8.55	16.25	19.872
	Sub-Total	8.55	16.25	19.872
Zone 4				
Low-Cost Housing	244	109.80	208.62	250.56
Business		0.9	1.53	1.728
Educational Facilities		0.42	0.71	0.864
	Sub-Total	111.12	210.86	253.152
Zone 5				
Low Income Housing	114	43.24	82.16	98.496
Business		1.61	2.74	3.456
Educational Facilities		0.69	1.17	1.728
	Sub-Total	45.24	85.50	102.816
	Total	462.37	869.45	1041.122

The total ADWF is 462.37 Kl/day, the PDWF is 869.45Kl/day and the PWWF is 1041.122 Kl/day.

Refer to Appendix A for all hydraulic load calculations and design assumptions.

Figure 3-2 below indicates the sewer drainage zone post development.

Figure 3-2: Sewer Drainage zone Post Development

4. Existing Sewerage Infrastructure

4.1 Sewer Reticulation

The current sanitation services at Woodlands Settlement consist of digester tanks and a 110 mm diameter small-bore gravity sewer reticulation system. Effluent from the digesters is regularly removed by vacuum tankers and transported to the WWTW at Woodlands Settlement, located 0.5 km south of the southwestern boundary of the Woodlands Settlement.

The effluent undergoes an activated sludge treatment process via a package plant followed by clarification, where the solids and liquids are separated before the final effluent is discharged into a surface watercourse. Sludge is conveyed to a pit near the treatment works for disposal. Once the pit reaches 80% capacity, it is backfilled, and a new pit is created.

The existing small-bore gravity sewer reticulation and digester system has proven problematic, particularly during peak conditions such as the festive season, resulting in overflows. Additionally, the municipality’s limited capacity to clean the digesters has often led to unsanitary conditions within the Woodlands Settlement.

4.2 Bulk Collector Sewer

The existing bulk sewer lines have a diameter of 160 mm and extend to an approximate length of 3.9 km. This bulk main collects effluent from multiple small holdings situated between the R102 and the N2. The bulk main runs along the western boundary of the Woodlands Settlement, efficiently transporting the collected sewage to the existing WWTW located within the Woodlands Settlement for treatment and disposal.

The existing sewer reticulation system is indicated in Figure 4-1 below, the brown line represents the bulk sewer main, and the blue lines represent the internal water reticulation.

Figure 4-1 Existing Sewer Reticulation

4.3 WWTW Package Plant

4.3.1 Process Description

The WWTW is located 0.5km south of the southwestern boundary of the Woodlands Settlement. Effluent then undergoes an activated sludge treatment process followed by a clarification process where the solids-and liquid are separated before the final effluent is discharged into a surface water course. Sludge settlement is conveyed to a pit close to the treatment works where it is then disposed of. As soon as the hole is 80% full it is then backfilled, and a new hole is formed.

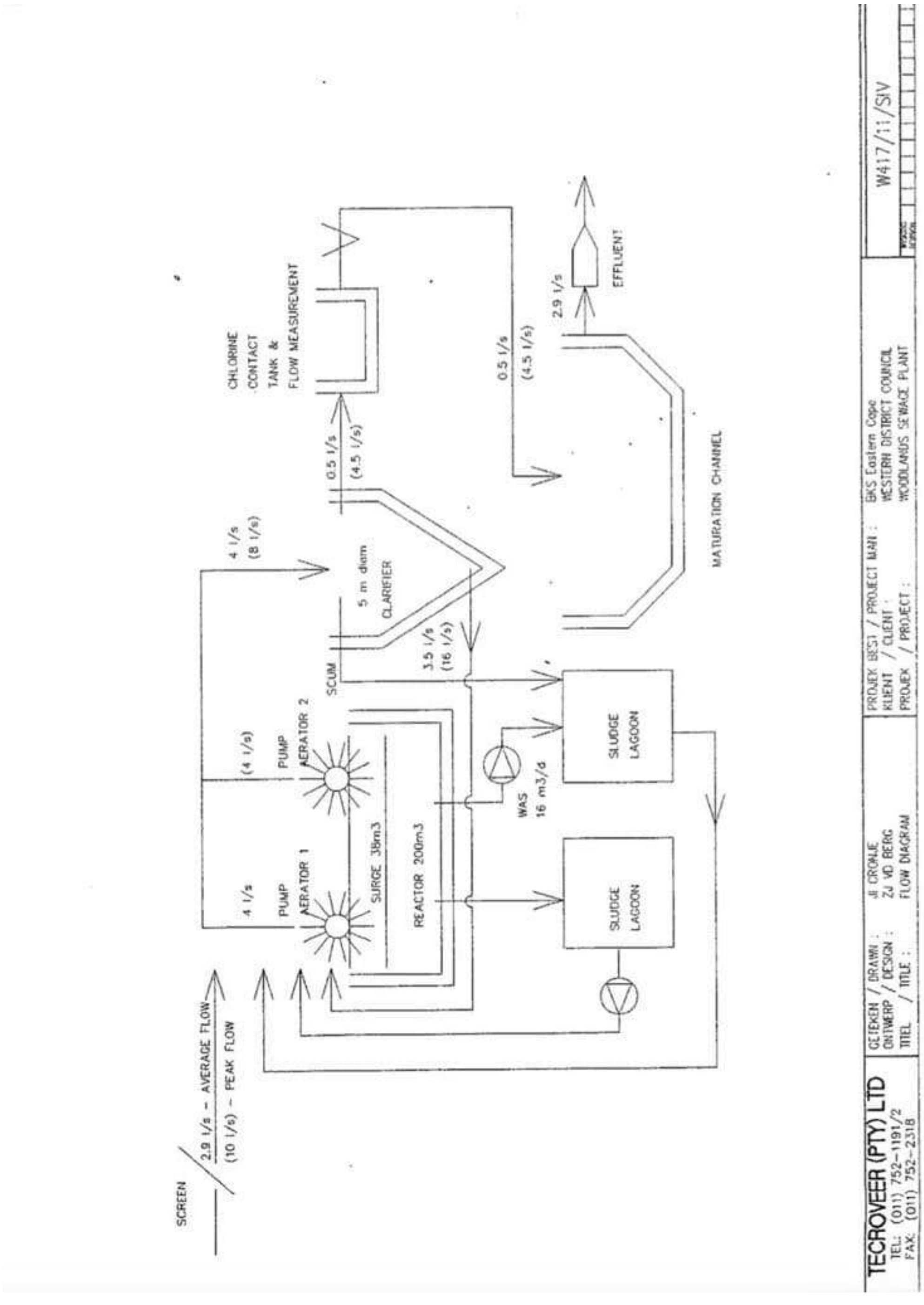


Figure 4-1: Woodlands WWTW Process Flow Diagram

The existing reactor and clarifier details is shown in Figure 4-2 below:

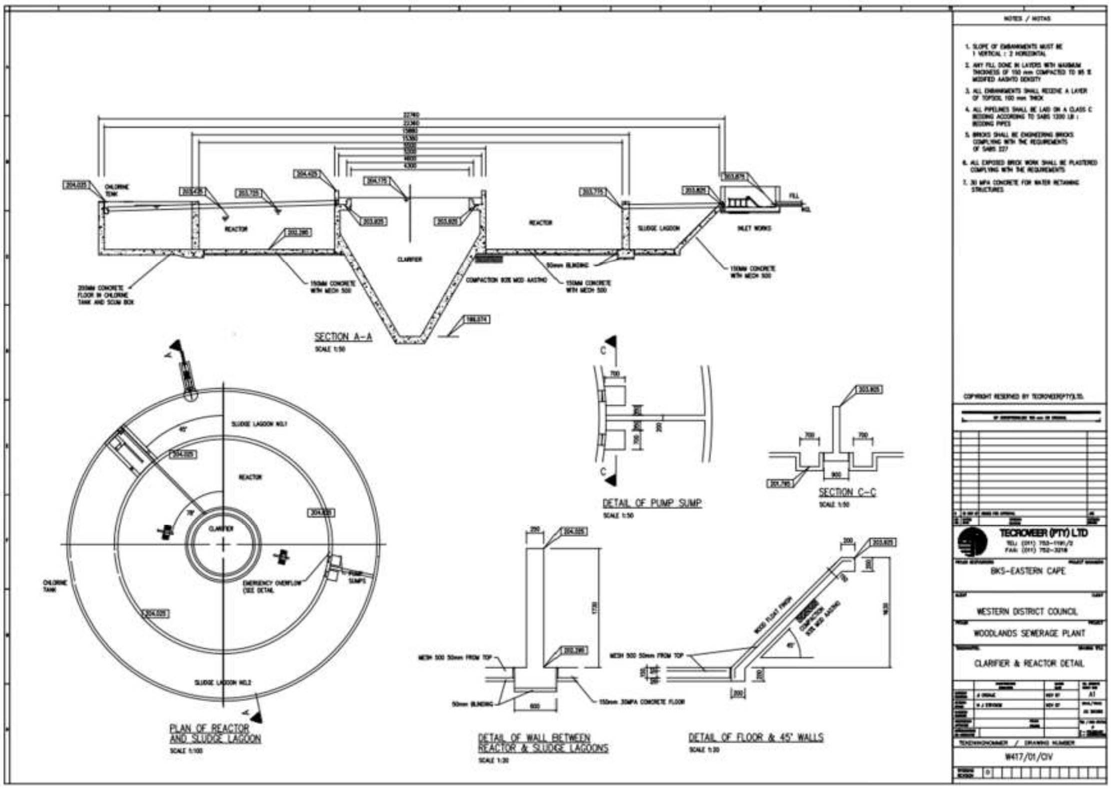


Figure 4-2: Woodlands WWTW Reactor and Clarifier detail

4.3.2 Treatment Capacity

The hydraulic and treatment capacity of the existing treatment plant is 250 kl/d. It must also be noted that the system was designed to take septic tank sludge and not normal domestic wastewater. This was verified with Tecroveer.

4.3.3 Condition

SMEC technical team, Nosipho Bota (client) and Gareth Williams (plant operator) had a meeting on the 26th of August 2024 to inspect the existing wastewater treatment plant and distribution network.

The following findings were made on site during the WWTW inspection:

1. Solid waste (glass, plastic) overflows the existing solid waste management site on the approach road and the plant itself.
2. Stormwater run-off from the solid waste site collects and discharges into the wastewater plant and into the process units.
3. No controlled access or security fencing on the wastewater plant.
4. Small chemical store building dilapidated, and roof and windows vandalised and stolen.
5. Electrical panel and cabling to the plant vandalised and stolen.
6. Plant is not operational for the past 5 years.
7. No operators' facilities (ablution, locker room, lab, storeroom, breakroom)
8. Limited space on the site resulted in the use of a packaged plant as opposed to a simple pond system.

The following process related findings are listed below:

1. No screening facility (due to solids free sewer network being used)
2. Plant has not functioned in the last 5 years.
3. Aerator motors are removed.
4. Method of dosing chlorine is by HTH chips/tablets in the outlet sump.

5. Sludge dams are full.
6. No place to remove and dry sludge. It is reported that sludge is disposed of in a pit nearby and covered once full. Future designs to look at improved sludge management practices.
7. No chlorine contacts tank/designated tank filed with sludge.

Figure A Overgrown Manhole

Figure B Pedestrian Bridge

Figure C Overgrown Sedimentation Tank

Figure D Corroded Motor

Figure E Pedestrian Bridge

Figure F Pedestrian Bridge

Figure G Elevation view of WWTW

Figure H Overgrown Sedimentation Tank

Figure I Elevation view of WWTW

4.3.4 Operations and Maintenance

There are obvious issues with maintenance. The current brush aerator is hard to remove and difficult to replace.

4.3.5 Compliance

The effluent obviously does not comply with General Authorizations as its not operational. Effluent data is shown below for 21 November 2021:

Table 4-1 Effluent data 21 November 2021

LABORATORY ANALYTICAL REPORT

Parameter	Units	Method Reference / Method No	Results
Chemical Oxygen Demand	mg/l O_2	Hach 8000	191
Nitrate	mg/l NO_3	Hach 10206	0.6
Ammonia	mg/l N	Hach 10031	40.0
Nitrite	mg/l N	Hach 10019	0.021
Nitrate/Nitrite	Ratio	Calc.	0.078
Suspended Solids @ 105ºC	mg/l	APHA 2540D	30
E. coli	count/100ml	Idexx Colilert*-18	>2420
Faecal Coliforms	count/100ml	Idexx Colilert*-18	>2420
Orthophosphate	mg/l $PO4^{3-}$	Hach 8048	5.39

4.3.6 Treatment Objectives

The following treatment objectives are identified for the upgraded Woodlands WWTW and is summarised in Table 4-2 below. Additionally, SMEC identified proposed processes and technologies to be considered for the plant to meet the objectives.

Table 4-2 : Treatment Objectives compared to Woodlands availability

Treatment Objectives	Process Available	Comments
Screening	No	
Degritting	No	
Peak Flow Balancing / Overflow storage and return	Reactor capacity available for surge	Undersized for future flow/stormwater flow
Storm water accommodation	No	
Biological treatment	Yes	Undersized for future flow
Clarification	Yes	Undersized for future flow
Disinfection	No	Abandoned building, but no contact tank is used for sludge. It is understood HTH was dosed before
Sludge Management	No	Only holding tank available
Fencing, security access and Process Controller Facilities	No	Urgently needed

4.3.7 Conclusion

It is proposed to abandon refurbishing the existing plan t for the following reasons:

1. The existing plant only has an ADWF capacity of 250kl/d, as opposed to the future need of 500kl/d
2. The plant was designed to treat septic tank sludge and not waterborne domestic sewage
3. There is no Inlet works, thus no screening, degritting or flow measurement as legislated by DWS
4. There is no inlet for “honey suckers” as is required by Client
5. There is no chlorine contact tank
6. There is no sludge management system

5. Proposed Sewerage Infrastructure

5.1 Sewer Reticulation

The current digester tank system will be discontinued due to inefficiency during peak conditions. All internal reticulation pipes will be replaced with 160mm diameter class 34 uPVC pipes. The new system will operate as a gravity sewer, directing all pipes towards the settlements lower points. The 160mm diameter pipes are chosen for their sufficient capacity and ability to accommodate flow despite infrequent maintenance and potential blockages from fats, oils, or debris. Manholes should be placed every 60m, at pipe bends and all terminal pipe connections.

5.2 Bulk Sewer Collector

The current Bulk Sewer Main runs adjacent to the boundary of the Woodlands Development. Future development will place dwelling units over the pipe route, complicating maintenance and potentially causing unsanitary conditions if a pipe bursts.

To mitigate these issues, the Bulk Main sewer should be rerouted to run alongside the new developments and within the road reserves. The existing bulk mains will be removed where they intersect future developments. A 160mm diameter pipe, operating at 80% capacity, is sufficient for the development. To accommodate more than the anticipated 20% stormwater ingress, the pipe size will increase to a 200mm diameter class 34 uPVC pipe for the final 900 meters, connecting to the WWTW. Manholes should be placed every 80m, at pipe bends and all pipe connections.

5.3 Wastewater Treatment works

5.3.1 Wastewater Treatment Plant Design Objectives

Design Capacity

- The plant shall be designed for waterborne domestic sewage for the following flows: ADWF – 500kl/d, PDWF – 800kl/d, PWWF – 1000kl/d.
- There is an additional requirement for receiving sewage from “honey suckers”

Design Influent Water Quality

As the current inflow is septic tank sludge, sampling will not be an indicator of the raw water characteristics. The influent to the proposed will comprises domestic. Table 5-1 below indicates the strength of municipal and minor industrial wastewater of various parameters.

Table 5-1 Typical composition of influent municipal wastewater with minor contributions of industrial wastewater in (mg/l) (Chen et al, 2020)

Parameter	Low	Medium	High
COD total	500	750	1200
COD soluble	200	300	480
COD suspended	300	450	720
BOD	230	350	560
VFAs (as acetate)	10	30	80
TKN	30	60	100
Ammonia -N	20	45	75
Nitrate + Nitrite -N	0.1	0.2	0.5
Organic N	10	15	25
P total	6	15	25
Ortho-P	4	10	15
Organic P	2	5	10
Sulphate	24	36	72
TSS	250	400	600
VSS	200	320	480

The influent wastewater from households is expected to primarily consist of domestic sewage, containing a mixture of water, organic, and inorganic substances, both dissolved and suspended. Organic substances will include carbohydrates, proteins, fats, soap, detergents, and their decomposition products. The strength of sewage, whether high or low, can indicate patterns of water consumption: high strength may suggest low water usage for consumption, while low strength may indicate higher water consumption and potential dilution from stormwater infiltration. High sewage strength is often associated with low-income groups, whereas low sewage strength is characteristic of high-income groups.

Compared to the typical sewage strength, the sewage entering Woodlands WWTW is expected to be medium sewage strength. The proposed raw wastewater characteristics to be used is shown in Table 5-2 below.

Table 5-2 Typical raw wastewater quality data percentiles

Parameter	Units	Assumed Influent wastewater
COD	mg/l	750
TKN	mg/l	60
TP	mg/l	15
pH		7.0 le

Design Effluent Water Quality

In accordance with the National Water Act 1998 (Act No 36 of 1998), all wastewater treatment works being operated in South Africa are required to have a valid water use license which sets out the allowable quantity and quality of the effluent that can be discharged. The Woodlands WWTW currently has a valid General Authorization in place dated 28 September 2017. The GA (Ref 27/2/2/K480/7/8) allows a volume of 1772.8 m³/annum into the Groot River.

The applicable General Limits therefore are:

- pH between 5.5 - 9.5
- EC 5mS/m above intake of 150mS/m
- Chemical Oxygen Demand ≤ 75 mg/l
- Nitrate as N ≤ 15 mg/l
- Ortho phosphate as P ≤ 10 mg/l
- Total ammonia as N ≤ 6 mg/l
- Suspended Solids ≤ 25 mg/l
- Faecal coliforms 1 000 cfu/100 ml
- *E.coli* 1 000 cfu/100 ml

5.3.2 Proposed Wastewater Treatment Solution

5.3.2.1 Option 1 - Oxidation Ponds

Oxidation ponds, also called lagoons or stabilization ponds, are large, shallow ponds designed to treat wastewater through the interaction of sunlight, bacteria, and algae. Algae grow using energy from the sun and carbon dioxide and inorganic compounds released by bacteria in water. During the process of photosynthesis, the algae release oxygen needed by aerobic bacteria. Mechanical aerators are sometimes installed to supply yet more oxygen, thereby reducing the required size of the pond. Sludge deposits in the pond must eventually be removed by dredging. Algae remaining in the pond effluent can be removed by filtration or by a combination of chemical treatment and settling.

For purposes of the Woodlands WWTW, the utilization of ponds to treat sewerage can be considered if more land can be made available.

Figure 5-1 Oxidation Pond process configuration

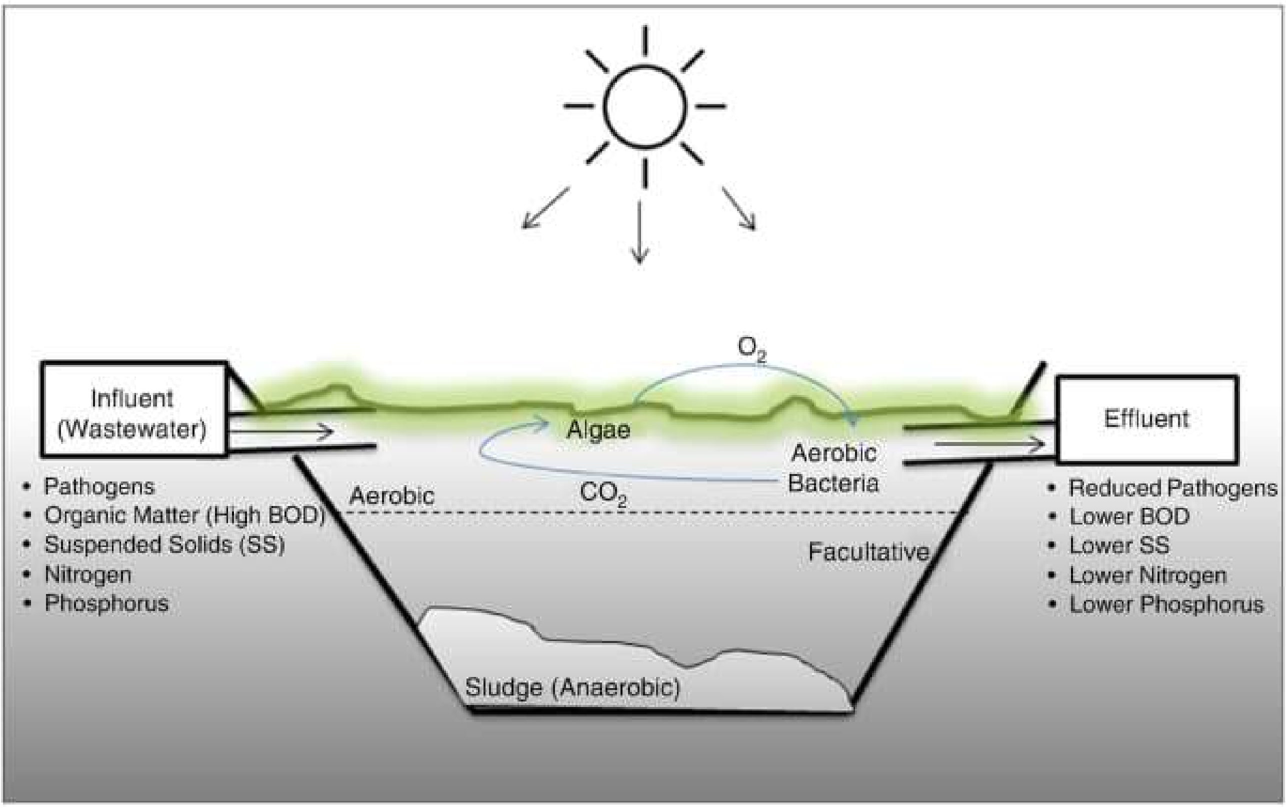


Figure 5-2 Typical layout for oxidation ponds

5.3.2.2 Option 2 – Rotating Biological Contactors

In this treatment system a series of large plastic disks mounted on a horizontal shaft are partially submerged in primary effluent. As the shaft rotates, the disks are exposed alternately to air and wastewater, allowing a layer of bacteria to grow on the disks and to metabolize the organics in the wastewater.

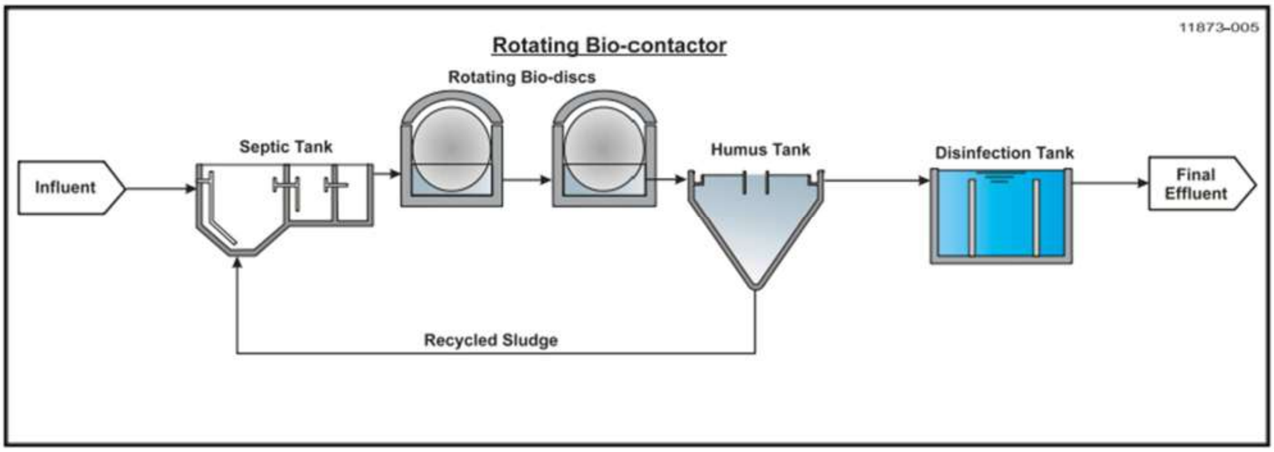


Figure 5-3 Typical rotating bio-contactor process configuration

Figure 5-4 Typical layout for RBC

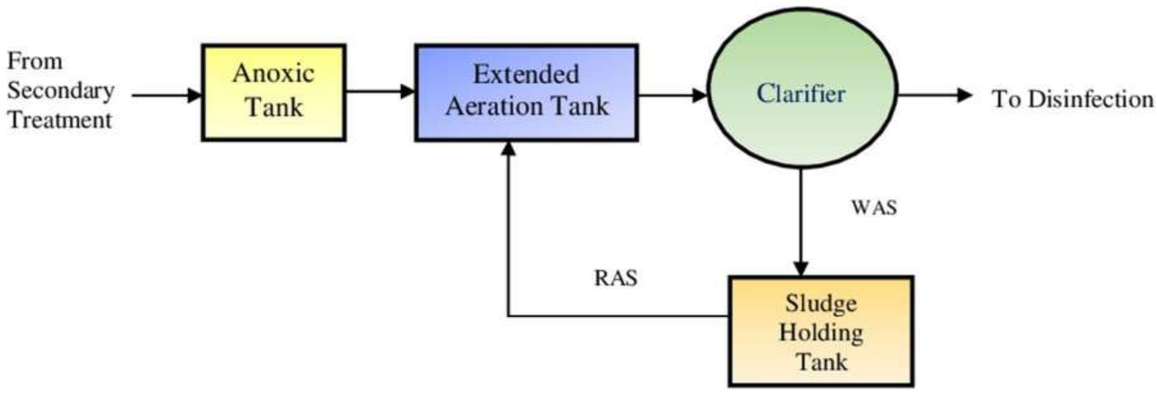
5.3.2.3 Option 3 - Extended Aeration Activated Sludge

Extended aeration means that the raw sewage only undergoes screening and grit removal and is then aerated in an extended aeration plant without any primary sedimentation. Extended aeration is the simplest form of activated sludge and, if using robust aeration equipment; it provides a simple and reliable treatment option. It is capable, due to long sludge ages and long hydraulic retention times, to accommodate shock loads better than conventional activated sludge with its shorter sludge age and hydraulic retention time. The long sludge age also offers the benefit that the sludge can dry on sludge drying beds without additional sludge treatment such as anaerobic digestion.

It is also not uncommon that waste activated sludge is taken to sludge lagoons for further stabilisation due to natural fermentation and then the sludge is pumped from the lagoons to drying beds in an even more stable form which would be less prone to odour problems.
SMEC recommends that biological denitrification should form part of any form of activated sludge. The process offers the following benefits:

- The denitrification process increases and reinstates the alkalinity consumed and is destroyed during the nitrification process. This released alkalinity ensures the effluent becomes less aggressive/corrosive.
- The process reduces the energy required for treatment significantly as part of the COD would degrade through the chemical oxygen created in the nitrification process. Nitrification is the conversion of ammonia NH_4 to nitrate NO_3, and by recycling the NO_3 rich mixed liquor to an anoxic zone where no air is introduced, the bacteria are forced to utilise the O_2 bound in the NO_3 molecule for metabolic action, and in the process, N_2 gas forms for release to the atmosphere, as 80 % nitrogen.
- The biological denitrification process in a WWTW is a simple process, and it renders the effluent suitable for downstream reuse as potable water. If the effluent is not void of nitrate, it would require removal at the downstream water treatment works before using it as potable water. Potable water must have > 9.0 mg/ℓ nitrate to be safe for use, especially by infants. Processes to remove nitrate at a water treatment works are expensive and complex and involves ion exchange, reverse osmosis or adsorption processes all of which are expensive and complex. It is thus the opinion of SMEC that maximum denitrification in an activated sludge plant should be encouraged.

A typical process flow diagram for an Extended Aeration System (EA) is shown as below:



Extended Aeration System (EA)

Figure 5-5 Typical extended aeration process configuration (Onevproject.com, 2016)

5.3.3 Plant Design

During the design phase, careful consideration will be given to safety, leak and damage prevention, government regulations and environmental concerns. As far as reasonably practicable, interruption to the operations of the existing works will be avoided with minimal downtime for the cross-connection between the existing and new works.

5.3.3.1 Head of Works

The new inlet works will be designed with coarse screening (for the removal of rags, paper and large debris) and degritting channels (for the removal of sand and grit). The head of works will be provided with a means of flow measurement as required by the Department of Water and Sanitation.

The screens must be able to screen initial minimum hourly flows as well as expected PWWF for the design capacity of the Works. The head of works will include:

- A tanker dumping area
- 1x 10mm coarse mechanical screen
- 2x degritting channels.

The flow will be measured in a Parshall flow flume and an ultra-sonic level sensor. A simple mathematical equation will be used to convert the level measurements to flow data which records the total influent flow to the plant. This

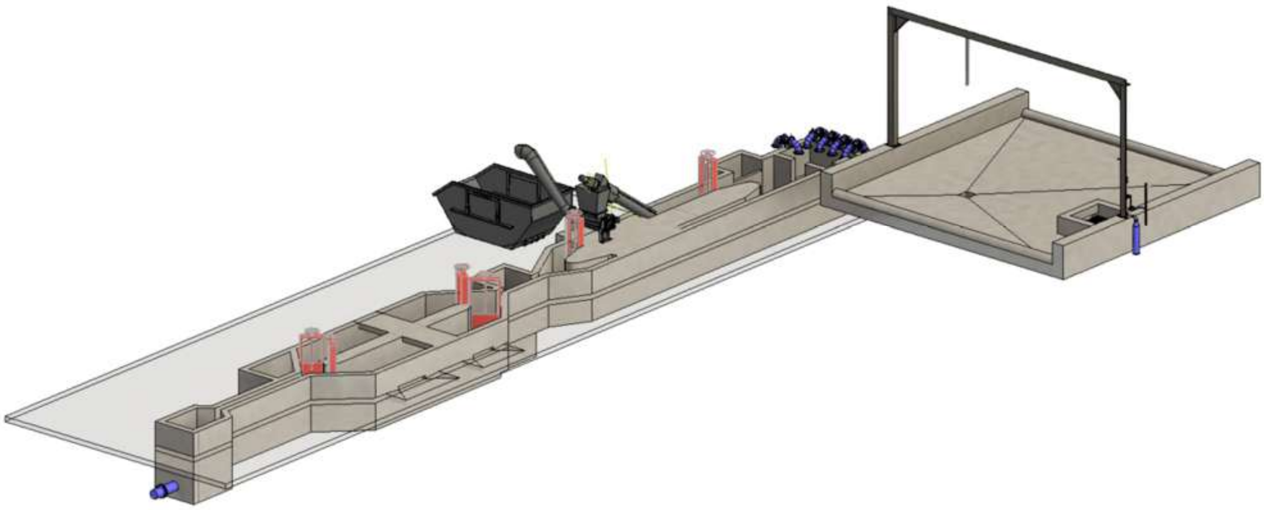


Figure 5-6 Head of Works

Option 2 – Rotating Biological Contactor

A high-level configuration and more detailed overview of the proposed proses is shown in the figures below:

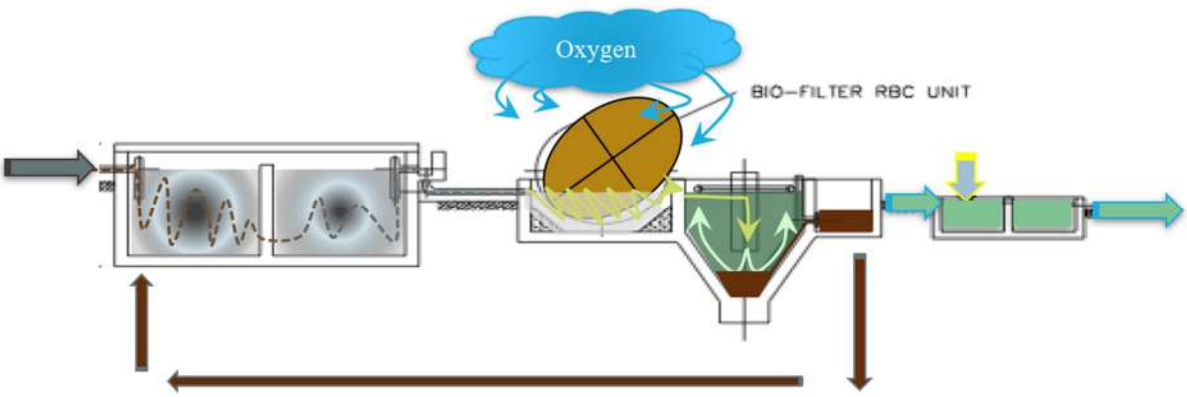


Figure 5-7 High level RBC proses

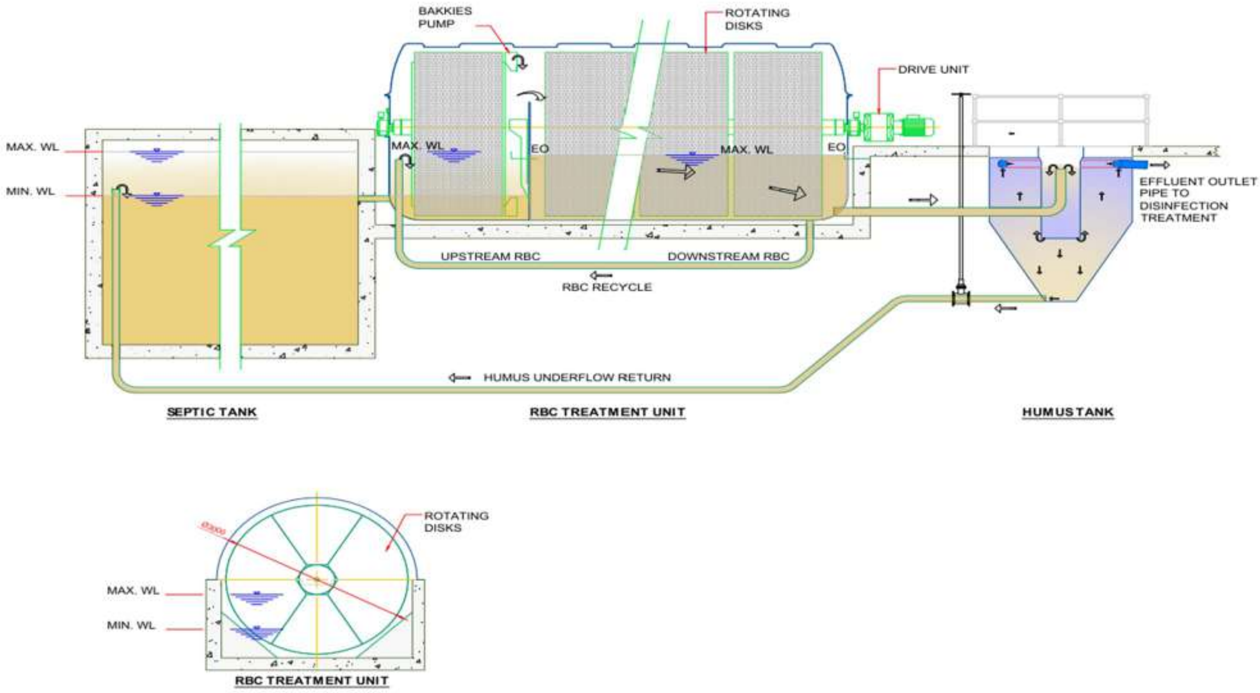


Figure 5-8 Head of Works

Primary Phase Separation

The septic tank allows for the gross removal of organic material by settlement and anaerobic oxidation. The septic tank makes provision for the accumulation of this material and has design features incorporated to ensure that this activity does not cause unnecessary blockages across the tank.

All septic tanks do require servicing and desludging at some stage since the rate of sludge accumulation exceeds the slow growth rate of the anaerobic bacteria and hence their capacity to break down organic material.

The settled sewage from the septic tank is then discharged under gravity to the RBC stage where further organic reduction and ammonia nitrification is achieved under aerobic conditions. The aerobic conditions are achieved by the rotation of the discs, on which the micro-organisms are attached and growing, at a low speed of approximately 3 to 4 RPM. The discs are 3m in diameter and 5m long with 6151m2 EBA. End bearings are provided to secure the unit to the RBC basin. The energy requirement per rotor is 2.25kW.

A secondary settling tank, or humus tank, is required for the collection and removal of surplus bacteria that is removed from the discs by the rotating action of the discs in and out of the water. The Becon Watertech design utilises the standard Dortmund type tank for this application. The collected humus is returned to the septic tank for anaerobic digestion, eliminating the need for sludge drying beds on site. A desludge pump is provided for this purpose.

Since pathogenic bacteria are not removed by the micro-organism population generated in any sewage treatment process by any adequate degree, a tertiary disinfection stage is typically deployed to eliminate the potentially disease forming bacteria. Provision has been made for disinfection (sodium hypochlorite dosage recommended).

Option 3 – Extended Aeration Activated Sludge

Balancing Tank

The common use of a balancing tank within the process train at a wastewater facility is to attenuate daily peak flow rates through the works. This will ensure that only the Average Dry Weather Flow needs to be catered for in the Biological Reactor Unit, which will reduce capital expenditure. This will ensure a constant food source for the BNR, thereby also ensuring a constant organic and hydraulic load on downstream unit processes.

Two tanks are proposed for maintenance purposes. Each tank, with a proposed volume of 150 m³, will be equipped with one 4 kW platform-mounted mixers to keep suspended solids in suspension and prevent settling.

Additionally, a bypass weir and spilling well will be connected to a storm flow retention pond to contain any sewage during emergencies, such as maintenance or flood events.

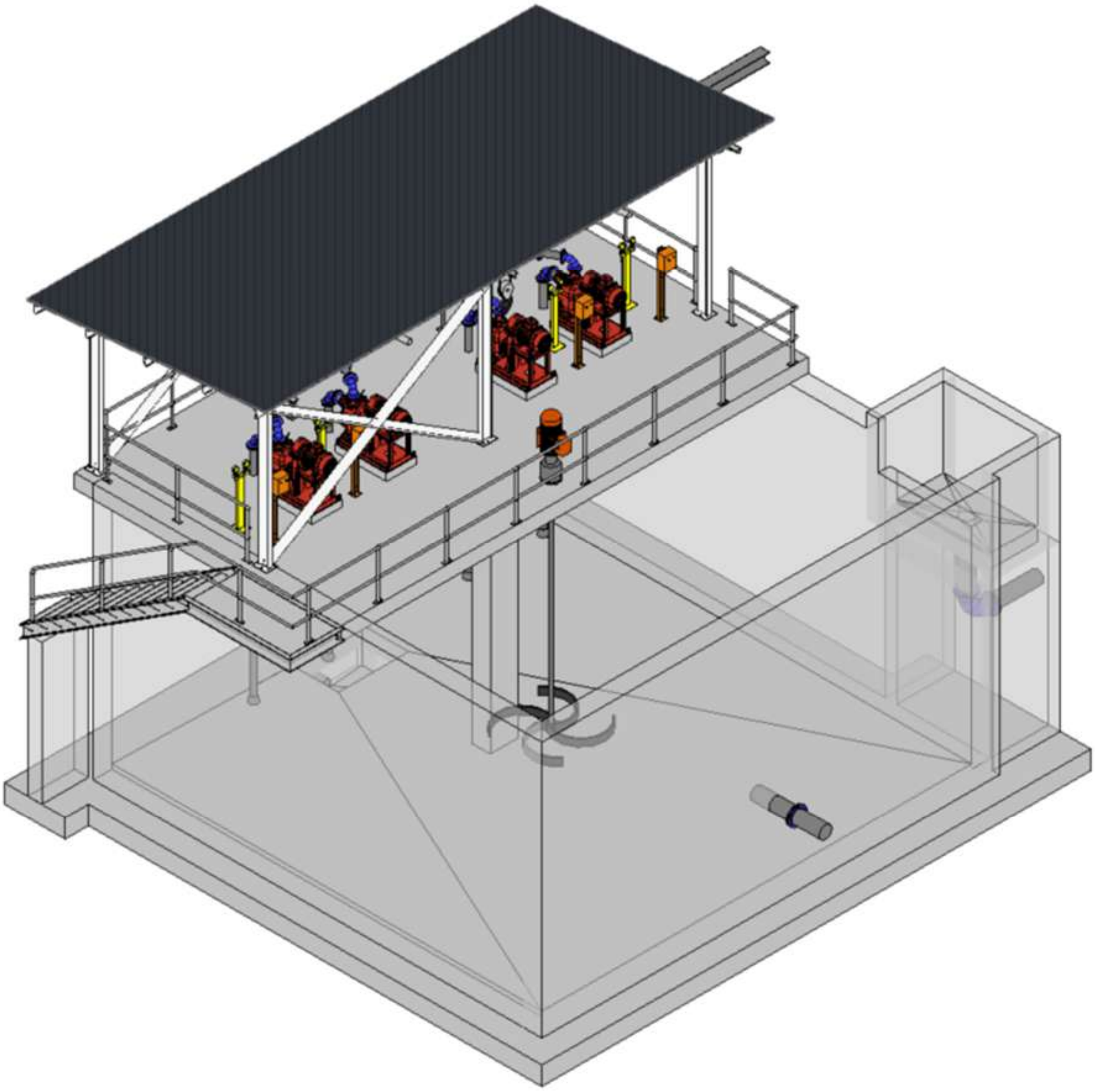


Figure 5-9 Balancing Tank

5.3.3.2 Biological Reactor Unit

The expected temperature for winter is 13ºC and for summer 23ºC. These temperatures are important for ensuring the effectiveness of microbial cell growth and effectiveness in the biological treatment process. The intended mixed liquor suspended solids (MLSS) for winter to be 4500 mg/ℓ and 3500 mg/ℓ for summer. The plant will be able to operate in 3-stage Phoredox process mode.
There will be one biological nutrient reactor comprising the anaerobic, anoxic, and aerobic zones.

The Anaerobic Zones

The function of this zone is to remove the phosphorous from the sewage using the bacteria in the activated sludge passing through the zone and preconditioned to take in excess phosphate.
The anaerobic zone receives the following streams:

- Balanced flow from the balancing tank,
- The return activated sludge (RAS or s-Recycle) from the SST's, when operated in the 3 Stage Phoredox process configuration. The recycle rate may vary between 0.75 x ADWF and 1.5 x ADWF, and

- The zone will have a volume of ±64 m^3 and will be fitted with one 4kW vertical shaft mixers to facilitate mixing of the mixed liquor.

Anoxic Zone

This zone is the main denitrification reactor in the process. The main anoxic zone receives the following streams:

- Mixed liquor from the anaerobic zone
- The a-recycle flow from the aerobic zone, when operated in the conventional 3 Stage Phoredox process configurations. This recycle is abstracted from the end of the aerobic zones and the flow rate can be adjusted in accordance with the nitrate concentration in the effluent up to a maximum of 6 x ADWF with three axial flow pumps operational (3 duty, 1 standby).
- This zone will be fitted with 1 x 4kW vertical shaft mixers to facilitate the agitation of the mixed liquor. The compartment will have a volume of ± 84 m^3.

The a-Recycle rate will be adjustable by running a different number of pumps. Flow will be extracted from the aerobic zone into a suitably sized canal fitted with a flow-measuring flume and separate discharge points depending on the treatment process selection.

Allowance will be made to abstract mixed liquor from the anoxic zone (for the r-Recycle stream) at two different locations within the zone according to the process configuration chosen by means of a single axial flow pump, fitted with a variable speed drive (VSD).

The Aerobic Zone

The function of this zone is to oxidise the organic matter in the sewage, to oxidise ammonia to nitrate. It employs air from environment to provide aeration for oxidation of ammonia process called nitrification. The aerobic zone receives flow from the main anoxic zone. This zone will have a total volume of approximately ± 275 m^3.

The aeration capacity is based on oxygen transfer rates under standard conditions and adjusted for site conditions. A drop between the un-aerated and aerated zones is required to prevent back mixing. If these two zones are at the same level, aeration from the aerobic zone can flow back towards the anoxic zone which needs to be prevented.

Wasted Activated Sludge (WAS) will be wasted from both the end of the aerobic zone of the biological nutrient reactor and from the sludge return flow stream. The significance of wasting sludge is to remove excess and dead microorganisms from the process to keep the biological system in balance.

Surface Aeration

The surface aeration provides air (contains oxygen) into the mixed liquor in the aerobic zone to ensure sufficient dissolved oxygen (DO) content is maintained. It oxidizes the organic matter, reduces the concentration odour, and taste caused by substances such as hydrogen sulphide and other various organic compounds.

Air will be introduced into the mixed liquor by means a surface aerator with a total energy input of approximately 22 kW.

Low dissolved oxygen concentrations have been noted more than any other cause for the production of MLSS with poor settling characteristics into what is known as bulking sludge, which defines a condition in the activated sludge clarifier that can cause high effluent suspended solids and poor treatment performance. The mechanical aeration equipment has therefore been sized to maintain a dissolved oxygen concentration of 2 mg/l in the aeration basin as higher values will constitute a wastage of energy.

The surface aerator will be equipped with timers that will switch the units on and off based on the DO levels in the reactor. In addition, an adjustable tilting weir will be provided at the outlet to control the immersion and therefore the power drawn by the aerators. The weir will be equipped with an actuator that receives a signal from one or more Dissolved Oxygen (DO) meters indicating the required oxygen demand.

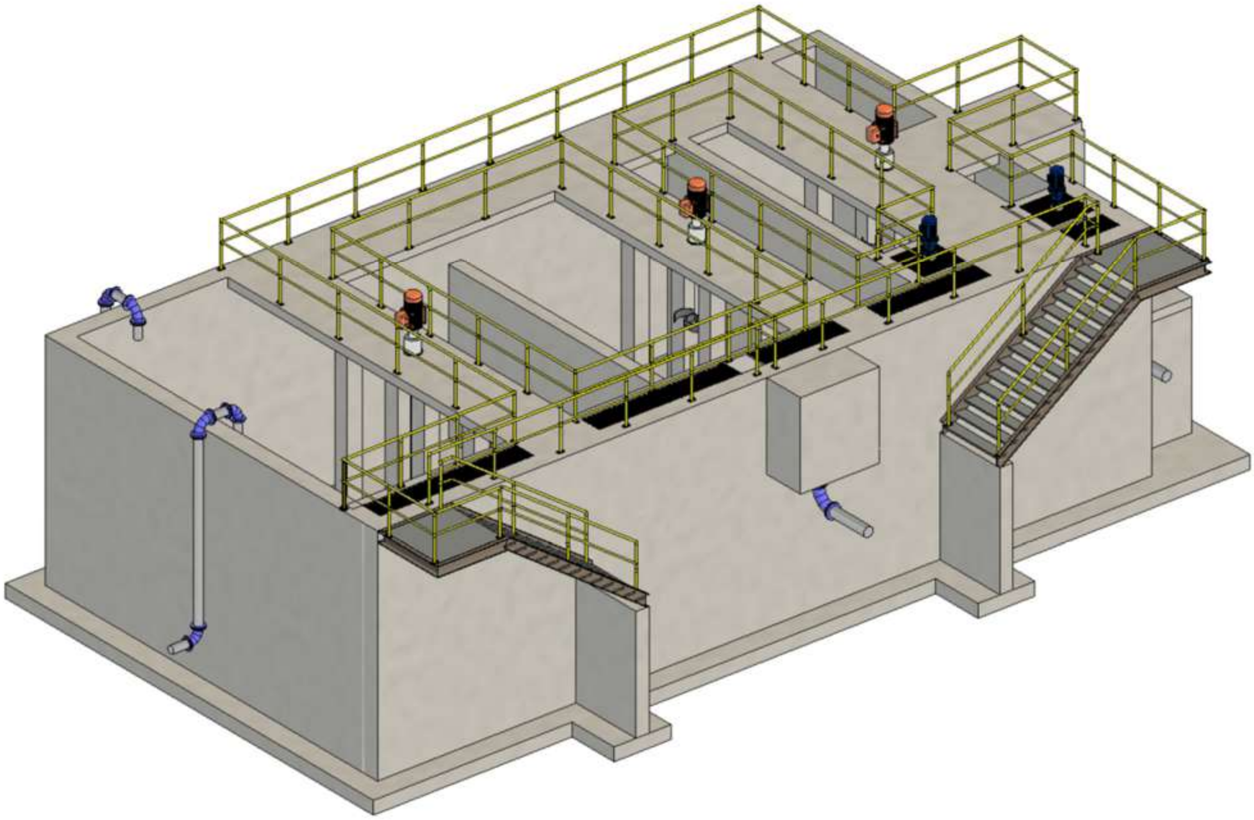


Figure 5-10 Biological Nutrient Removal

5.3.3.3 Clarifier

Clarification is the process of separating solids by settling of activated sludge to produce clear effluent for downstream processes. There will be one 6m diameter clarifier with a 3m side wall depth will be provided to separate the return-activated sludge (RAS) from the effluent. An upward velocity of 0.7 m/h will be maintained peaking at 0.8 m/h. Flux loading in summer can be expected to be 50 kg TS/m^2/day and 65kg/m^2/day in winter.
The tanks will be designed with sloping floors and sludge will be scraped towards a central sludge collecting hopper with a logarithmic spiral-type scraper assembly suspended from a peripherally driven bridge. Sludge will be withdrawn to the sludge pump station, either by telescopic bellmouths discharging into a sump or alternatively the sludge lines will be directly coupled to the pumps. The typical return-activated sludge concentration will be 0.6 to 1.5% peaking at 2.0 to 3.0%.

The treated effluent will flow over V-notch weirs into a peripheral launder. It will then be collected in a common effluent channel which gravitates to the chlorine contact tank. At the end of the channel, the flow is measured in a venturi flume. Figure 56 depicts the Secondary Settling Tank model developed using a 3D Revit.

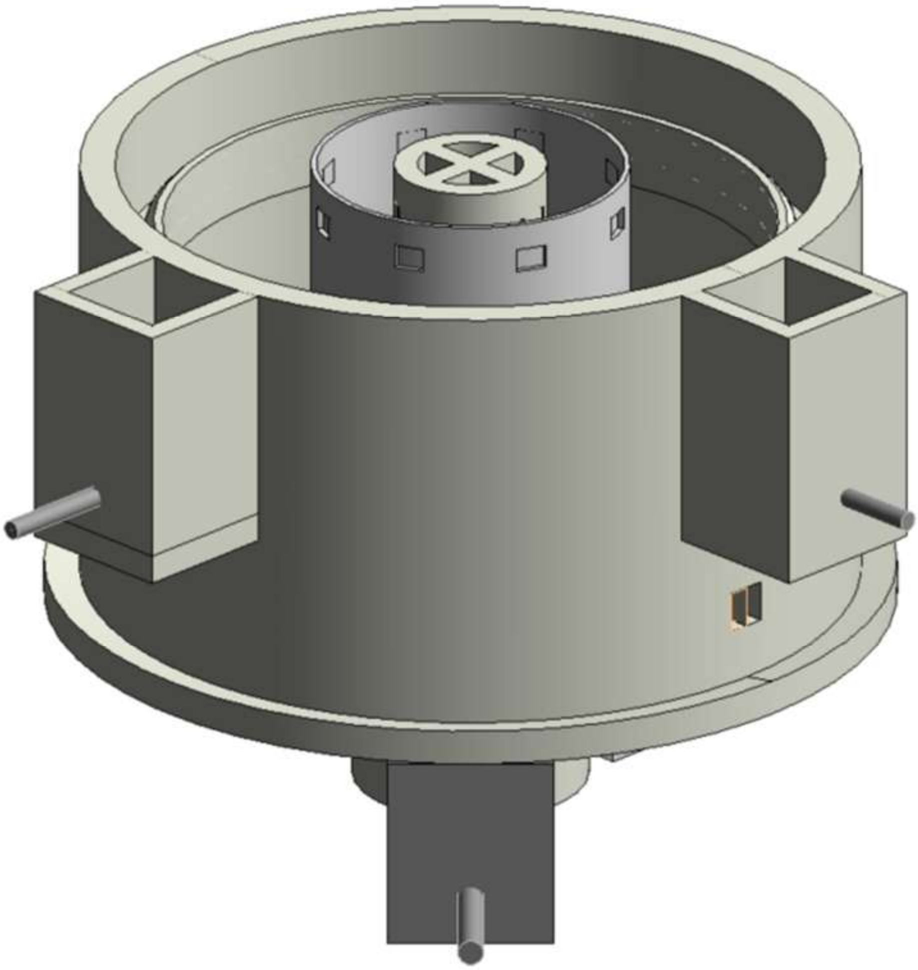


Figure 5-11 Clarifier

5.3.3.4 Chlorination

The process of reducing pathogenic microorganisms in wastewater to mitigate potential health risks by using physical or chemical methods is called disinfection. Chlorine disinfection was employed to ensure the removal of pathogens in the effluent from the clarifier. There will be two chlorine contact tanks for the new Woodlands WWTW and each train of treatment will have its chlorine contact tank.
The effluent from the clarifiers is collected in a common sump and then distributed into a 13m³ chlorine contact tank. Chlorine will be dosed at the inlet weir or in the pipe upstream of the inlet to the chlorine contact tanks. The chlorine contact tank provides 20-30 minutes of contact time at PWWF. An auto-flow metering system will be installed to ensure that a chlorine dosing rate of 5mg/l is maintained.

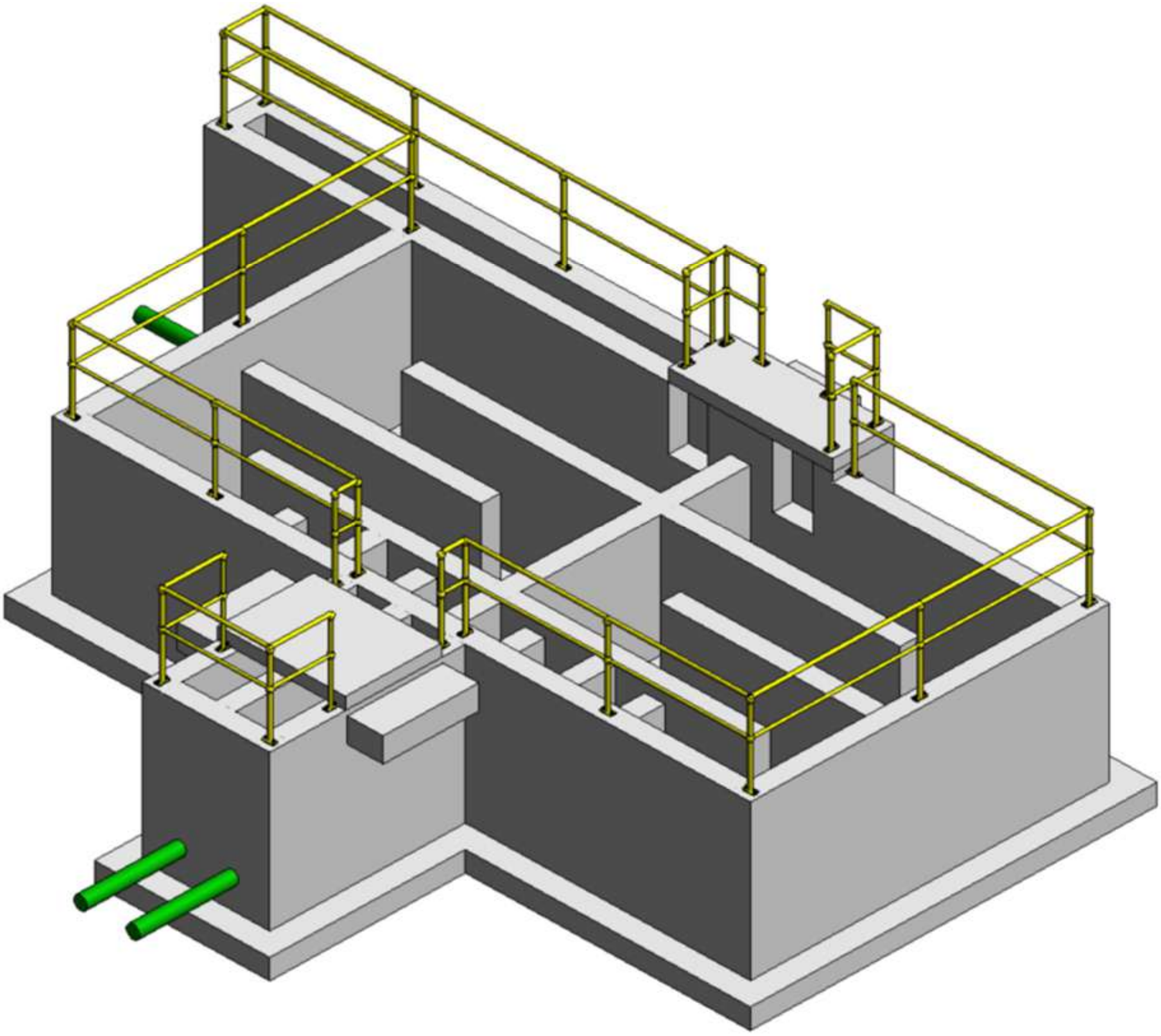


Figure 5-12 Chlorine Contact Tank

5.3.3.5 Storm Water Management

There currently is currently no Stormwater Management. A stormwater dam whereby the excess flow overflows at the Inlet works and gravitates to a stormwater dam is recommended. After the storm event the contents can be pumped back to the inlet works at a slow rate to ensure the microorganisms are not washed out. However, the available land needs to be investigate to make this feasible.

5.3.3.6 Sludge Management System

There are several alternative processes and emerging technologies that can be used to thicken and stabilize the sludge generated by the liquid treatment process. Improvements in sludge quality and cost savings can be expected with some pre-treatment and process upgrades. Several post-stabilization processes can broaden the range of potential recycle/reuse options.

Alternative sludge treatment processes can be classified into four categories:

- Sludge Thickening
- Sludge Stabilization
- Sludge Dewatering
- Sludge Storage

These sludge processing alternatives are illustrated in Figure 58.

Sludge Thickening

Sludge Thickening/Dewatering

Sludge thickening normally refers to the process of reducing the free water content of sludges, whereas dewatering refers to the reduction of floc-bound and capillary water content of sludges. These processes' purpose is to remove water from the activated sludge. The sludge feed content is about 1 to 3 % of solids, which needs to be increased prior to its disposal due to its difficulty in handling and transportation since its watery.

The method employed to remove solids and liquids includes filtration and sedimentation. Regardless of the type of sludge, the concentration of the thickened solids should be high enough to promote effective digestion, but not too thick to adversely affect the pumping and mixing of the sludge in the digester. In smaller plants, thickening is achieved in the primary settling/sedimentation tank or in the sludge digestion unit. In larger plants, there may be a separate thickener, e.g. gravity and dissolved air flotation thickeners.

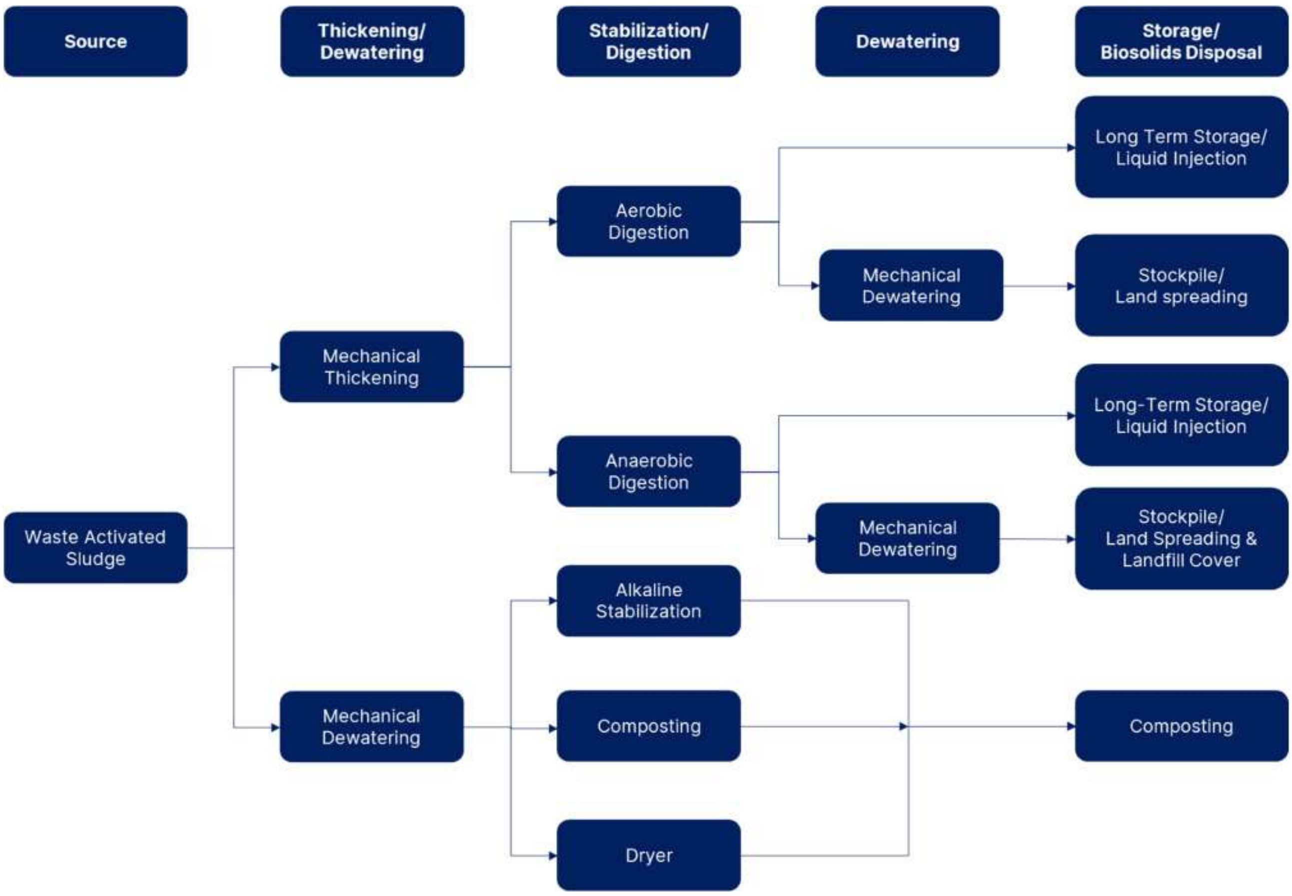


Figure 5-13 Waste Activated Sludge (WAS) processing alternatives

Figure 5-14 below illustrates the sludge holding tank as the detention facility to be used prior sludge treatment.

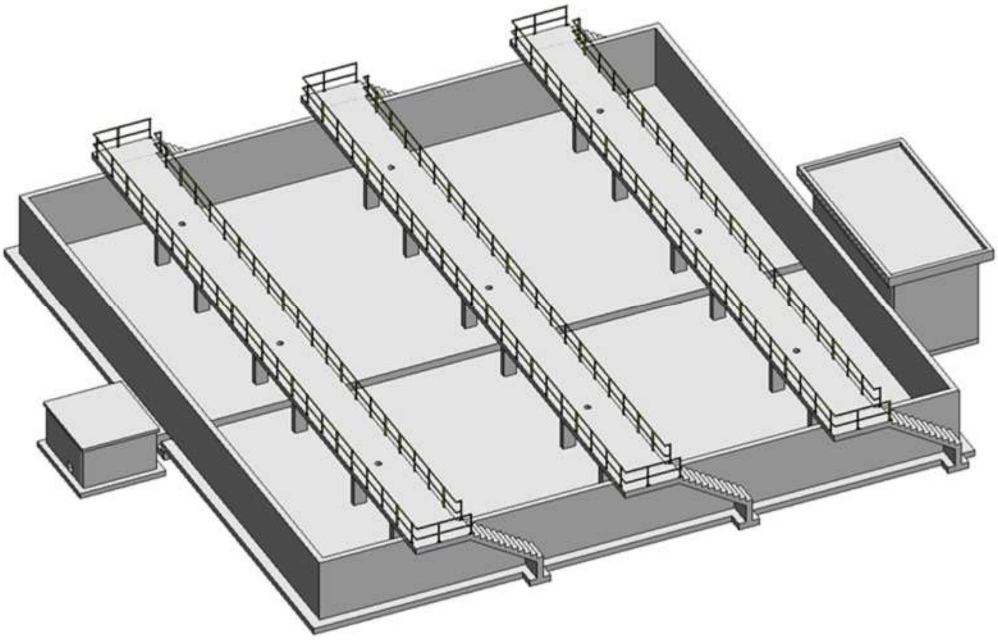


Figure 5-14 Sludge holding tank.

Rotary Drum Thickener

A rotary drum thickener (RDT) consists of a rotating drum and an external variable speed drive. A cylindrical screen inside the rotating drum captures solids as it rotates, allowing water to pass through the screen. An auger located inside the screen transports the remaining solids from the feed end of the drum to the outlet. Like other thickening processes, polymer addition is required to increase the solids capture rate and is added upstream of the drum in a flocculation tank.

RDTs generally can handle moderate variations in flow and sludge consistency without adjustments to the drum or flocculator speeds. Washwater is required to periodically clean the drum to improve thickening. RDTs have a small footprint, low horsepower, and few moving parts. The RDT is a slow-moving thickening unit that is simple to operate and maintain and has been used successfully in municipal plants to thicken WAS (no primary treatment) in the world. Table 5-3 below summarizes the advantages and disadvantages of RDTs.

Table 5-3 Rotary drum thickener advantages and disadvantages

Advantages	Disadvantages
Low energy use	Large footprint
Low-speed process	Performance highly dependent on sludge characteristics
Easy shutdown capabilities	Moderate to high polymer use
Few moving parts	Odour potential
Less impacted by grit	Moderate operator attention
Moderate noise level	

Screw Thickener

Screw thickeners operate in a similar manner to RDTs by using a screen that allows water to pass while capturing solids. The screw thickener is oriented at an angle to allow an auger, located inside the screen, to transport solids from the bottom of the thickener to the top, while water flows through the screen and out the bottom of the thickener. Like the RDT, screw thickeners have minimal moving parts requiring maintenance. The motors required to operate the auger are small and require much less energy compared to a centrifuge. Table 5-4 summarizes the advantages and disadvantages of a screw thickener.

Table 5-4 Advantages and disadvantages of screw thickener

Advantages	Disadvantages
Low energy use	Large footprint
Low speed process	Performance highly dependent on sludge characteristics
Easy shutdown capabilities	Moderate to high polymer use
Few moving parts	Odour potential
Less impacted by grit	Moderate operator attention
Moderate noise level	

Gravity Belt Thickener/ Belt Filter Press

Sludge is fed into a gravity belt thickener (GBT) over a porous serpentine belt that acts as a filter, allowing water to drain through while capturing solids on the belt. A polymer is mixed with the sludge prior to entering the GBT to increase the solids capture efficiency. A substantial volume of high-pressure wash water is required to clean the belts. Typically, GBTs require a substantial amount of fine-tuning of the belt tension, which causes high operational costs compared to other thickening processes. GBT design considerations include curbs around the unit to capture the wash water. Table 5-5 summarizes the advantages and disadvantages of a GBT.

Table 5-5 : Advantages and disadvantages of gravity belt thickener/belt filter press

Advantages	Disadvantages
Low energy use	Large footprint
Low speed process	Dirty appearance, poor odour catchment
Easy shutdown capabilities	High volume of wash water
Few moving parts	Many moving parts
Less impacted by grit	Close supervision required
	High noise level

Sludge Stabilization

Sludge stabilization is essential to reduce solids' aesthetic impacts (e.g., odour generation and appearance), vector-attraction features, waste volume and mass, and to increase biosolids' dewaterability. Aerobic digestion, aerobic-anoxic digestion, anaerobic digestion, and alkaline digestion are some of the sludge stabilization procedures.
For small wastewater treatment, two types of solids digestion are usually used: anaerobic and aerobic. When practicable, anaerobic digestion is favoured since it provides fuel (methane) and can reduce plant energy costs. Anaerobic digestion, on the other hand, is more difficult to operate and has higher capital expenses than aerobic digestion. Aerobic digestion is often used in facilities with influent flows of up to 20,000 m^3/d. Anaerobic digestion becomes more economically feasible at higher influent flows.
In the case of Gansevallei WWTW, it is envisioned that Aerobic digestion will be facilitated in the BNR by engaging a sludge age in excess of 21days, thus no further stabilisation is required.

Composting

Composting is a process that involves the aerobic breakdown of organic materials by microbes. It is a self-heating process that kills germs and produces humus-like material. Compost that has been properly stabilized can be stored for an extended amount of time and emits little odour. The product is a dark, humus-like substance that can be used for soil amendments and other beneficial purposes. Carbon to nitrogen ratio, oxygen control, temperature management, and moisture content are all important parameters impacting the process. The rate of composting is accelerated in the presence of oxygen, and odour is reduced. Composting occurs in three stages: mixing with the bulking agent, active composting at elevated temperatures, and curing, which can take up to six months. For thermophilic composting, the compost is typically heated to 50-70°C during active composting. The temperature drops throughout the curing period, allowing a stable and mature compost to form. Microbial activity requires a sufficient amount of moisture. However, excessive wetness reduces the empty spaces in the compost, resulting in decreased oxygen transmission.

Drying

Sludge drying is typically used after stabilization to produce which are used on parks, golf courses, and general turf applications. Heat drying will reduce pathogenic viruses, bacteria, and helminth ova to below detectible levels, and also reduce the water content of the biosolids. Two basic types of sludge drying processes are used: indirect (auger screw, paddle), and direct (belt dryers, rotary drum dryers).
Numerous manufacturers use these methods to increase the percent solids to at least 90%. Thus, the volume of biosolids produced by drying is much lower than any other sludge treatment methods. Sludge drying is a proven technology that requires moderate to high operator attention. Drying requires no chemical addition; however, there are increased power and natural gas requirements. Due to the degree of dryness, there is limited odour in the end product. Dried biosolids are desirable for turf application if not too dusty, among other uses. Table 5-6 summarizes the advantages and disadvantages of drying.

Table 5-6 Advantages and disadvantages of drying

Advantages	Disadvantages
It can be started quickly	High capital and operating costs
Capable of producing high quality biosolids	No usable gas is produced
Substantial reduction of pathogens	Energy intensive
Resulting biosolids have reduced pathogens and odours	Produces an off gas that must be treated
Retain nutrients	Grease content in the sludge decreases heat transfer
Substantially reduces volume	Requires skilled operators

Sludge Dewatering

Sludge is a mixture of solid matter, both organic and inorganic, and water. The amount of solids in this mixture, or suspension, is usually defined as the ratio of the mass of dry solids to the total mass of the sludge and is expressed as a percentage. Dewatering is therefore important in reducing the volume of sludge to be disposed.

- Volute dehydrator/Sludge drying pas
- Belt filter press/ Sludge drying pad
- Sludge drying beds (filter media)

Volute dehydrator

The key design of the Volute Dehydrator is in the dewatering drum. It consists of rings with a variable pitch auger running through the centre. Every second ring is fixed to the barrel assembly and separated by spacers. Intermediary rings are free to move. The internal diameter of the fixed rings is larger than the diameter of the auger. The intermediary rings have an internal diameter slightly less than the auger and hence are moved in an orbital motion as the auger turns. The movement of the intermediary rings constantly cleans the barrel assembly allowing free drainage of water. This arrangement allows for extremely low power draw. Dilute sludge is introduced into a flocculator tank at the rear of the unit and mixed with a polymer solution to produce floccs. The floccs then overflow into the barrel and free water is drained as they are transported along the auger. Final compression of the sludge cake at the end of the auger is enhanced by decreasing both the pitch of the auger and the spacing between the fixed and intermediary rings.

The biggest benefit of this technology is that you have thickening and dewatering in one technology, as shown below:

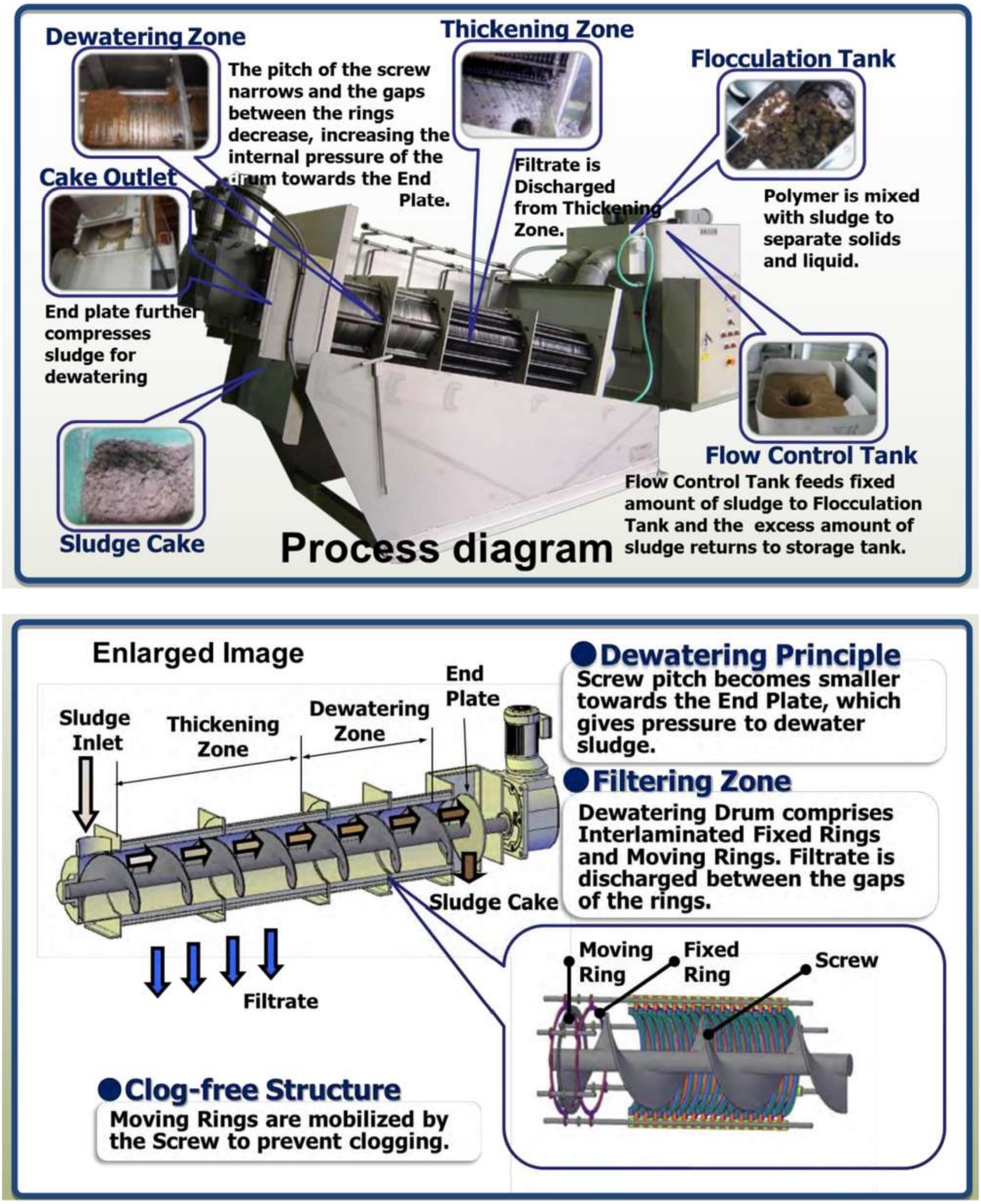


Figure 5-15 Volute dehydrator

The only known detractor is the high polymer input, however benefits are:

- Extremely low energy and water consumption
- Single step dewatering capability from 0.2% -18% in without pre thickening
- 24 hour automatic operation.
- Extremely low noise & vibration
- Easy maintenance
- Ability to handle oily sludge
- Small footprint
- High recovery rate

Belt Filter Press

Flocculent is added to the thickened sludge to aid in the dewatering process. It is usually supplied as a powder and needs to be mixed. In this respect it must be correctly stored in an area where the chemical can be contained, should there be any spills from the bags. If belt presses are being used for dewatering sludge, they must be kept in working order to avoid the problem of sludge building up. The dewatered sludge will then be sent to the solar drying pads for further processing.

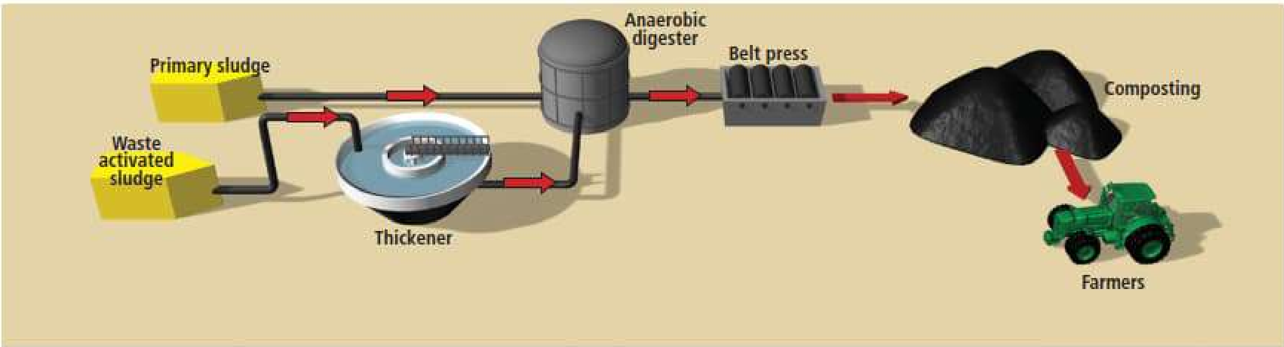


Figure 5-16 Belt filter press

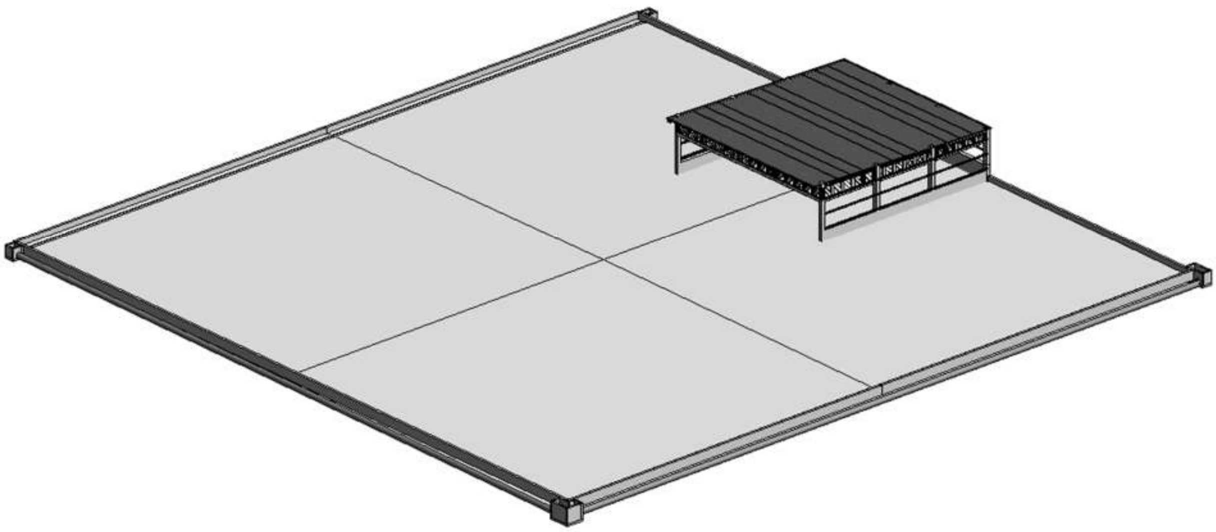


Figure 5-17 Solar drying pad

Drying beds

A cheaper and much lower maintenance option for dewatering is the use of drying beds. Drying beds are essentially filters of sand in a rectangular walled area onto which sludge is layered and through which the water will drain. As the sludge dries out it is carefully removed and placed in an area from which it can be used or disposed depending on the class. After dewatering, the sludge can be used for further composting to make a saleable product.

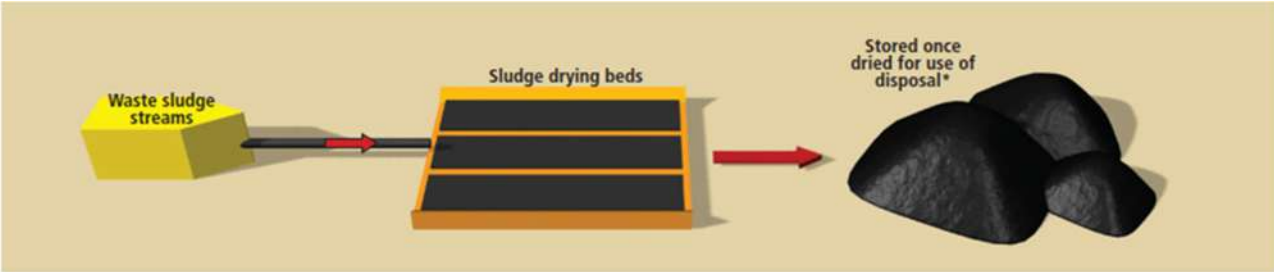


Figure 5-18 Solar Drying Bed

Sludge Management Options

As shown on the list of potential sludge treatment processes, there are many potential alternatives, which would be very time-consuming and impractical to review at a high level of detail. A set of screening criteria have been selected and described below to gauge a technology's applicability to the WWTW.

Proven Technology: The option must be in common use for waste activated sludge treatment in similar sized installations in South Africa

Reliability / Risk of Failure: The option must always provide reliable biosolids processing and disposal with little risk of failure due to mechanical or process breakdown.

Cost-Effectiveness: Based upon experiences at other locations, the technologies chosen should all be competitive with respect to both operating and capital costs. Therefore, processes fail this criterion when: they need to be conservatively designed to increase compliance under the Department of Water Affairs operating conditions, or they have excessive operating costs because of power requirements or routine replacement of rapid-wearing components.

Easy Operation and Maintenance: The process should be capable of tolerating a range of sludge feeding conditions, and easy to operate with a minimum level of requirements for operator attention and specific process knowledge.
Hence, sludge dewatering using sludge drying beds is cheaper, and composting was selected as a preferred option for sludge management.

Conclusion

It is essential that the Sludge Management System adhere to the nationally accepted "Sludge Guidelines". To ensure this the following is proposed:

- Sludge Drying beds – depending on land available.

Figure 5-19 Sludge drying beds

The volume of sludge wasted per day will be adjusted from the control room, however, should telemetry failure occur a backup manually operated valve will also be provided. The dried sludge will then be transferred to the suitable landfill site or alternatively it can be transfer to a composting area with the skid loader and stacked in windrows. It is accepted that the scope of work is to produce waste sludge suitable for general landfill disposal or an A1a sludge that can be used for beneficiation. Supernatant from the sludge management system will be returned to the inlet works.

5.3.3.7 Electrical and Instrumentation

Council Power Supply

The capacity of the existing main electrical supply point shall be verified during the detail design stage and the capacity required at the new extension shall be determined during the detail design stage as well. The existing main electrical supply point shall be upgraded should the need arise.

The design shall be such that to ensure continuous operation even with the failure of the main supply. In this regard, it is proposed to make provision for standby generator set/s with an automatic changeover system to continue with the operation of critical processes during main supply outages.

Site Lighting

Scissor masts shall be installed to provide proper levels of site illumination for the safe and correct operation of the plant. The scissor masts shall ensure easy maintenance of the site lighting structure.

Electrical Installations in Buildings

The electrical installations in buildings shall include all small power and lighting requirements as well as emergency lighting if required.

Lightning Protection

All structures, hand-railing and open conductive parts on site shall be earthed in terms of the relevant statutory requirements. Surge protection devices complete with the required earth continuity paths shall be provided on all equipment where necessary.

Motor Control Centres (MCC's)

Equipment for each load centre shall be powered and controlled from an MCC. Each MCC shall have a dedicated PLC.

Each MCC shall incorporate power factor correction to reduce the effects of harmonics on the distribution system, to improve energy efficiency and hence to save on energy consumption costs.

SCADA System

The type or make of the Supervisory Control and Data Acquisition System on the existing plant shall be verified during the detailed design stage. A new SCADA system shall be installed for the new extension. Remote control of the plant shall allow operating staff to control plant functions or processes.

Programmable Logic Controllers

Programmable Logic Controllers (PLC's) shall be distributed on the site and shall be linked by means of fibre optic cables between PLC's and the SCADA system. The existing communication systems between the SCADA system and plant processes shall be verified during the detailed design stage. All major plant processes shall be monitored and controlled by local PLC equipment that shall provide a fully automated system for some of the processes. The PLC shall also serve as an interface between the SCADA System and the plant equipment.

Uninterruptable power supply units shall be supplied at all PLC installations to provide backup power required during shut shutdown of plant processes in the event of power failures.

Instrumentation

All instrumentation (flow meters, level meters, pH meters, MLSS meters, DO meters, motorised valves, etc) shall be monitored and displayed on the SCADA system. Where control functions require the measured parameters in any section of the plant, this information shall be made available in the PLC / SCADA automation platform.

Documentation and Procurement

SMEC will compile all the technical components of the tender documentation, including drawings, specifications, data sheets and Bill of Quantities, aiding the client during the tender clarification meeting as well as assisting with the tender evaluation process, to appoint a suitable contractor.

Construction

Occupational Health and Safety (OH&S) Precautions

All the work to be executed under this contract shall comply with the Occupational Health and Safety Act (Act No.85 of 1993) and the latest Construction Regulations.

Technical Standards

The design and implementation of the infrastructure to be provided will adhere to relevant statutory guidelines and design codes. Guidelines and project specifications provided by the client will receive priority and National Standards will be considered. This will not release the consultants from striving to provide solutions in the best interest of the client.

Labour-intensive Works

Where practical and economically feasible, construction work will be undertaken using labour-intensive methods as outlined as a requirement by the BITOU LM.

Construction Programme and Cost Estimate

SMEC will provide an estimated construction programme as well as an estimated construction budget for the project as part of Stages 2 and 3. The assumptions for the construction estimate will be indicated and updated during subsequent phases of the project.

Construction Monitoring and Close-out

SMEC will provide the client with the necessary resources to successfully provide construction monitoring for the duration of the contract, as well as assist with all the necessary contract administration. SMEC will complete a detailed close-out report on the project highlighting the success and lessons learned.

5.3.3.8 Ancillary Design Requirements

Admin

It is recommended that a Process Controller Facilities (including ablutions), Storeroom, small Laboratory, security access and formalising the access roads be included as required by DWS.

Construction Phasing

It is proposed that the WWTW be constructed in specific phases to accommodate existing influent, honey suckers that will be used to clear sewage as a temporary measure while the sewer network is being upgrade, and possibly de-sludging activities from the current septic tank system.

6. Cost Estimates

6.1 Sewerage Reticulation

The cost estimate for the internal sewer reticulation and the Bulk sewer main is indicated in Table 6-1 below:

Table 6-1 Sewer Reticulation

Sewer Reticulation	
SECTION 1 : PRELIMINARY AND GENERAL	R 4 225 256,25
SECTION 2 : SITE CLEARANCE	R 1 465 700,00
SECTION 3: BULK SEWER	R 4 034 575,00
SECTION 4: INTERNAL SEWER	R 11 400 750,00
SUBTOTAL	R 21 126 281.25
CONTINGENCIES (10%)	R 2 112 628,13
Sub total	R23 238 909,38
VAT (15%)	R3 485 836,41
GRANDTOTAL	R26 724 745,78

6.2 WWTW

6.2.1 Refurbishment Cost Estimate

The estimated cost of refurbishment is given below:

Table 6-2 Refurbishment cost

Woodlands WWTW Refurbishment	
Civil Works	
SECTION 1 : PRELIMINARY AND GENERAL	R477 702.14
SECTION 2 : HEAD OF WORKS	R136 023.38
SECTION 3: CHLORINATION CONTACT CHANNELS	R75 400.57
SECTION 4: CHLORINE BUILDING	R48 042.76
SECTION 5: SLUDGE HANDLING	R909 186.43
SECTION 6: STORMWATER DAM INFRASTRUCTURE	R203 752.76
SECTION 7: ROAD WORKS	R260 183.34
SECTION 8: SUNDRIES	R91 638.30
SECTION 9: ADMIN	R186 581.05
CONTINGENCIES (10%)	R191 080.86
CPA (10%)	R191 080.86
Sub total	R2 770 672.44
Mechanical Works	
SECTION 1 : PRELIMINARY AND GENERAL	R388 125.00
SECTION 2 : SUPPLY AND DELIVERY	R2 250 000.00
SECTION 3 : INSTALL, TEST AND COMMISSION	R337 500.00
CONTINGENCIES (10%)	R258 750.00
CPA (10%)	R258 750.00
Sub total	R3 493 125.00
Electrical Works	
SECTION 1 : PRELIMINARY AND GENERAL	R129 375.00
SECTION 2 : SUPPLY AND DELIVERY (Electrical)	R750 000.00
SECTION 3 : INSTALL, TEST AND COMMISSION	R112 500.00
SECTION 4 : SUPPLY AND DELIVERY (C & I)	R0.00
SECTION 5 : INSTALL, TEST AND COMMISSION (C & I)	R0.00
CONTINGENCIES (10%)	R86 250.00
CPA (10%)	R86 250.00
Sub total	R1 164 375.00
TOTAL	R7 428 172.44
VAT (15%)	R1 071 582.68
GRANDTOTAL	R8 499 755.12

6.2.2 New WWTW Cost Estimate

Capital Cost Estimation

WWTW – Option 2 Rotating Biological Contactor
The estimated cost of Option 2 is given below:

Table 6-3 Capital cost RBC

Woodlands WWTW - RBC	
Civil Works	
SECTION 1 : PRELIMINARY AND GENERAL	R1 458 701.28
SECTION 2 : HEAD OF WORKS	R136 023.38
SECTION 3 : SEPTIC TANK	R2 076 556.67
SECTION 4 : RBC BASINS	R1 500 000.00
SECTION 5: HUMUS TANKS	R713 516.00
SECTION 6: FERRIC CHLORIDE DOSING	R22 502.94
SECTION 7: CHLORINATION CONTACT CHANNELS	R75 400.57
SECTION 8: CHLORINE BUILDING	R48 042.76
SECTION 9: OUTFALL	R92 697.00
SECTION 10: SLUDGE HANDLING (to septic tank)	R0.00
SECTION 11: STORMWATER DAM INFRASTRUCTURE	R203 752.76
SECTION 12: SITE PIPELINES	R427 910.35
SECTION 13: ROAD WORKS	R260 183.34
SECTION 14: SUNDRIES	R91 638.30
SECTION 15: ADMIN	R186 581.05
CONTINGENCIES (10%)	R583 480.51
CPA (10%)	R583 480.51
SUB TOTAL	R8 460 467.42
Mechanical Works	
SECTION 1 : PRELIMINARY AND GENERAL	R755 493.60
SECTION 2 : SUPPLY AND DELIVERY	R5 036 624.00
SECTION 3 : INSTALL, TEST AND COMMISSION	R58 500.00
CONTINGENCIES (10%)	R509 512.40
CPA (10%)	R509 512.40
SUB TOTAL	R6 869 642.40
Electrical Works	
SECTION 1 : PRELIMINARY AND GENERAL	incl
SECTION 2 : SUPPLY AND DELIVERY (Electrical)	incl
SECTION 3 : INSTALL, TEST AND COMMISSION	incl
SECTION 4 : SUPPLY AND DELIVERY (C & I)	incl
SECTION 5 : INSTALL, TEST AND COMMISSION (C & I)	incl
CONTINGENCIES (10%)	R0.00

CPA (10%)	R0.00
SUB TOTAL	R0.00
GRAND TOTAL	R15 330 109.82
VAT (15%)	R1 594 996.73
TOTAL	R16 925 106.55

WWTW – Option 3 Biological Nutrient Removal

The estimated cost of Option 3 is given below:

Table 6-4 Biological Nutrient Removal Cost Estimate

Woodlands WWTW - BNR	
Civil Works	
SECTION 1 : PRELIMINARY AND GENERAL	R1 322 846.83
SECTION 2 : HEAD OF WORKS	R136 023.38
SECTION 3 : BALANCING TANK	R457 826.88
SECTION 3 : FLOW DIVISION	R53 544.13
SECTION 4: PROCESS TANK	R2 218 602.65
SECTION 4: FERRIC CHLORIDE DOSING	R22 502.94
SECTION 5: CLARIFIER	R375 573.76
SECTION 6: RAS AND WAS PUMPING STATION	R34 983.17
SECTION 7: CHLORINATION CONTACT CHANNELS	R75 400.57
SECTION 8: CHLORINE BUILDING	R48 042.76
SECTION 8: OUTFALL	R92 697.00
SECTION 9: SLUDGE HANDLING	R606 124.29
SECTION 10: STORMWATER DAM INFRASTRUCTURE	R203 752.76
SECTION 11: SITE PIPELINES	R427 910.35
SECTION 12: ROAD WORKS	R260 183.34
SECTION 13: SUNDRIES	R91 638.30
SECTION 14: ADMIN	R186 581.05
CONTINGENCIES (10%)	R529 138.73
CPA (10%)	R529 138.73
SUB TOTAL	R7 672 511.63
Mechanical Works	
SECTION 1 : PRELIMINARY AND GENERAL	R202 855.39
SECTION 2 : SUPPLY AND DELIVERY	R1 305 992.17
SECTION 3 : INSTALL, TEST AND COMMISSION	R46 377.09
CONTINGENCIES (10%)	R135 236.93
CPA (10%)	R135 236.93
SUB TOTAL	R1 825 698.50
Electrical Works	
SECTION 1 : PRELIMINARY AND GENERAL	R193 397.39
SECTION 2 : SUPPLY AND DELIVERY (Electrical)	R998 497.03
SECTION 3 : INSTALL, TEST AND COMMISSION	R105 805.10
SECTION 4 : SUPPLY AND DELIVERY (C & I)	R166 615.80
SECTION 5 : INSTALL, TEST AND COMMISSION (C & I)	R18 398.00
CONTINGENCIES (10%)	R128 931.59
CPA (10%)	R128 931.59

SUB TOTAL	R1 740 576.51
TOTAL EXCL VAT	R11 238 786.64
VAT (15%)	R1 685 818.00
TOTAL	R12 924 604.63

6.2.3 O&M Cost Estimation

WWTW – Option 2 Rotating Biological Contactor
The estimated O&M cost of Option 2 is given below:

Table 6-5 O&M cost RBC

Period/Term	Expected Operating Cost (1)	Expected Maintenance Cost (2)	Total O & M Cost (3=1+2)
Year1	R 649 733	R 162 433	R 812 166
Year2	R 658 829	R 164 707	R 823 536
Year3	R 668 052	R 167 013	R 835 065
Year4	R 677 405	R 169 351	R 846 756
Year5	R 686 889	R 171 722	R 858 611
Total	R 2 654 019	R 663 505	R 3 317 523

WWTW – Option 3 Biological Nutrient Removal
The estimated O&M cost of Option 3 is given below:

Table 6-6 O&M cost BNR:

Period/Term	Expected Operating Cost (1)	Expected Maintenance Cost (2)	Total O & M Cost (3=1+2)
Year1	R 516 984	R 129 246	R 646 230
Year2	R 524 222	R 131 055	R 655 277
Year3	R 531 561	R 132 890	R 664 451
Year4	R 539 003	R 134 751	R 673 754
Year5	R 546 549	R 136 637	R 683 186
Total	R 2 111 770	R 527 943	R 2 639 713

7. Recommendations

Internal Sewer Reticulation

It is recommended that the usage of the digestor tanks be discontinued and all existing 110mm diameter uPVC sewer pipes be replaced with the standard 160mm diameter uPVC class 34 pipes as indicated on the layout on Appendix B.

Bulk Sewer Main

It is recommended that a 160mm diameter uPVC class 34 pipe be used for the Bulk Main, running along the route suggested on Appendix B. This route is the most suitable considering the position of the future developments but is subject to change depending on the Environmental screening report. The last 500m to the WWTW the diameter should be increased to 200mm, to accommodate the expected stormwater infiltration.

Wastewater Treatment Works

It is recommended that the land around the current works be confirmed regarding ownership. The easiest treatment option remains Option 1 – Oxidations Ponds. The second easiest option to operate and maintain is the Rotating Biological Contactors (Option 2).

8. Conclusion

The existing sewer system in the Woodlands Settlement has been problematic, especially during peak times, resulting in overflows and unsanitary conditions. In order to alleviate the situation, the current digester tanks should be discontinued, and all existing 110mm diameter sewer pipes should be replaced with 160mm diameter pipes. A 160mm diameter uPVC class 34 pipe should be used for the Bulk Main, with the final 500 meters to the WWTW increased to 200mm to accommodate stormwater infiltration. Oxidation Ponds is the suggested solution as part of the refurbishment of the existing WWTW in Woodlands.

The EAP noted that there are wetlands in the area, this could have an impact on the timeline on the project and on the current designs but will be confirmed once the comprehensive environmental screening report is made available.

The estimated cost of the Sewer Reticulation and Bulk Main is R26 724 745,78. The estimated cost of the WWTW refurbishment is R 8 499 755.12 and the cost of a new WWTW by means of rotating biological contactors is R16 925 106.55. The estimated cost for the operation and maintenance of the rotating biological reactors plant is estimated as R 3 317 523.00 over a five-year period.

Appendix A Hydraulic Load Calculations

APPENDIX A: ZONE 1	WATER & SEWER DEMAND CALCULATIONS												
CLIENT:	Koukamma Municipality		PROJECT NAME:	Woodlands Waste Water Treatmentworks				PROJECT NUMBER:	C3357	DATE:	08-11-2024	REVISION:	00
DEVELOPMENT LAND USE					ESTIMATED WATER DEMAND					ESTIMATED SEWER OUTFLOW			
Precinct Name/Use	Land Use		Number of units	Avg Erf Size (m²)	Estimated AADD/unit (ℓ/day/unit)	Description	AADD (kℓ/day)	*Peak demand (ℓ/s)	** Peak demand incl. reduction factor (ℓ/s)	% of water consumption to sewer	ADDWF (kℓ/day)	*** PDWF (kℓ/day)	**** PWWF (ℓ/s)
	Type	Density											
Commercial			100										
Business	Business / Commercial	n/a	4,748	1187	650	l per 100m²	3,09	0,06	0,06	80%	2,47	4,20	0,06
Institutional	Educational Facilities	n/a	37,3	9325	600	l per 100m²	22,38	0,44	0,44	65%	14,55	24,73	0,34
Public Open Spaces	Parks	n/a	0	0	12000	l per 100m²		0,00	0,00		0,00	0,00	0,00
							25,47	0,50			17,02	28,93	0,40
Single Unit Housing													
Dwelling Units	Residential	High Density	94	407,6	400	per unit	37,60	0,96	0,96	95%	35,72	67,87	0,94
							37,60	0,96			35,72	67,87	0,94
TOTALS							63,07	1,46			52,74	96,80	1,34

NOTES:	DESIGN FACTORS:	Business	Educational	Commercial	Residential
AADD: Average Annual Daily Demand	* Assumed Peak Factor on Water Demand as per Table J.9, Red Book	1,7	1,7	1,7	2,2
ADDWF: Average Daily Dry Weather Flow	** On-site Supplementary Water Sources Reduction %	0%			
PDWF: Peak Dry Weather Flow	*** Assume Peak Factor on Sewer Flows as per Red Book	1,7	1,7	1,7	1,9
PWWF: Peak Wet Weather Flow	**** Assume Stormwater Infiltration for Sewers as per Red Book	20%			
	Floor Space Ratio	0,4			

APPENDIX A: ZONE 2	WATER & SEWER DEMAND CALCULATIONS												
CLIENT:	Koukamma Municipality		PROJECT NAME:	Woodlands Waste Water Treatmentworks			PROJECT NUMBER:		C3357	DATE:	08-11-2024	REVISION:	00
DEVELOPMENT LAND USE					ESTIMATED WATER DEMAND					ESTIMATED SEWER OUTFLOW			
Precinct Name/Use	Land Use		Number of units	Avg Erf Size (m²)	Estimated AADD/unit (ℓ/day/unit)	Description	AADD (kℓ/day)	*Peak demand (ℓ/s)	** Peak demand incl. reduction factor (ℓ/s)	% of water consumption to sewer	ADDWF (kℓ/day)	*** PDWF (kℓ/day)	**** PWWF (ℓ/s)
	Type	Density											
Commercial			100										
Business	Business / Commercial	n/a	7,88	1970	650	l per 100m²	5,12	0,10	0,10	80%	4,10	6,97	0,10
Institutional	Educational Facilities	n/a	59,84	14960	600	l per 100m²	35,90	0,71	0,71	65%	23,34	39,67	0,55
Public Open Spaces	Parks	n/a	58,79	5879	12000	l per 100m²		0,00	0,00		0,00	0,00	0,00
Institutional	Cemetery	n/a	70,64	7063,943	12000	l per 100m²		0,00	0,00		0,00	0,00	0,00
							41,03	0,81			27,44	46,64	0,65
Single Unit Housing													
Dwelling Units	Residential	High Density	553	407,6	400	per unit	221,20	5,63	5,63	95%	210,14	399,27	5,55
		Low Density, extra-large sized	13	14246,384	400	per unit	5,20	0,13	0,13	95%	4,94	9,39	0,13
Dwelling Units	Residential stands	Low Density, large sized	5	15064,368	400	per unit	2,00	0,00	0,00	95%	1,90	4,18	0,05
							228,40	5,76	5,76	2,85	216,98	412,83	5,72
TOTALS							269,43	6,57			244,42	459,47	6,37

NOTES:

AADD: Average Annual Daily Demand

ADDWF: Average Daily Dry Weather Flow

PDWF: Peak Dry Weather Flow

PWWF: Peak Wet Weather Flow

DESIGN FACTORS:	Business	Educational	Commercial	Residential
* Assumed Peak Factor on Water Demand as per Table J.9, Red Book	1,7	1,7	1,7	2,2
** On-site Supplementary Water Sources Reduction %	0%			
*** Assume Peak Factor on Sewer Flows as per Red Book	1,7	1,7	1,7	1,9
**** Assume Stormwater Infiltration for Sewers as per Red Book	20%			
Floor Space Ratio	0,4			

APPENDIX A: ZONE 3	WATER & SEWER DEMAND CALCULATIONS												
CLIENT:	Koukamma Municipality		PROJECT NAME:	Woodlands Waste Water Treatmentworks			PROJECT NUMBER:		C3357	DATE:	08-11-2024	REVISION:	00
DEVELOPMENT LAND USE					ESTIMATED WATER DEMAND					ESTIMATED SEWER OUTFLOW			
Precinct Name/Use	Land Use		Number of units	Avg Erf Size (m²)	Estimated AADD/unit (ℓ/day/unit)	Description	AADD (kℓ/day)	*Peak demand (ℓ/s)	** Peak demand incl. reduction factor (ℓ/s)	% of water consumption to sewer	ADDWF (kℓ/day)	*** PDWF (kℓ/day)	**** PWWF (ℓ/s)
	Type	Density											
Elongated Residential Units on LHS of R102 Road													
Single Unit Housing													
Dwelling Units	Residential stands	High Density, small sized	15	10717,217	600	per unit	9,00	0,23	0,23	95%	8,55	16,25	0,23
							9,00	0,23			8,55	16,25	0,23
TOTALS							9,00	0,23	0,00	0,00	8,55	16,25	0,23
NOTES:			DESIGN FACTORS:			Business	Educational	Commercial	Residential				
AADD: Average Annual Daily Demand			* Assumed Peak Factor on Water Demand as per Table J.9, Red Book			1,7	1,7	1,7	2,2				
ADDWF: Average Daily Dry Weather Flow			** On-site Supplementary Water Sources Reduction %			0%							
PDWF: Peak Dry Weather Flow			*** Assume Peak Factor on Sewer Flows as per Red Book			1,7	1,7	1,7	1,9				
PWWF: Peak Wet Weather Flow			**** Assume Stormwater Infiltration for Sewers as per Red Book			20%							
			Floor Space Ratio			0,4							

APPENDIX A:ZONE 4	WATER & SEWER DEMAND CALCULATIONS												
CLIENT:	Koukamma Municipality		PROJECT NAME:	Woodlands Waste Water Treatmentworks			PROJECT NUMBER:		C3357	DATE:	08-11-2024	REVISION:	00
DEVELOPMENT LAND USE					ESTIMATED WATER DEMAND					ESTIMATED SEWER OUTFLOW			
Precinct Name/Use	Land Use		Number of units	Avg Erf Size (m^2)	Estimated AADD/unit (ℓ/day/unit)	Description	AADD (kℓ/day)	*Peak demand (ℓ/s)	** Peak demand incl. reduction factor (ℓ/s)	% of water consumption to sewer	ADDWF (kℓ/day)	*** PDWF (kℓ/day)	**** PWWF (ℓ/s)
	Type	Density											
Nuweplaas part of phase 2													
Commercial			100										
Business	Business / Commercial	n/a	1,73	433,2	650	l per $100m^2$	1,13	0,02	0,02	80%	0,90	1,53	0,02
Institutional	Educational Facilities	n/a	1,07	268	600	l per $100m^2$	0,64	0,01	0,01	65%	0,42	0,71	0,01
Public Open Spaces	Parks	n/a	5,34	534	12000	l per $100m^2$		0,00	0,00		0,00	0,00	0,00
Agricultural	Including Irrigation	n/a	82,7942	8279,42	4000	l per $100m^2$	331,18	3,83	3,83		0,00	0,00	0,00
Institutional	Community Facilities	n/a	1,696	424	600	l per $100m^2$		0,00	0,00		0,00	0,00	0,00
							1,77	0,03			1,32	2,24	0,03
Single Unit Housing													
Dwelling Units	Residential stands	Low Density, large sized	244	200	600	per unit	146,40	3,73	3,73	75%	109,80	208,62	2,90
							146,40	3,73			109,80	208,62	2,90
TOTALS							148,17	3,76			111,12	210,86	2,93

NOTES:

AADD: Average Annual Daily Demand

ADDWF: Average Daily Dry Weather Flow

PDWF: Peak Dry Weather Flow

PWWF: Peak Wet Weather Flow

DESIGN FACTORS:	Business	Educational	Commercial	Residential
* Assumed Peak Factor on Water Demand as per Table J.9, Red Book	1,7	1,7	1,7	2,2
** On-site Supplementary Water Sources Reduction %	0%			
*** Assume Peak Factor on Sewer Flows as per Red Book	1,7	1,7	1,7	1,9
**** Assume Stormwater Infiltration for Sewers as per Red Book	20%			
Floor Space Ratio	0,4			

APPENDIX A: ZONE 5	WATER & SEWER DEMAND CALCULATIONS												
CLIENT:	Koukamma Municipality		PROJECT NAME:	Woodlands Waste Water Treatmentworks			PROJECT NUMBER:		C3357	DATE:	08-11-2024	REVISION:	00
DEVELOPMENT LAND USE					ESTIMATED WATER DEMAND					ESTIMATED SEWER OUTFLOW			
Precinct Name/Use	Land Use		Number of units	Avg Erf Size (m²)	Estimated AADD/unit (ℓ/day/unit)	Description	AADD (kℓ/day)	*Peak demand (ℓ/s)	** Peak demand incl. reduction factor (ℓ/s)	% of water consumption to sewer	ADDWF (kℓ/day)	*** PDWF (kℓ/day)	**** PWWF (ℓ/s)
	Type	Density											
Nuweplaas part of phase 1													
Commercial			100										
Business	Business / Commercial	n/a	3,104	776	650	l per 100m²	2,02	0,04	0,04	80%	1,61	2,74	0,04
Educational	Educational	n/a	1,768	442	600	l per 100m²	1,06	0,02	0,02	65%	0,69	1,17	0,02
Public Open Spaces	Parks	n/a	18,93	1893	12000	l per 100m²		0,00	0,00		0,00	0,00	0,00
Institutional	Community Facilities	n/a	9,12	2280	600	l per 100m²		0,00	0,00		0,00	0,00	0,00
							3,08	0,06			2,30	3,92	0,05
Single Unit Housing													
Dwelling Units	Residential stands	High density, small sized	114	350	400	per unit	45,60	1,16	1,16	95%	43,32	82,31	1,14
							45,60	1,16			43,32	82,31	1,14
TOTALS							48,68	1,22			45,62	86,22	1,20

NOTES:	DESIGN FACTORS:	Business	Educational	Commercial	Residential
AADD: Average Annual Daily Demand	* Assumed Peak Factor on Water Demand as per Table J.9, Red Book	1,7	1,7	1,7	2,2
ADDWF: Average Daily Dry Weather Flow	** On-site Supplementary Water Sources Reduction %	0%			
PDWF: Peak Dry Weather Flow	*** Assume Peak Factor on Sewer Flows as per Red Book	1,7	1,7	1,7	1,9
PWWF: Peak Wet Weather Flow	**** Assume Stormwater Infiltration for Sewers as per Red Book	20%			
	Floor Space Ratio	0,4			

Development Type	Average Daily Dry Weather Flow (ADWF) (Kl/day)	Peak Daily Dry Weather Flow (PDWF) (Kl/day)	Peak Wet Weather Flow (PWWF) (Kl/day)
Zone 1			
Low Income Housing	35.72	67.87	79.49
Business	2.47	4.20	5.18
Educational Facilities	14.55	24.73	29.38
Sub-Total	**52.74**	**96.8**	**114.05**
Zone 2			
Low Income Housing	216.98	412.83	494.208
Business	4.10	6.97	8.64
Educational Facilities	23.34	39.67	47.52
Sub-Total	**244.42**	**459.47**	**550.368**
Zone 3			
Low Income Housing	8.55	16.25	19.872
Sub-Total	**8.55**	**16.25**	**19.872**
Zone 4			
Low-Cost Housing	109.80	208.62	250.56
Business	0.9	1.53	1.728
Educational Facilities	0.42	0.71	0.864
Sub-Total	**111.12**	**210.86**	**253.152**
Zone 5			
Low Income Housing	43.24	82.16	98.496
Business	1.61	2.74	3.456
Educational Facilities	0.69	1.17	1.728
Sub-Total	**45.24**	**85.50**	**102.816**
Total	462.37	869.45	1041.122

Appendix B Drainage Zone Layout

SEWERAGE DRAINAGE ZONES						
ZONE	BUSINESS UNITS	INSTITUTIONAL UNITS	DWELLING UNITS	AVERAGE DAILY FLOW (Kl/DAY)	PEAK DAILY FLOW (Kl/DAY)	PEAK WET WEATHER FLOW (Kl/DAY)
1	2	7	94	52,740	96,800	114,050
2	4	12	571	244,420	459,470	550,368
3	0	0	15	8,550	16,250	19,872
4	10	11	244	111,120	210,860	253,152
5	3	6	114	45,540	86,070	103,680
TOTAL	19	36	1038	462,370	869,490	1041,120

LEGEND

EXISTING INFRASTRUCTURE:

GENERAL

ERVEN

SEWER RETICULATION

SEWER RETIC PIPE

SEWER RISING MAIN PIPE

SEWER MANHOLE

PROPOSED INFRASTRUCTURE:

GENERAL

ERVEN

SEWER RETICULATION

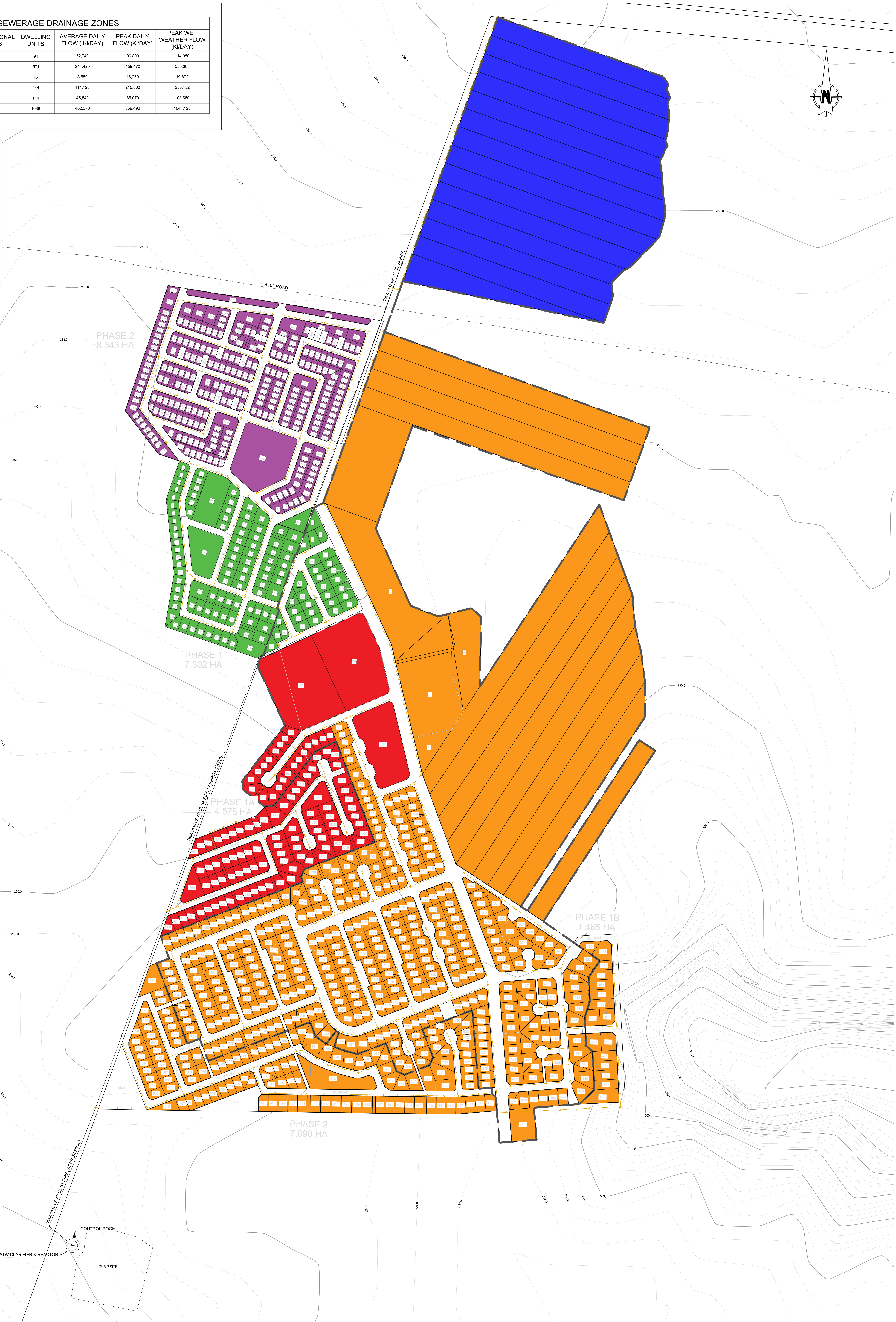
SEWER RETIC PIPE(160mm)

SEWER BULK PIPE(200mm)

SEWER BULK PIPE(160mm)

SEWER MANHOLE

EXISTING ERVEN BOUNDARY



Amendments			
Rev.	Date	Description	Initials
0	Nov 2024	Sewer Catchment Zones	EDT

Service authority approval

Position	Name	Date	Signature

Client(s)

Signature ____________ Date ________

Client Drawing No.: Sht Of

Project title

Woodlands Sewer Reticulation Upgrades

Drawing title

SEWER CATCHMENT LAYOUT

Scale: *1:2 000* Co-ordinate System: *WGS84 - LO23*

Paper Size: *A0*

Signature ____________ PR ________ Date ________

Process	Name	Date	Signature
Designed	E. DU TOIT		
Checked	D. SHARP		
Verified	J. KAMPMAN		
Drawn	E. DU TOIT		
Checked	J. KAMPMAN		

SMEC Drawing No.: EC0047-WDS-SEW-GEN-020 Rev 0 Sht 1 Of 1

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