Detail Design Report

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

Prepared for: Koukamma Local Municipality
29 July 2025
Client Reference No. DWS 22/23-058

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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	WW

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 detailed 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.

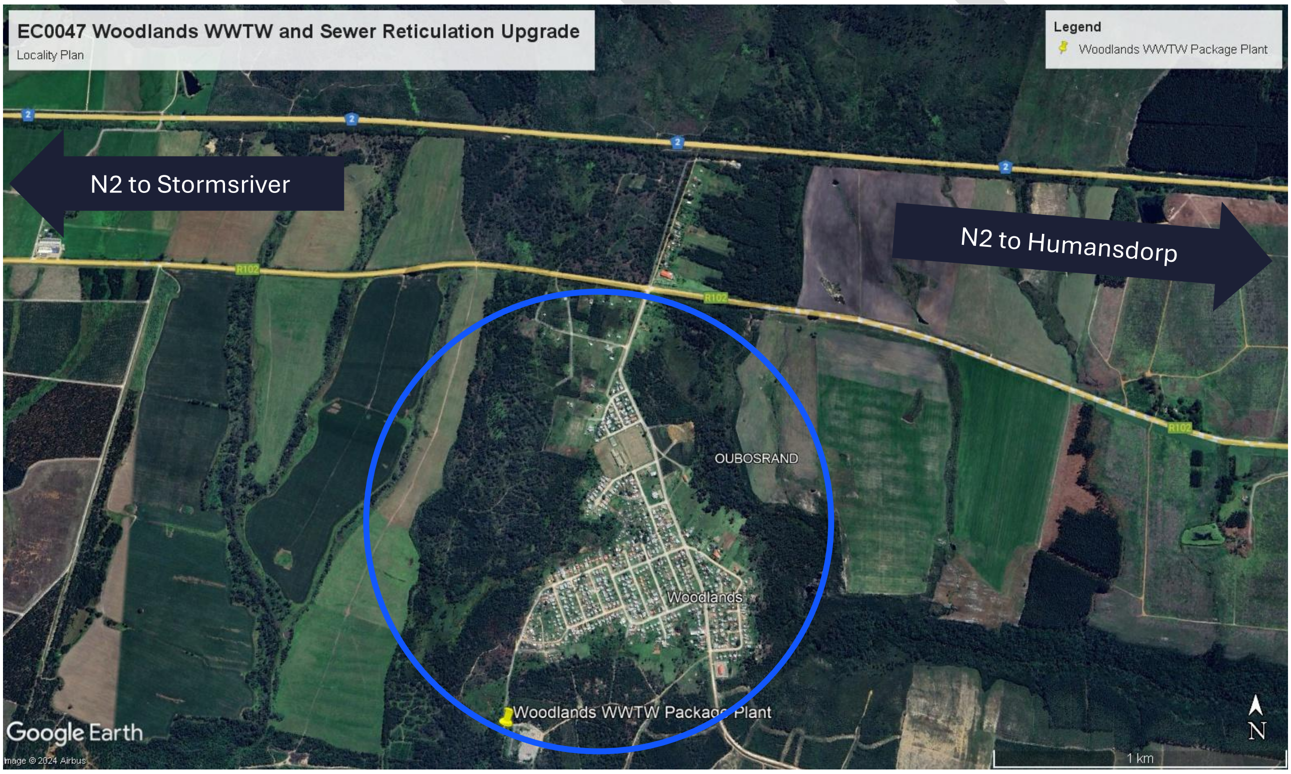


Figure 1.2-1: Woodlands Locality

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
5. **Detail Design and Report (This 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 Detailed 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 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
• Confirmation of Erf	28 October 2024

2. Specialist Service Providers

2.1 Engineering & Land Survey

NPM Geomatics was appointed to undertake a topographical survey of the site, with the initial survey completed on 5 March 2025. The proposed pipe alignment required revision to accommodate topographical constraints and environmental limitations, including the presence of wetlands and the proximity to the 1:100-year flood line. As a result, two additional topographical surveys were conducted to inform the revised design. These surveys were received on 14 March 2024 and 22 April 2024, respectively.

The survey identified numerous existing informal structures encroaching on the areas earmarked for future development. The general topography of the site is moderately undulating, with a prominent high point located near the entrance of the WWTW. This elevation significantly influenced the alignment of the bulk sewer line, necessitating design adjustments to maintain appropriate gradients.

2.2 Flood line Determination

SMEC SA was appointed on the 6th of May 2025 to determine the 1:100-year flood line and provided the flood line analysis on 22nd of May 2025. The 1:100 flood line is indicated in blue in Figure 2.2-1 Below:

Figure 2.2-1 1:100-year Flood line

2.3 Environmental Assessments

Blue Pebble was appointed on the 17th of October 2024 as the Environmental Assessment Practitioners (EAP) on the project and a site evaluation was conducted on the 24th of October 2024.

2.3.1 Environmental Assessment

The following findings were made during the environmental screening 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

Figure 2.3-1 below indicates the proximity of the WWTW site to the wetlands in the area.

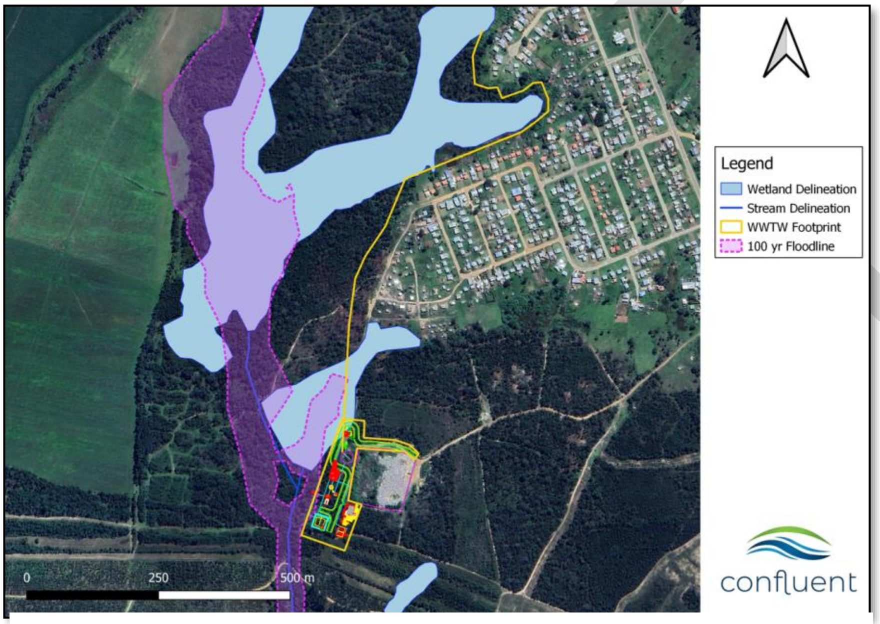


Figure 2.3-1 Wetland Delineation

Currently, the land is not registered under the municipality yet and this is an ongoing process.

2.3.2 Water Use Licence

The current WWTW does not have a Water Use Licence and is not registered with the Department of Water and Sanitation (DWS). Therefore, Confluent was appointed as part of the Environmental to assist in applying for a Water Use Licence. The environmental team had a meeting with DWS and is in contact with them to arrange a compulsory site visit.

2.4 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.

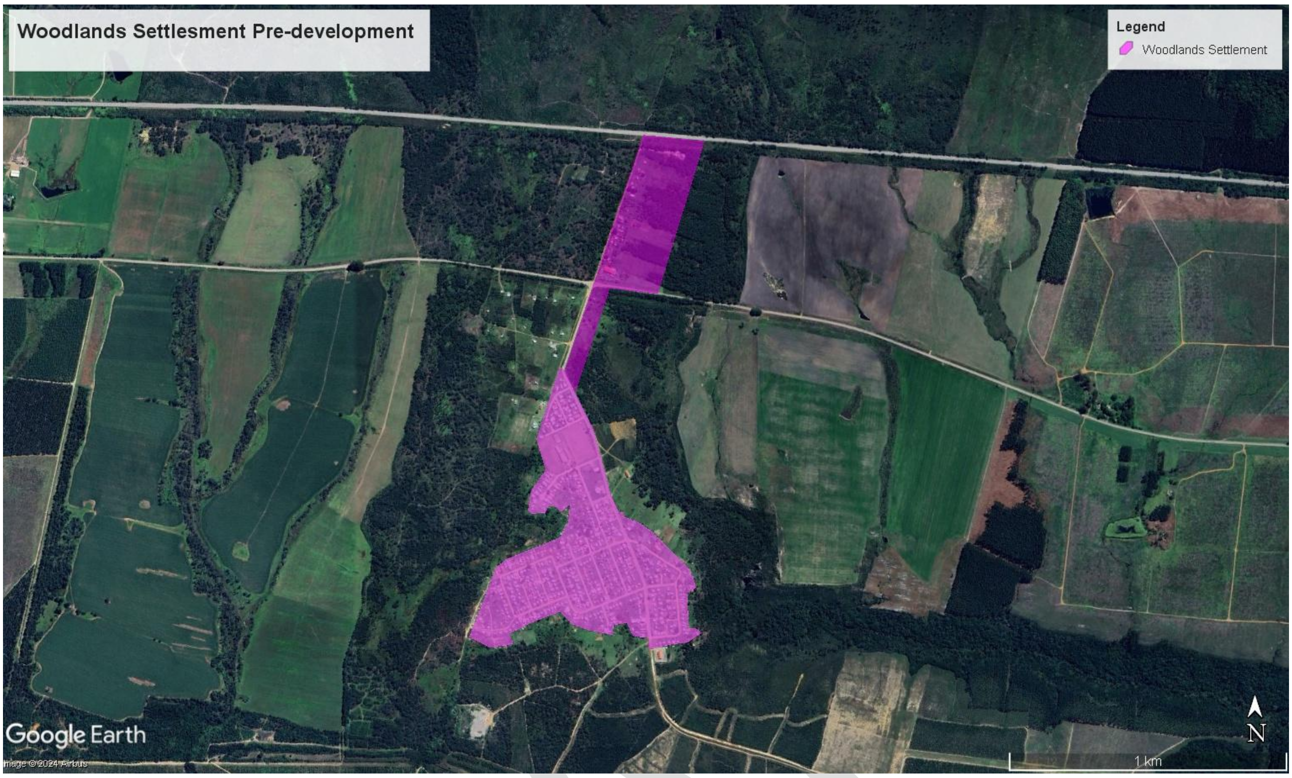


Figure 3-1 Sewerage Drainage zone Pre-Development

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.

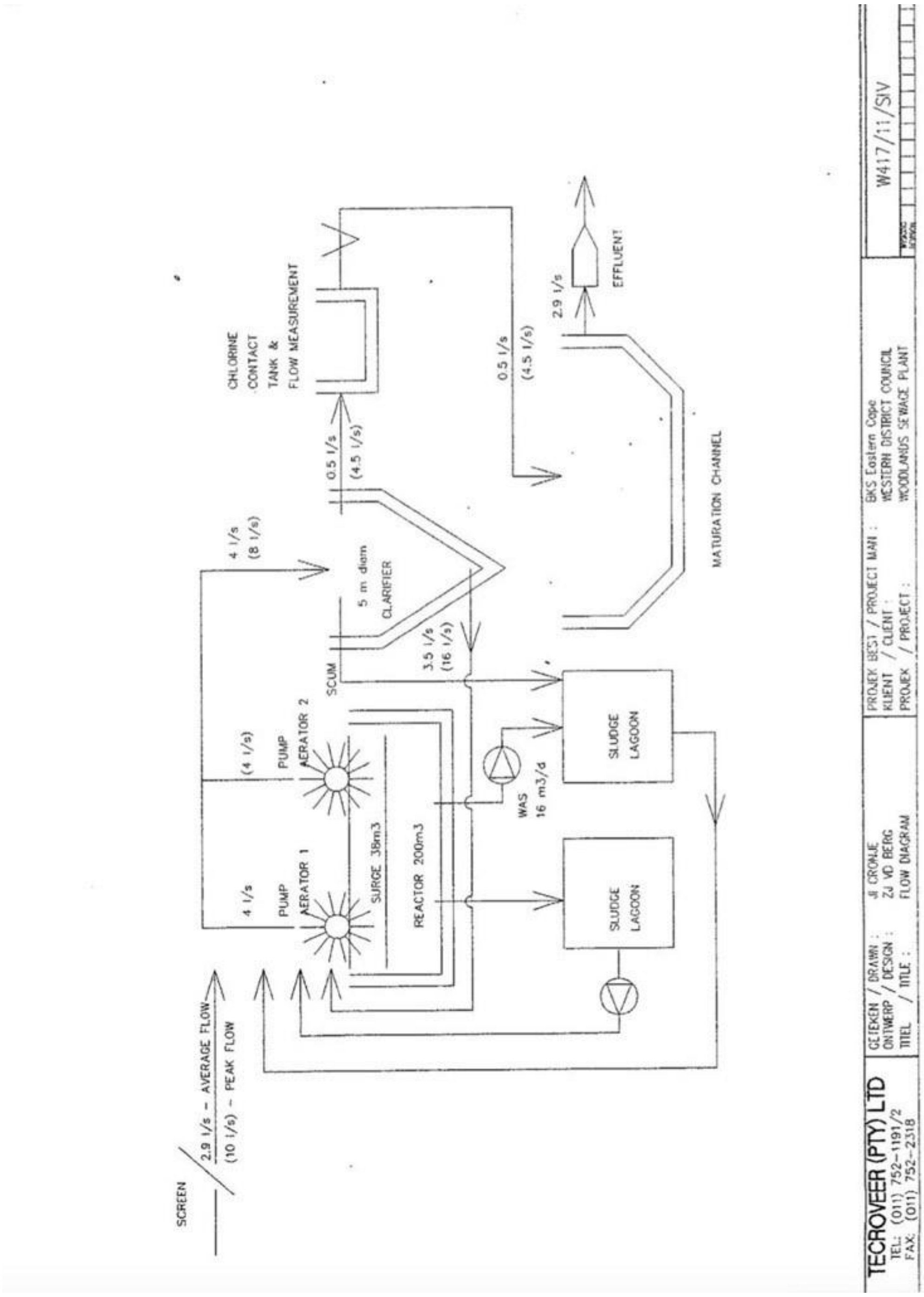


Figure 4-1: Woodlands WWTW Process Flow Diagram

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

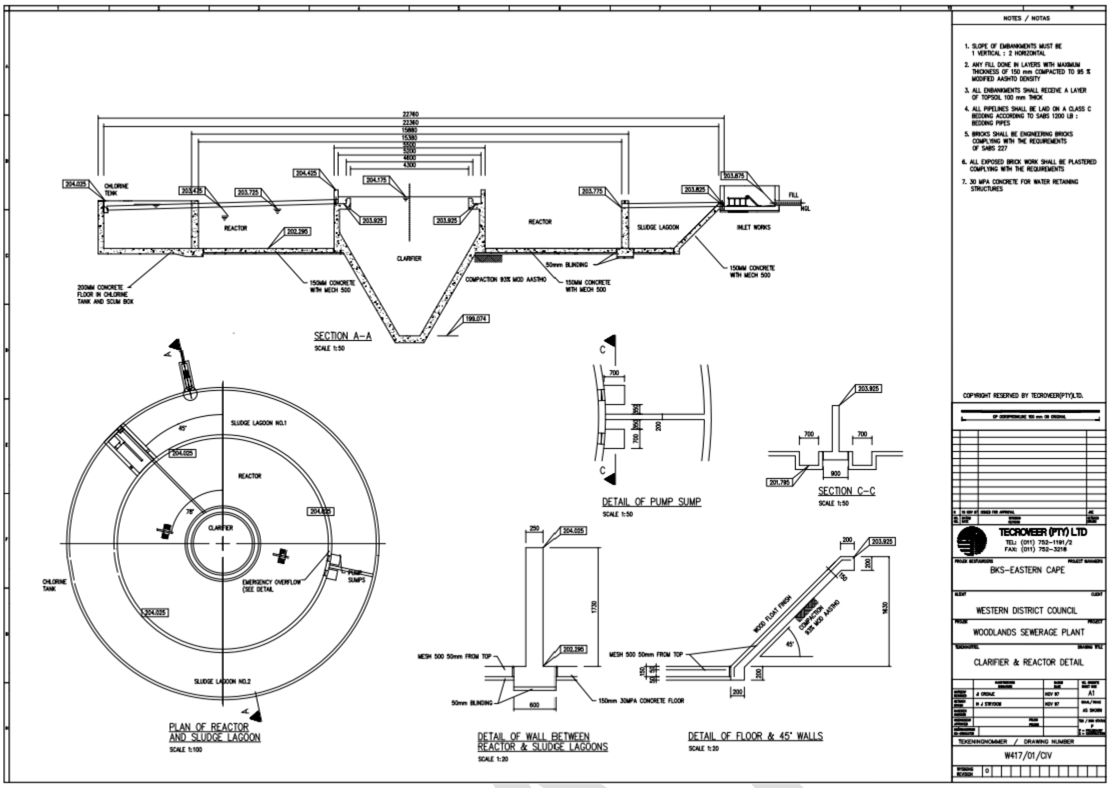


Figure 4-2: Woodlands WWTW Reactor and Clarifier detail

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 Internal Reticulation

5.1.1 Horizontal and Vertical Alignment

The pipes are placed on the higher side of the road, as most of the internal road have stormwater channels on the lower side of the road. This will lead to minimal disruption to the existing stormwater channels. The road reserves range from 10m to 12m. The land survey did not indicate any existing underground services within neighbourhood, therefore there should be enough space for the sewer pipes, and it will have minimal clashes with other services.

The minimum pipe depths is 1m, to allow for at least 800mm of cover for the pipes running in the road reserve.

5.1.2 Pipe Size and Material

All internal sewer reticulation pipelines will be upgraded to 160 mm diameter Class 34 uPVC pipes. The proposed system is designed to function as a gravity-fed network, directing flow toward the lowest elevation points within the settlement. The selection of 160mm diameter pipes is based on hydraulic capacity considerations, ensuring adequate flow even under conditions of limited maintenance and the potential presence of blockages caused by fats, oils, and solid debris.

The use of uPVC is specified due to its favourable properties, including ease of installation, corrosion resistance, low maintenance requirements, and a long operational lifespan, making it well-suited for municipal sewer infrastructure.

All the proposed pipes are made of flexible pipe Material and therefore the pipe bedding will be in accordance with SANS 1200:LB bedding for "Flexible Pipe "as seen in Figure 5.1-1:

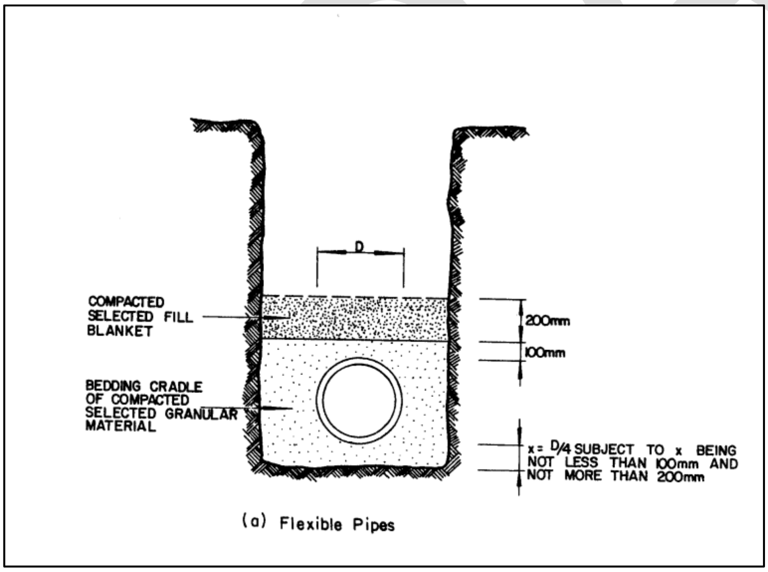


Figure 5.1-1 Flexible Pipe Bedding

5.1.3 Manholes

Manholes should be placed every 80m, at pipe bends and all pipe connections, this is to allow sufficient entry points for maintenance to be conducted. Manholes are placed at the start of every internal line for maintenance purposes.

Given the high likelihood of theft and vandalism in the area, polymer concrete covers are specified in place of traditional cast iron lids. Polymer concrete has a low resale value and limited demand in scrap markets, significantly reducing the likelihood of theft, while still providing the required strength and durability for long-term use.

5.1.4 House Connections

The existing sewer digester tanks will be decommissioned and will not form part of the proposed system. Each erf will be connected to the new internal reticulation network via 110 mm diameter uPVC pipes.

5.2 Bulk Reticulation

5.2.1 Horizontal and Vertical Alignment

The bulk sewer main is aligned along the eastern boundary of the development, following the natural topography which slopes towards the south-east. To minimise environmental impact, the alignment has been designed to avoid direct disturbance to existing wetlands in the area. However, at one location, the sewer main crosses the wetland and traverses within it for approximately 50 metres. In this section, the pipeline will be installed above ground and supported on concrete saddles, thereby eliminating the need for excavation within the wetland and reducing potential ecological disruption.

Refer to **Annexure A: Detail Drawings** for the Bulk Sewer Layout and Long sections.

5.2.2 Pipe Size and Material

A 160 mm diameter uPVC pipe, operating at 80% of its full flow capacity, is adequate to convey the anticipated wastewater generated by the development under normal operating conditions. However, to account for potential stormwater ingress exceeding the expected 20%, the pipe diameter will be increased to 200 mm (Class 34 uPVC) for the final 900 metres of the network, extending to the connection point at the wastewater treatment works (WWTW). This design adjustment ensures sufficient hydraulic capacity and mitigates the risk of surcharge during peak inflow events.

All the proposed pipes are made of flexible pipe Material and therefore the pipe bedding will be in accordance with SANS 1200:LB bedding for “Flexible Pipe "as seen in Figure 5.1-1

5.2.3 Manholes

Manholes should be placed every 80m, at pipe bends and all pipe connections, this is to allow sufficient entry points for maintenance to be conducted. In sections where elevation changes would otherwise result in excessive gradients, ramp junction manholes are introduced to limit pipe slopes to less than 6%, thereby maintaining acceptable flow velocities and reducing the potential for scouring and erosion within the pipeline.

Polymer Concrete manholes lids will be used, as discussed in section 5.1.2.

5.3 Wastewater Treatment Works

5.3.1 Civil Infrastructure

5.3.1.1 Access Roads

The proposed access road has a 10-meter-wide road reserve, which includes a 2-meter-wide service corridor on either side to accommodate underground utilities. The road has been designed to accommodate a SANRAL single-unit design vehicle, which requires a minimum turning radius of 10 meters.

The layout allows for two-way traffic and incorporates an access control point at the entrance to regulate vehicular movement. The pavement structure will consist of an asphalt surfacing layer, underlain by a bituminous-treated base and a C4 quality subbase layer, as illustrated in Figure 5-1.

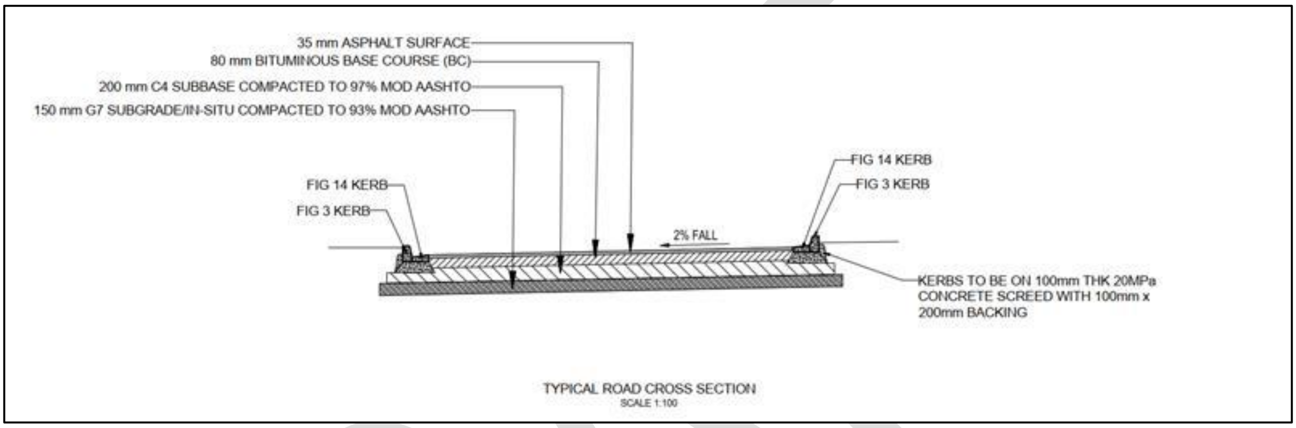


Figure 5-1 Pavement Layers

5.3.1.2 Stormwater Management

Rainfall Data

Table 5-1 below contains the design rainfall data obtained from the nearest rainfall station Klipdrift (34º 4' Lat; 24º 17' Long) with an altitude of 105 m and a mean annual precipitation of 931 mm.

Table 5-1: Woodlands Rainfall Data

Return Period (years)	Duration (days)						
	1	2	3	4	5	6	7
2	76,10	95,60	109,20	114,90	119,50	123,40	126,80
5	112,50	141,30	161,40	169,80	176,60	182,40	187,40
10	141,20	177,30	202,60	213,10	221,60	228,90	235,20
20	172,80	217,00	248,00	260,90	271,40	280,20	287,90
50	220,70	277,10	316,60	333,10	346,50	357,80	367,70
100	262,50	329,60	376,60	396,20	412,10	425,60	437,30
200	309,90	389,20	444,60	467,80	486,60	502,40	516,30

Design rational and frequency

Stormwater will be managed overland via sheet flow, caught into kerb inlets, and conveyed to a stormwater detention pond. Minor storm events are analysed at 1:5-year recurrence interval and major events at a 1:100-year recurrence interval.

A stormwater berm will be constructed along the boundary adjacent to the landfill site to prevent stormwater runoff generated on the landfill site from entering the Wastewater Treatment Works (WWTW) site.

Design Runoff

The Pre and Post development flows are indicated in Table 5-2 below.

Table 5-2: Pre-and Post Development flows

	Area (m^2)	Run off (m^3/s) during storm event					
		1:2	1:5	1:10	1:20	1:50	1:100
Pre-Development	16135	0,014	0,022	0,030	0,045	0,079	0,118
Post Development	16135	0,062	0,091	0,115	0,154	0,215	0,266
Difference	0	0,048	0,069	0,085	0,109	0,136	0,148

The table indicates that the post development runoff is much higher than pre-development runoff. This is due to the increase in impermeable surfaces. Stormwater will be detained in a retention pond and discharge at pre-development runoff rates.

Retention Facility

The stormwater retention facility is designed to accommodate runoff from a 1:50 year storm event, with a required storage volume of 194 m^3. Stormwater from the site will be conveyed to the retention pond via a system of underground pipelines. The outlet structure of the pond will function as an overflow, with discharge governed by orifice flow principles.

5.3.1.3 Water Supply

Demand and flowrate

The WWTW will have a staff ablution facility consisting of two toilets, a hand wash basin, and a shower. The admin building also has a kitchen with a basin, and laboratory with a basin. Table 2 in SANS 10252 Part 1 guided the water demand calculation while Table 3 is used to determine the design flow rate.

Table 5-3: Water Demand and Flow Rate

Fitting	No. of Fittings	Daily Demand (l) per person	Design Flow (l/min)
Wash Hand Basin*	4	6	40
Waste Closet*	4	14	20
Shower	2	6	30
	Total	**26**	**90**

* This water is assumed to go to the conservancy tank (see Sanitation section of this report).

The table indicates that the facility has a daily demand of 26 l per person and a design flow of 1.5 l/s (90 l/min).

Reticulation

A 50 mm Ø HDPE PE100 PN10 metered water connection is proposed at the southwestern corner of the site. Currently, the water connection point for the site is unknown.

5.3.1.4 Sewer Reticulation

Reticulation rationale

The site is situated downstream of the head of works of the WWTW and is therefore unable to connect into the system unless a pump system is used. Since the facility is envisioned to be operated by eight to 10 persons during the day, it will generate low volumes of effluent and it is therefore not feasible to pump wastewater. A small conservancy tank is proposed to store effluent for one month before a vacuum tanker empties it. A 110 mm Ø uPVC Class 34 Heavy Duty Solid Wall pipe will convey effluent from the ablution to the conservancy tank.

Conservancy tank

The conservancy tank is sized to store a single month of effluent before being emptied. The tank size is based on a future maximum of three staff on site using the demand figures in Table 6-4 Water Demand and Flow.

Conservancy Tank Size (l) = Staff (No.) x Average Waste Water Loading (l/d) x Storage Duration (days)
= 10 staff x 25 l/d x 30 days
= 7 500 litres

The required storage is 7 500 l therefore an 8000 to 8500 l conservancy tank should be used. A recycled Linear Low-Density Polyethylene (LLDPE) non-corrosive wastewater tank is specified. The product should have minimum 10-year warranty.

It is proposed that a 1.8 m high security fence be installed along the perimeter with a single sliding gate.

5.3.2 WWTW Design Considerations

This section explains the factors that were considered for the preliminary process design of the new Woodlands WWTW. These factors are explained in detail in this chapter:

- Population and flow projections
- Catchment area and wastewater plant site location
- Relevant legislation and regulatory requirements and effluent discharge limits]
- Characteristics of raw wastewater and degree of treatment
- Selection of treatment processes, equipment, and process train
- Plant layout
- Plant hydraulic conditions
- Plant hydraulic profile
- Energy and resource requirements plant economics
- Environmental Impact Assessments

5.3.2.1 Flow Projections

This section refers to the hydraulic load calculations done under section 3 of this report.

5.3.2.1.1 Flow Variation

The sewage flows to the wastewater treatment plant vary over 24 hours and are based on wet and dry conditions. Infiltration of groundwater and ingress of surface stormwater into the sewerage system will affect the rate of flow significantly. Hence flow recording during both wet and dry weather conditions is necessary to establish peak factors.

In addition to the planned incoming flow from the outfall sewers, provision has also been made for receiving sewage from honey suckers.

Average Dry Weather Flow (ADWF)

Average dry weather flow (ADWF) is the total influent wastewater flow entering the treatment plant during normal daily operations flow and it is used when designing treatment units. (ADWF = 500 Kl/d)

Peak Dry Weather Flow (PDWF)

Peak dry weather flow (PDWF) is the maximum flow rate in the sewage treatment plant during dry weather. It is computed by multiplying ADWF with the peak dry weather factor. (PDWF: 500 kl/d x 1.6 = 800 Kl/d)

Peak Wet Weather Flow (PWWF)

Wet weather flows include the sewage flow and runoff that infiltrate into the sanitary sewer systems during a storm event. Then, the highest flow during the event is called peak wet weather flow (PWWF). It is determined by the wet day peak factor multiplied by ADWF. The geology and climate of the area therefore needs to be considered when planning for wet weather peaks. (PWWF: 500 kl/d x 2 = 1000 Kl/d)

5.3.2.2 Legislation and regulatory requirements and effluent/discharge limits

The list of major legislation governing wastewater are as follows:

- Constitution of the Republic of South Africa, 1996
- Water Services Act, No. 108 of 1997
- Municipal Systems Act 32 of 2000
- The National Water Act 36 of 1998
- National Environmental Management Act (NEM) No.107 of 1998
- NEM: Biodiversity Act No. 10 of 2004
- NEM: Protected Areas Act No. 57 of 2003
- NEM: Waste Act No. 59 of 2008
- NEM: Air Quality No. 39 of 2004
- NEM: Environmental Impact Assessment Regulations 2014
- National Heritage Resources Act No. 25 of 1999
- Occupational Health and Safety Act No. 85 of 1993

A list of major regulations governing wastewater activities are mentioned below:

- Regulations on the discharge of waste or water containing waste into a water resource through a pipe, canal, sewer, or other conduit; and disposing in any manner of water which contains waste from, or which has been in, any industrial or power generation process. Revision of General Authorisations in terms of Section 39 of the National Water Act,1998 (Act. No. 36 of 1998) sections 21 (f) and (h) (Gazette No.36820, dated 06 September 2013).
- Regulations on the disposing of waste in a manner that may detrimentally impact a water resource. Revision of General Authorisations in terms of Section 39 of the National Water Act,1998 (Act. No. 36 of 1998) sections 21 (g) (Gazette No.36820, dated 06 September 2013)

5.3.2.3 Characteristics of raw wastewater and degree of treatment

It is significant to have reliable raw wastewater characteristics for the design of Woodlands WWTW. These characteristics are developed based on flow conditions, and physical, chemical, and biological parameters. The data is a requirement for the initial and the design year. This data will include average dry weather flows; peak weather flows; and chemical parameters i.e., chemical oxygen demand (COD) and biochemical oxygen demand (BOD), total suspended solids (TSS), Inorganic suspended solids (ISS), Total Kjeldahl Nitrogen (TKN), Ammonium-nitrogen (NH_4-N), total phosphorous (TP), alkalinity, and toxic chemicals.

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 5-4 below indicates the strength of municipal and minor industrial wastewater of various parameters.

Table 5-4: 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 5-5 below.

Table 5-5: 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

5.3.2.4 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 m^3/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

5.3.2.5 Plant Site Layout

It refers to the configuration of the treatment units, piping, and building over the selected site of the proposed wastewater treatment plant. Various crucial factors are considered including topography, soil condition, accessibility, hydraulics, future expansions, aesthetics, and environmental control. The Woodlands WWTW site layout is attached on Appendix C of this report.

5.3.2.6 Plant Hydraulic Conditions

Wastewater treatment plants utilize pipes and channels for connecting treatment units, pumping, flow measurement, and sometimes flow equalization. Although these components do not provide any direct treatment, they are considered an integral part of the overall process design for both bulk liquid and sludge streams.

Connecting Conduits: At a WWTW, a variety of connecting conduits are available to transfer wastewater from upstream to downstream units. Many of these conveyance systems consist of open channels, pipes (force mains), and partially flowing circular sewers.

Pumping: In the WWTW, there is a location where gravity flow is not applicable, and the use of pumping of wastewater is required. Pumps are utilised to provide sufficient head (elevation) to achieve flow by gravity through various process units. Dosage of chemicals such as chlorine, coagulants and polymers use positive displacement pumps.

Flow measurement: Measurement of wastewater flow, sludge, and chemical/coagulant solutions at WWTW facilities is essential for plant operation, process control, and record keeping. The flow measurement devices may be located in the pump discharge, recycle streams, and sludge plant.

Flow and Mass Equalization: Flow and mass equalization is simply the dampening of the flow rate and mass-loading variations. With flow equalization, the plants can be designed and operated under a nearly constant ideal flow and mass-loading condition. This minimizes shock and achieves maximum utilization of the wastewater treatment plant.

5.3.2.7 Plant Hydraulic Profile

The hydraulic profile is the graphical representation of the hydraulic grade line through the treatment plant. Hydraulic profile is prepared to ensure that:

a. adequate hydraulic gradient exists for wastewater to flow by gravity,

b. pumps deliver the adequate head, and

c. treatment units are not flooded or backed up during periods of peak flow.

Connecting pipes, and collection and division boxes are provided to transmit flow from one unit to the other and to isolate some units from the process train for maintenance.

5.3.2.8 Energy and resource requirements and plant economics

The new Woodlands WWTW will need energy for plant operation, other consumables, and for running equipment during construction. Resource requirements include land, equipment, instrumentation, and labour. The plant economics is therefore not only based on the initial construction costs but also on annual operation and maintenance (O&M) costs.

5.3.2.9 Environmental Impact Assessments

The development of a WWTW may have both beneficial and adverse, primary and secondary effects, all of which must be included in the environmental impact assessment. The main effects are those that are directly related to the construction and operation of the WWTW.

For example, the main effects of the plant operation are changes in water quality and odours. The expansion or alteration in land use brought about by the construction of the plant or the sewers connected to it causes secondary effects. The design engineer will collaborate closely with the Water Service Authority or Water Service Provider responsible for the organization, development, and management of wastewater treatment facilities to meet these environmental concerns.

5.3.3 WWTW Process Design

This section explains the criteria for process design, methods of process selection, and the design of the preferred optional analysis.

5.3.3.1 Design Criteria

5.3.3.1.1 Design Life Assumptions

Civil, structural, and building works are designed and are to be constructed based on a 45-year service life. Design lives for other components of the project are given in Table 5-6.

Mechanical and electrical equipment shall be suitable for a 24-hour day continuous operation and under discontinuous operation under all local climatic conditions and shall further be designed such that complete replacement shall not be required until at least 15 years after the date of taking over.

All mechanical and electrical equipment to be supplied shall, wherever possible, have a proven reliability record in similar works. Wearing parts, other than consumable items, shall have a design life of at least 5.0 years assuming continuous operation.

Table 5-6: Asset Design Life

Description	Design Life (Years)
Buildings and Concert Structures	45
Pipework	30
Mechanical Plant	
Pumps	15
Valves and Actuators	15
Process Plant – Wastewater (wet train)	15
Process Plant – Sludge (sludge train)	15

Description	Design Life (Years)
Electrical Plant	
MV switchgear and transformers	25
LV Motor Control Centres	15
Electrical Installations	15
Instrumentation, Control and Automation equipment	10

5.3.3.1.2 Geotechnical Considerations

Geotechnical consideration is crucial in ensuring WWTW foundation design for structures can support the load imposed by the facility. The important factors include the soil type, groundwater conditions, and seismic activity when designing foundations. The slope stability within the proposed WWTW requires stability analysis.

Geotechnical investigations for the site are currently underway. This section will be updated upon completion of the studies and availability of the final geotechnical report.

5.3.3.1.3 Topographical survey

A topographical survey was conducted for the project site area. The figure below presents the 2 m contour survey of the site.

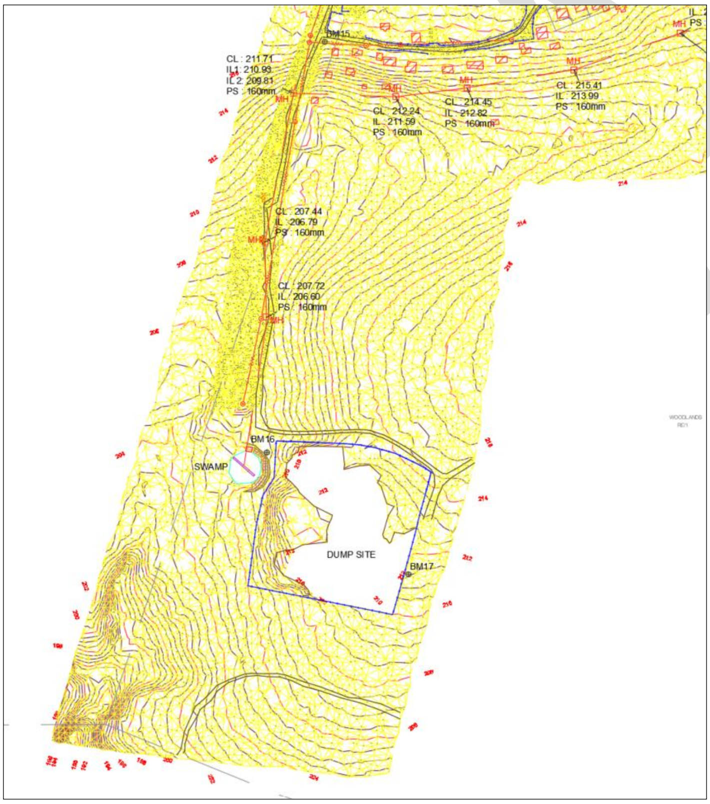


Figure 5.3-1 Topographical Survey

5.3.3.2 Suitable Process Technology Adopted

Following the submission and presentation of the Preliminary Design Report to the client, the Extended Aeration Activated Sludge process was selected as the preferred treatment option.

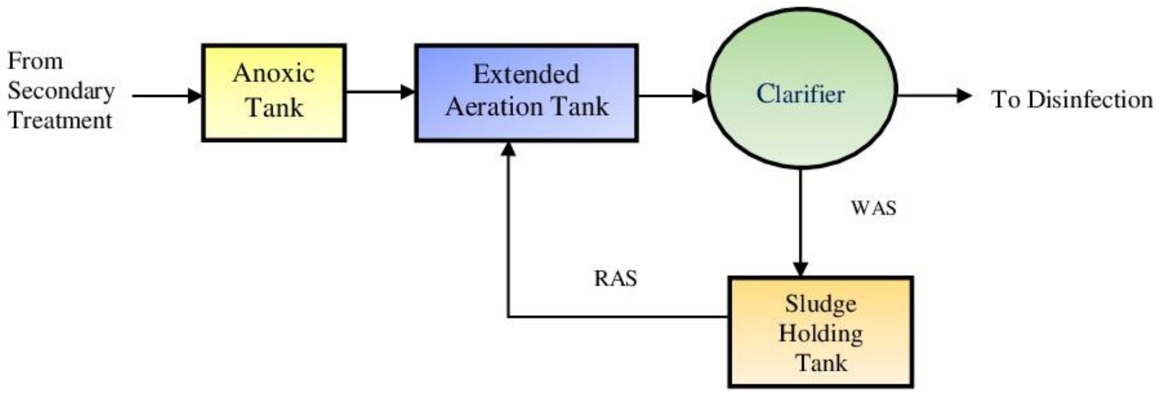
5.3.3.2.1 Extended Aeration Activated Sludge

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 5.3-2 Typical extended aeration process configuration (Onevproject.com, 2016)

5.3.3.3 Process Units

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.

This section describes the liquid treatment and solid/waste management process units. The liquid treatment process units include the preliminary treatment, plant flow measurement, flow balancing (balancing tank), secondary treatment (biological nutrient reactor and clarification) and disinfection. The solid/waste treatment unit operations include the following sludge thickening, stabilisation, dewatering and storage. Furthermore, this section explains the wet weather flow management, electrical and instrumentation design, and site layout.

5.3.3.3.1 Preliminary Treatment (Head of Works)

The new inlet works is 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 is provided with a means of flow measurement as required by the Department of Water and Sanitation.
The screens are designed to handle both the initial minimum hourly flows as well as expected PWWF for the design capacity of the Works. The head of works includes:

- 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.

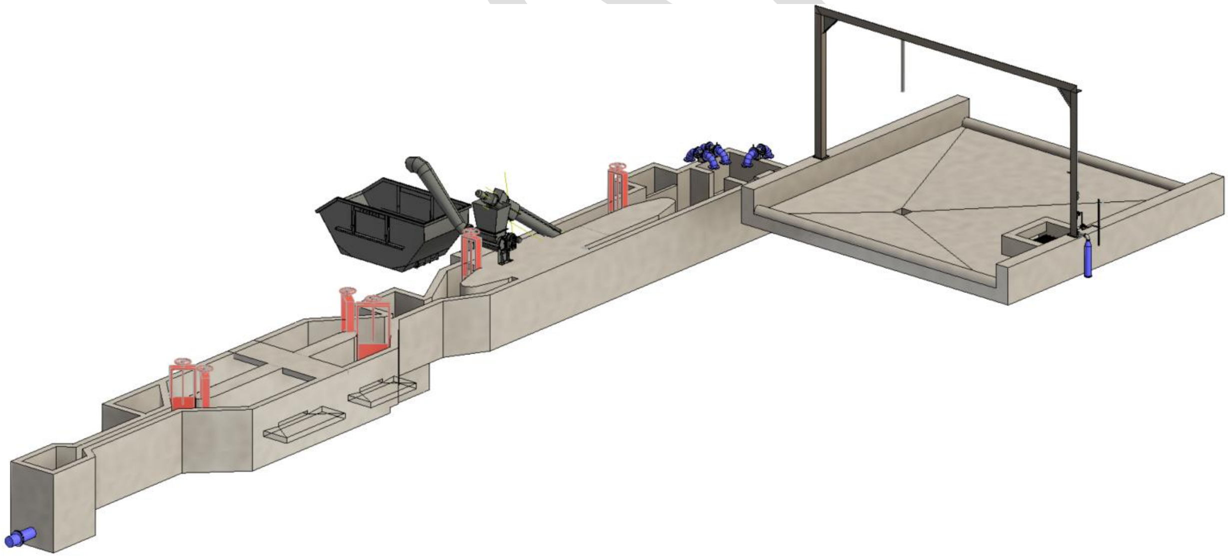


Figure 5-6 Head of Works

5.3.3.3.2 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.

SMEC is of the opinion that the existing Woodlands WWTW package plant can be repurposed and adapted for use as a balancing tank in the new WWTW. The structural integrity of the existing concrete tank will need to be assessed to confirm its suitability for this purpose. All mechanical components currently associated with the package plant will be removed, and the structure will be modified accordingly. Modifications will include creating appropriate openings for inlet and outlet pipelines, and installation of mechanical components such as a mixer. A bypass weir will be allowed from this structure and will be connected and spilling well will be connected to the stormwater dam to contain any sewage during emergencies, such as maintenance or flood events.

The details of the existing structure are provided under section 4.3 of this report.

5.3.3.3.3 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.

Anoxic Zone

This zone is the main denitrification reactor in the process. The WWTW is designed to operate on MLE process configuration. The main anoxic zone receives the following streams:

- Balanced raw sewage from the balancing tank.
- Return activated sludge (RAS or s-Recycle) from the clarifier. The recycle rate may vary between 0.75 x ADWF and 1.5 x ADWF.
- The A-recycle is abstracted from the end of the aerobic zones is pumped to the anoxic zone with a single axial flow pump operational (1 duty, 1 standby). The calibration of the internal recycle pumps will be manual and all flows will be measured by utilising the flumes in the open canal.
- 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 ± 150 m^3.
- Effluent will under gravity flow from the end of the Anoxic basin to the first aeration basin.

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 within the biological reactor is divided into two identically sized basins, each with a volume of ± 150 m^3, in series. The aerobic zone receives flow under gravity from the anoxic zone. The aeration capacity is based on oxygen transfer rates under standard conditions and adjusted for elevated site conditions. A hydraulic brake between the anoxic and aerated zones is provided to prevent back mixing.

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. An actuated, V-port knife gate valve, controlled by an inline electro-mechanical (MAG) type flow meter will control the rate of waste from the reactor. The flow of WAS will be under gravity to the sludge drying beds.

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 of surface aerators, with one aerator installed in each aerobic zone. Each aerator will have a power rating of approximately 15kW, resulting in total energy input of 30 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.

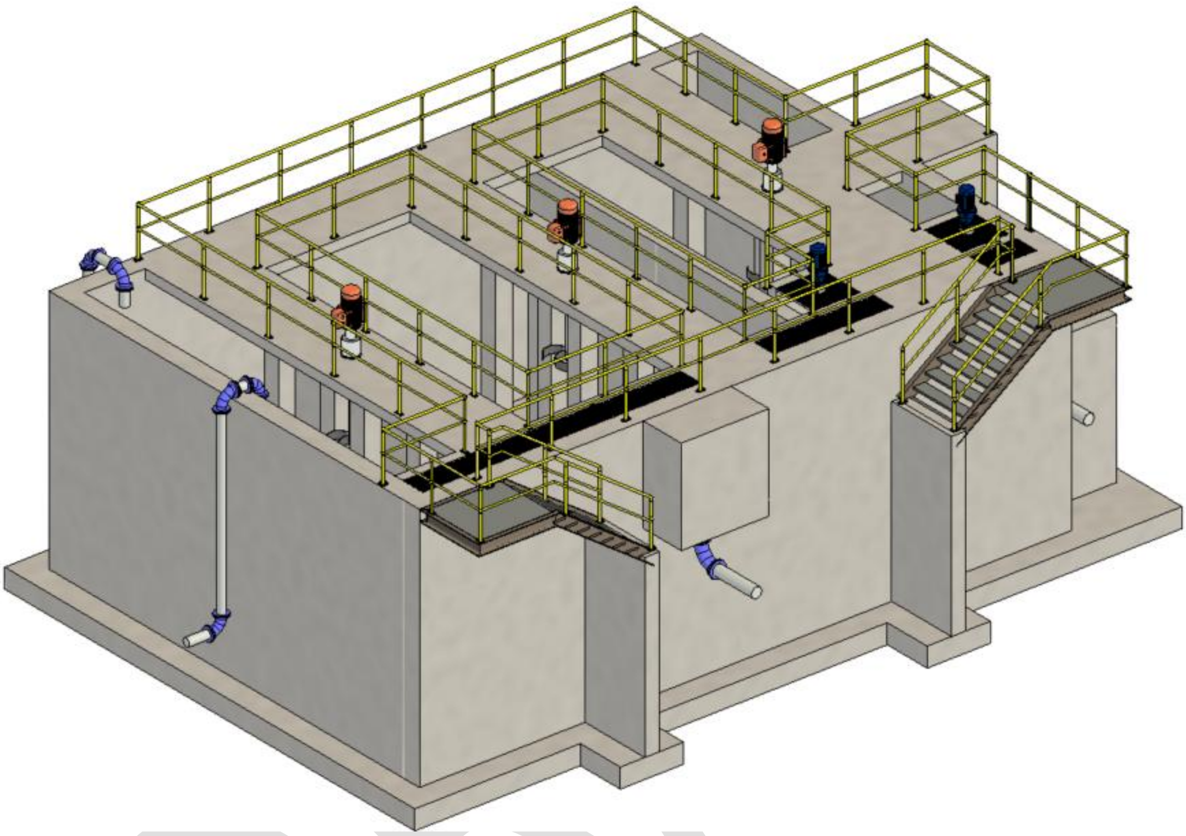


Figure 5-10 Biological Nutrient Removal

5.3.3.3.4 Clarifier

Clarification is the process of separating solids by settling of activated sludge to produce clear effluent for downstream processes. There will be one 7m 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.

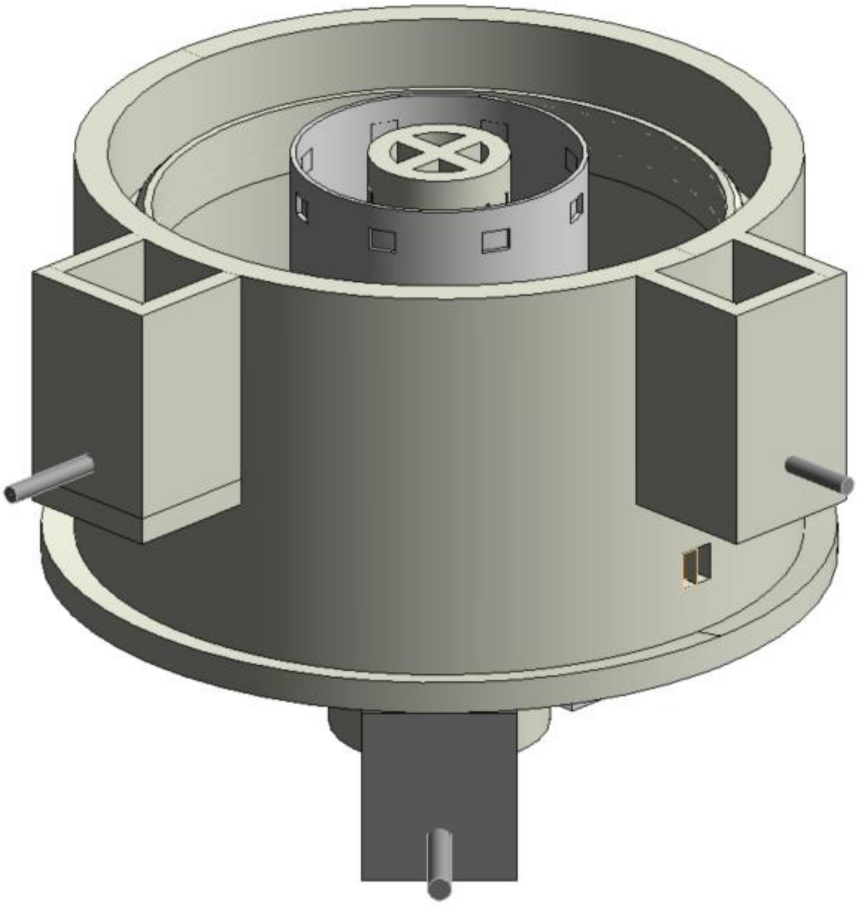


Figure 5-11 Clarifier

5.3.3.3.5 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 will be employed to ensure the removal of pathogens in the effluent from the clarifier.

The effluent from the clarifiers is collected in a common sump and then distributed into a $14m^3$ chlorine contact tank. Chlorine will be dosed at the inlet weir or in the pipe upstream of the inlet to the chlorine contact tank. The chlorine contact tank provides 20 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.

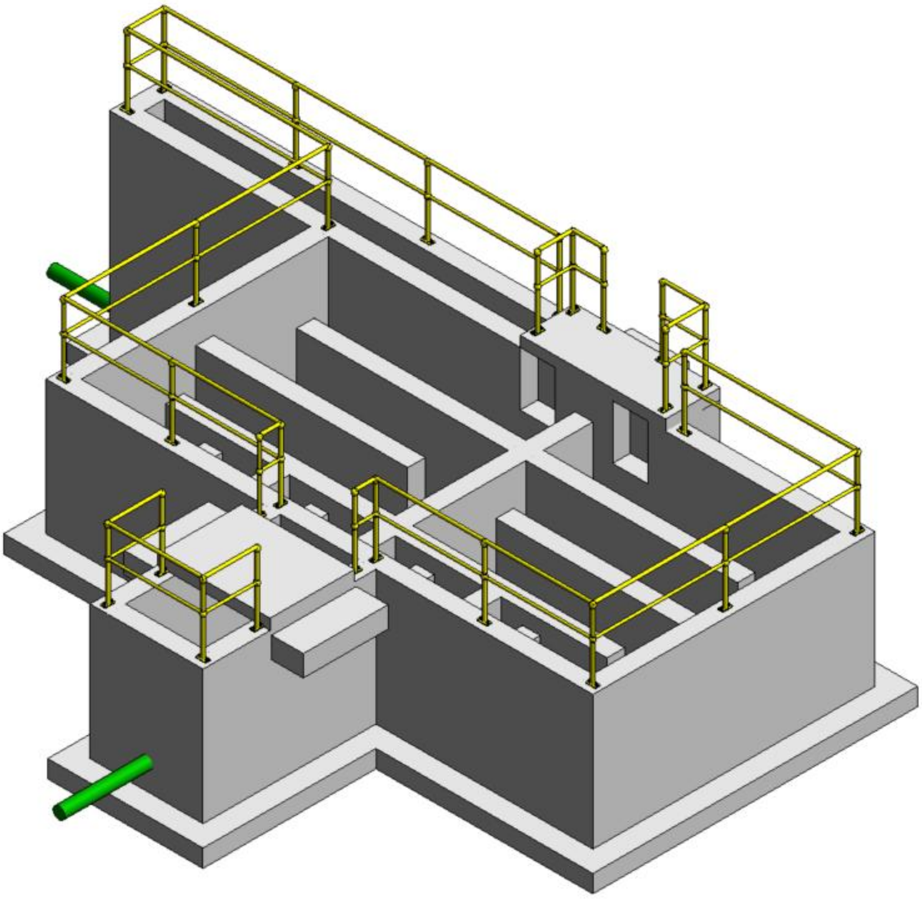


Figure 5-12 Chlorine Contact Tank

5.3.3.3.6 Storm Water Management

The excess overflow at the Inlet works, Balancing Tank, and Biological Reactor gravitates to a stormwater dam with a total storage capacity of ± 1100 m^3. The design incorporates a freeboard allowance of 500mm for additional capacity during extreme events.

The dam will be concrete lined to prevent seepage of raw sewage into the underlying soil, ensuring compliance with environmental protection standards and groundwater contamination mitigation measures. After the storm event, the contents will be pumped back to the inlet works at a slow rate to ensure the microorganisms are not washed out. Should the rain event exceed the capacity of the stormwater dam, the overflow will be discharged to the river.

5.3.3.3.7 Sludge Management System

There are two drying beds designed to receive Waste activated sludge (WAS) for the dewatering process. The discharge of WAS from the biological reactor will be initiated manually by the process controller. The volume wasted will be recorded by means of an inline flow measuring device. An actuated knife gate valve will be controlled by the means of the measuring device, by closing the valve once the pre-set discharge volume has been reached.

The selection of a drying bed will be at the discretion of the operator and/or process controller as instructed. The inlet valve to the selected will be manually opened and only closed once the WAS discharge flow has stopped.

Manually operated type stop log will allow after the initial sludge settling, the decanting of the residual supernatant water from the drying beds. The underflow and supernatant from the drying beds will be collected in a channel connected to the drying beds and will be pumped back to the head of works.

Once the sludge has dried, it will be manually removed. It is proposed that a skip bin be provided onsite for temporary storage of the dried sludge prior to disposal at a registered landfill site. The sludge treatment process is designed to produce waste sludge suitable for general landfill disposal or an A1a sludge that can be used for beneficiation purposes.

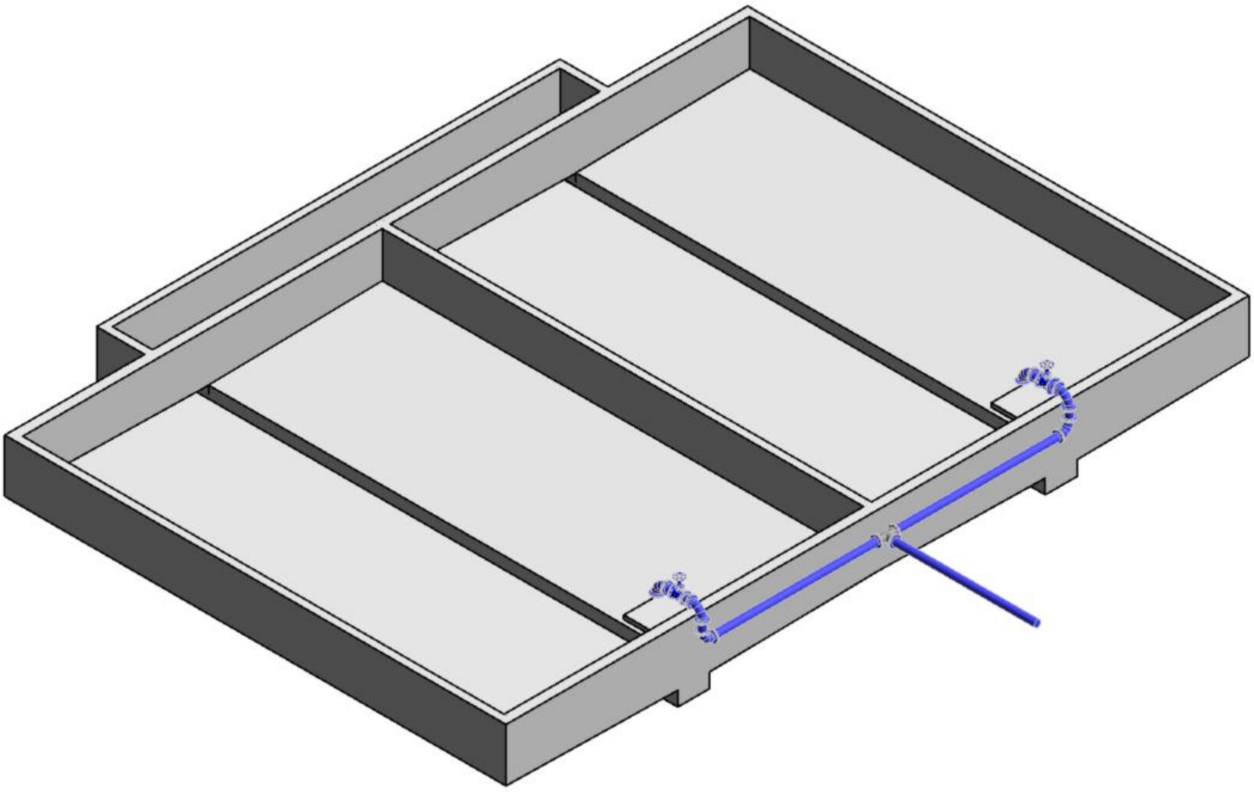


Figure 5-19 Sludge drying beds.

5.3.3.4 Admin Building

The on-site administration building will act as the receiving point for visitors and service providers to the new Woodlands WWTW. The building will have, offices, kitchen facilities, boardroom, laboratory, storeroom, and ablution facilities. Architectural renderings of the proposed administration building are provided below.

Figure 5.3-3 Administration building architectural renderings.

5.3.3.5 Electrical and Instrumentation

5.3.3.5.1 Council Power Supply

The capacity of the existing main electrical supply point and the capacity required at the new extension are still to be verified. 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.

5.3.3.5.2 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.

5.3.3.5.3 Electrical Installations in Buildings

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

5.3.3.5.4 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.

5.3.3.5.5 Motor Control Centre (MCC)

Equipment for each load centre shall be powered and controlled from an MCC. The 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.

5.3.3.5.6 SCADA System

The type or make of the Supervisory Control and Data Acquisition System on the existing plant needs to be verified. 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.

5.3.3.5.7 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 is to be verified. 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.

5.3.3.5.8 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.

5.3.3.6 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.

5.3.3.7 Construction

5.3.3.7.1 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.

5.3.3.7.2 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.

5.3.3.7.3 Labour-intensive Works

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

5.3.3.7.4 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.

5.3.3.7.5 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.

5.3.3.7.6 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 2 905 497,35
Section 2: Site Clearance	R 1 033 220.00
Section 3: Bulk Sewer	R 1 024 940,81
Section 4: Internal Sewer	R 12 469 325,04
Subtotal	R 17 432 984,10
Contingencies (20%)	R 3 486 596,82
Sub total	R20 919 580,92
VAT (15%)	R3 137 937,14
Grandtotal	**R24 057 518,06**

6.2 WWTW

The estimated costs of the WWTW are given below:

Table 6-2: Biological Nutrient Removal Cost Estimate

Woodlands WWTW - BNR	
Preliminary and General	R5 000 743.21
Schedule 1: Head of Works	R2 170 585.04
Schedule 2: Biological Reactor	R6 564 804.49
Schedule 3: Secondary Clarifier	R3 153 199.13
Schedule 4: Chlorine Contact Tank	R1 575 960.18
Schedule 5: Sludge Drying Bed	R2 215 378.91
Schedule 6: Chlorine Building	R934 895.13
Schedule 7: S-Recycle Pump Station	R544 839.25
Schedule 8: Submersible Pump Station	R363 601.94
Schedule 9: Motor Control Center Building	R572 378.05
Schedule 10: Interconnecting Pipielines	R526 595.68
Schedule 11: Stormwater Dam	R4 227 478.24
Schedule 12: Retrofitting Balancing Dam	R525 000.00
Schedule 13: Ext. Schedule: Admin Building (From Architect)	R1 629 000.00
Subtotal	R30 004 459.25
Contingencies (10%)	R3 000 445.93
Sub Total	R33 004 905.18
VAT (15%)	R4 950 735.78
Grandtotal	**R37 955 640.96**

6.2.1 O&M Cost Estimation

The estimated O&M costs are given below:

Table 6-3: BNR O&M Costs

Period/Term	Expected Operating Cost (1)	Expected Maintenance Cost (2)	Total O & M Cost (3=1+2)
Year1	R 1 200 178	R 300 045	R 1 500 223
Year2	R 1 216 980	R 304 246	R 1 521 226
Year3	R 1 234 018	R 308 505	R 1 542 523
Year4	R 1 251 294	R 312 824	R 1 564 118
Year5	R 1 268 812	R 317 204	R 1 586 016
Total	R 4 902 470	R 1 225 620	R 6 128 090

7. 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 R24 057 518.06. The estimated cost of the WWTW R37 955 640.96.

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:	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 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 (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 2													
Commercial			100										
Business	Business / Commercial	n/a	1,73	433,2	650	l per 100m²	1,13	0,02	0,02	80%	0,90	1,53	0,02
Institutional	Educational Facilities	n/a	1,07	268	600	l per 100m²	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 100m²		0,00	0,00		0,00	0,00	0,00
Agricultural	Including Irrigation	n/a	82,7942	8279,42	4000	l per 100m²	331,18	3,83	3,83		0,00	0,00	0,00
Institutional	Community Facilities	n/a	1,696	424	600	l per 100m²		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:	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 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 (KI/DAY)	PEAK DAILY FLOW (KI/DAY)	PEAK WET WEATHER FLOW (KI/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:

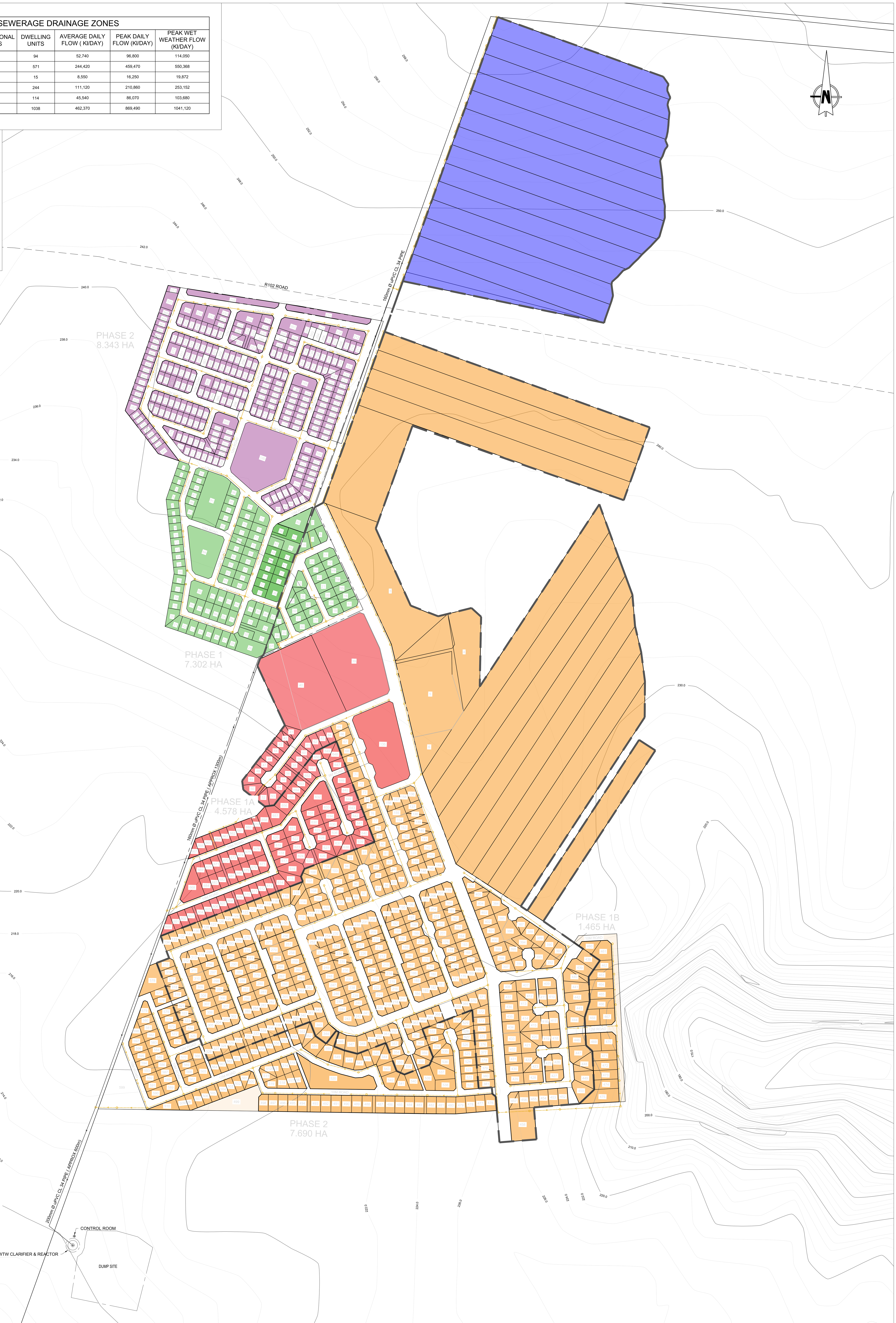
GENERAL
- ERVEN

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* Paper Size: *A0* Co-ordinate System: *WGS84 - LO23*

smec

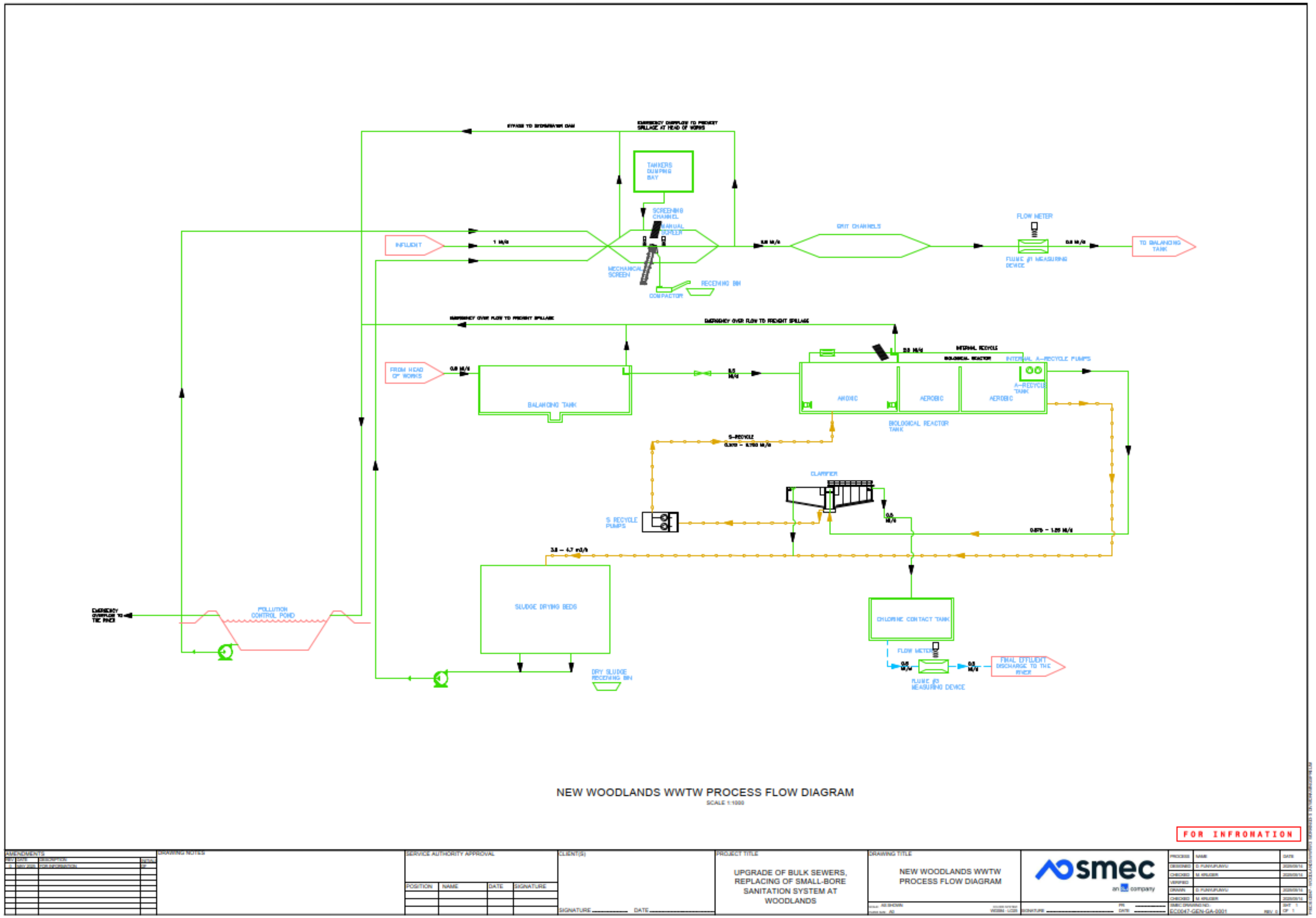
Signature__________ PR _____ Date _____

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

Appendix C WWTW Site Layout

Appendix D WWTW Process Flow Diagram



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