BITOU MUNICIPALITY

TECHNICAL REPORT

FOR

UPGRADING OF KURLAND WATER SOURCES, WATER TREATMENT WORKS, RESERVOIR AND BULK SUPPLY PIPELINES

(REVISION 5)

October 2022

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PROJECT 20028CG- DESIGN REPORT

REV	DESCRIPTION	ORIG	REVIEW	LYNERS APPROVAL	DATE	CLIENT APPROVAL	DATE
0	Report	PJ van Jaarsveld	Rev 0	FJ van Eck	12/05/2020		
1	Report	R Louwrens	Rev 1	FJ van Eck	19/01/2021		
2	Report	R Louwrens	Rev 2	FJ van Eck	15/09/2021		
3	Report	R Louwrens	Rev 3	FJ van Eck	20/09/2021		
4	Report	R Louwrens	Rev 4	FJ van Eck	30/05/2022		
5	Report	R Louwrens	Rev 5	FJ van Eck	06/10/2022		

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TECHNICAL REPORT FOR UPGRADING OF KURLAND WATER SOURCES, WATER TREATMENT WORKS, RESERVOIR AND BULK SUPPLY PIPELINE

1 INTRODUCTION

1.1 Location

Kurland falls under the jurisdiction of the Bitou Municipality and is a small residential township which is situated approximately 20 km north east of Plettenberg Bay, adjacent to the N2 Road. Kurland Township consists mostly of low-income households.

Bitou Municipality falls within the Eden District Municipal Area of the Western Cape Province. The Municipality is classified as a “Medium” capacity and Category “B” municipality. The Municipality is situated in the South-Eastern corner of the Province. Its Eastern boundary, the Bloukrans River, is also the boundary between the Western- and Eastern Cape Provinces and its southern border adjoins the Indian Ocean. Bitou Municipality falls within the Breede Gouritz CMA (BGCMA). The Municipality consists of the following seven (7) individual wards, is the only Water Services Authority (WSA) within this municipal area and is also the Water Service Provider (WSP).

1. Crags, **Kurland**, Keurbooms, Natures Valley and Covey.
2. Plettenberg Bay South and Plettenberg Bay North
3. Bossiegif, Qolweni, Pine Trees and Gatjie
4. New Horizons and Kwanokuthula Split VD
5. Phase 1 and 2 of Kwanokuthula
6. Phase 3 of Kwanokuthula
7. Kranshoek, Harkerville, Green Valley and Wittedrift

The Water Treatment Work (WTW) and reservoir will be constructed in the Kurland Water Treatment Works site about 3 km north of Kurland Township and the supply pipeline will be constructed from the WTW site to the development on Erf 562 directly south of Kurland.

1.2 Background Information

The Community Service Directorate is currently planning the integrated development of Erf 562 to the south of Kurland and has started with the EIA and Town Planning processes. The town planning layout on the 50-ha property has not been completed but the amount of low-cost serviced erven will be in the origin of 1 500. In addition, they are planning the development of 74 serviced sites within the existing township with a temporary relocation area (TRA) on a portion of Erf 562.

The development of erven surrounded by Erf 562, visible on Figure 1 below, are also considered in this report. These erven are currently privately owned, and it is estimated that the erven may be subdivided and developed in future. It was suggested by Bitou Municipality that provision must be made in terms of civil services to accommodate a maximum density of 52 units/ha on these erven. This amounts to 506 units.

The existing bulk water supply to the Kurland area needs to be supplemented to ensure sufficient bulk water supply for the existing Kurland Township, for the development on Erf 562 as well as for future growth of the area over the next 20 years.

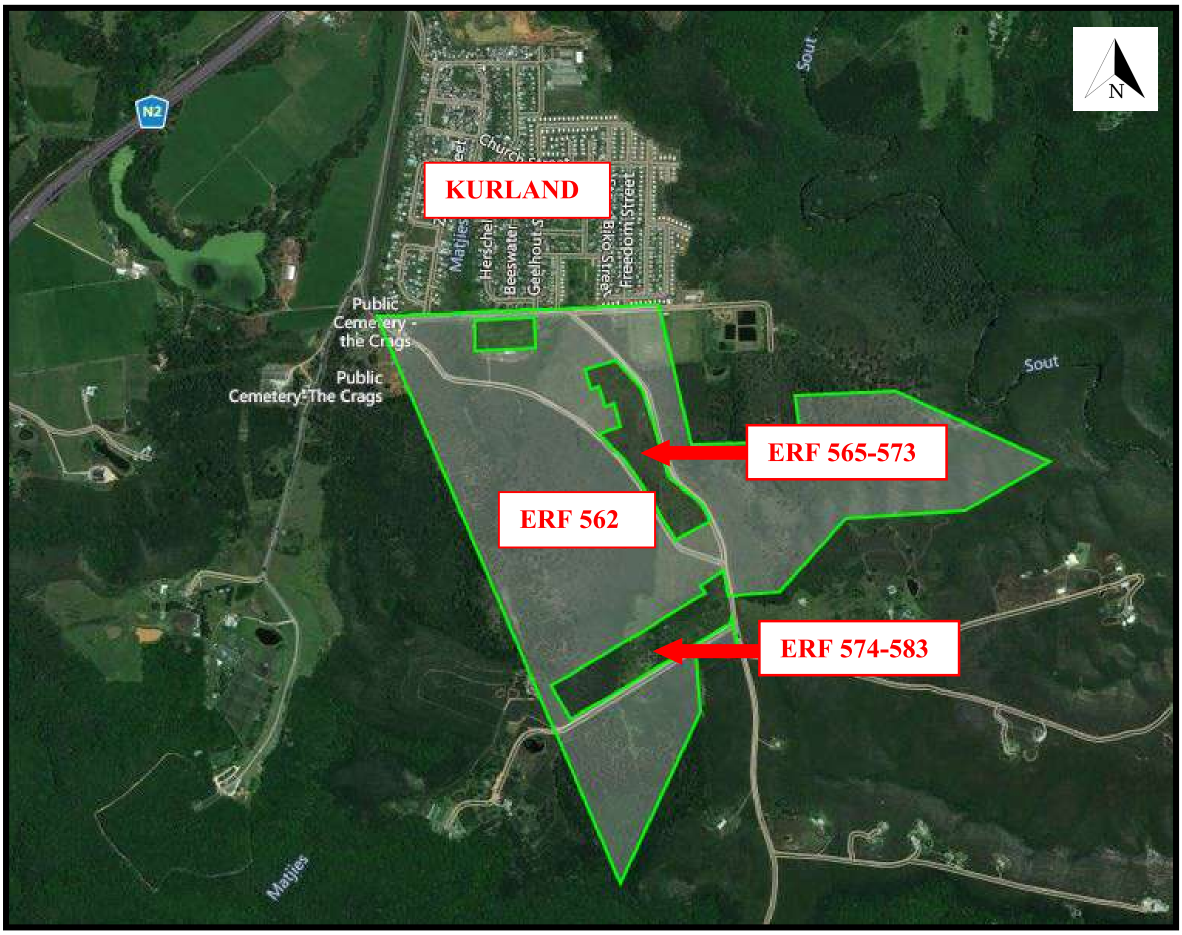


FIGURE 1: Locality of Erf 562 & Erven 565 - 583

1.3 Overview of Existing Bulk Infrastructure: Kurland

Raw Water Supply: The main raw water supply to the Kurland area is from the Wit River abstraction point. Water is pumped from a pump station at the Wit River abstraction point via a 700 m long 150 mm diameter rising main to the water treatment works. The capacity of the scheme is 600 Kl/day. The abstraction from the Wit River is not exceptionally reliable since the delivery of 600 kl/day reduces drastically during dry periods. Back-up sources are therefore important to provide sustainable supply.

There are two boreholes on the site of the Kurland water treatment works (WTW). GWA-KUR 1 with an inside diameter of 127 mm and casing installed to 150 m depth has been abandoned due to excessive iron content and clogging of the pipework. GWA-KUR 2 with an inside diameter of 146 mm and casing installed to 76 m depth has an optimum yield of 5 l/s (432kl/day).

Two (2) new boreholes Kur-3 and Kur-4 has been drilled within the WTW yard and are being equipped by Bitou Municipality. According to the report by Groundwater Africa attached under **Annexure C2** the four (4) boreholes should supply a sustainable yield of 8 L/s (961 Kℓ/d). In order to maintain a conservative approach towards water security the 5 L/s (432 Kℓ/d) shall be used as yield from the groundwater source.

In order to provide a reliable and sustainable bulk supply to Kurland a 3 km long 160 mm diameter uPVC pipeline has been laid in the past all along the N2 highway between the Kurland Reservoir and the Keurboom Strand Reservoir. This was done as Phase 1 of the proposed scheme to convey treated water from Keurboom Strand Reservoir to Kurland Reservoirs and a further approximately 9 km of 200 mm rising main will have to be laid all along the N2 to complete the scheme.

Water Treatment: The raw water is treated at the Kurland WTW, with a capacity of 600 Kl/day and the following processes exist at the WTW: Coagulation, flocculation, horizontal settlement, pressure filtration, gravity sand filtration, chlorination and PH correction.

Water Distribution: From the Kurland reservoirs treated water is fed via an existing 3.2 km long 200 mm diameter gravity supply pipeline to the Kurland Township. The potable water reticulation system consists of a total of 4,95 km of pipework ranging from 50 mm to 160 mm in diameter. Some reinforcement of pipes and inter-connection pipes will be necessary in future to improve the network conveyance.

*Continue to next page

2 POPULATION, WATER DEMAND AND SIZING OF WATER INFRASTRUCTURE

2.1 Future Water Demand

The 2011 census population figures showed an average growth rate of 5,35% for Bitou Municipality and a 4% growth rate for Kurland from 2001 to 2011.

Refer to **Annexure B** for two tables extracted from the 2018 updated Bitou Municipality WSDP showing the historical and future population and water demand for Kurland. The first table shows the future water demand at a growth rate of 4% and the second – at a growth rate of 5,35%.

The summarized future water demand for Kurland is as shown in Table 2.1 and 2.2. Year 2023 was taken as base month with the assumption that the development on Erf 562 will take place over a 10-year period from 2023 onwards.

Table 2.1: Kurland Future Water Demand – 4% Growth

Projected Water Demand (Kl/d) – 4% Growth	Year				
	2023	**2028**	**2033**	**2038**	**2043**
Average Annual Daily Demand (AADD) – Township (1)	575.0	575.0	575.0	612.0	651.0
Average Annual Daily Demand (AADD) – Erf 562 (2)	-	374.4	748.8	748.8	748.8
Average Annual Daily Demand (AADD) – Total (3)	575.0	949.4	1323.8	1360.8	1399.8

Table 2.2: Kurland Future Water Demand – 5,35% Growth

Projected Water Demand (Kl/d) – 5.35% Growth	Year				
	2023	**2028**	**2033**	**2038**	**2043**
Average Annual Daily Demand (AADD) – Township (1)	603.0	603.0	603.0	798.0	1027.0
Average Annual Daily Demand (AADD) – Erf 562 (2)	-	374.4	748.8	748.8	748.8
Average Annual Daily Demand (AADD) – Total (3)	603.0	977.4	1351.8	1546.8	1775.8

(1) : Projected demand figures for Kurland Township were obtained by subtracting the demand for Erf 562 from *the total average annual demand figures*

(2) : Erf 562 ***Average Annual Daily Demand***
2006 (1500+506) erven x 5 x 0,06 Kℓ/c/d x 1,2 (UAW)= 722.2 Kℓ/d
Plus 74 erven x 5 x 0,06 Kℓ/c/d x 1,2 (UAW) = 26.6 Kℓ/d
TOTAL = 748.8 Kℓ/d

The Assumption was made that the development on Erf 562 will phase in from 2023 to 2033

(3) : Projected demand figures and growth rates from the Bitou Municipality WSDP 2018 update (See Annexure B) were used and adjusted from 2033 to 2043 to make provision for the phasing in of the demand for erf 562

2.2 Sizing of Water Infrastructure

The design standards and – criteria in the DWS – RDP Guidelines and the CSIR – Guidelines for Human Settlement Planning and Design (Red Book) were used to evaluate the water infrastructure.

The evaluation of the infrastructure was based on the future water demand based on a **5,35% growth rate.**

- Raw Water Sources

  Required capacity: 1,5 x 1,1 x AADD $_{(10\ years)}$ = 1,5 x 1,1 x 1 351.8 Kℓ/d = 2 230.5 Kℓ/d

  Minus: Available capacity - Witrivier abstraction = 600.0 Kℓ/d
  - Boreholes in WTW yard = 432.0 Kℓ/d

  Additional Source Capacity Required = **1 198.5 Kℓ/d**

- Water Treatment Works (WTW)

  Required capacity: 1,5 x 1,1 x AADD $_{(10\ years)}$ = 1,5 x 1,1 x 1 351.8 Kℓ/d = 2 230.5 Kℓ/d

  Minus: Available capacity = 600.0 Kℓ/d

  Additional WTW Capacity Required = 1 630.5 **Kℓ/d**

- Storage Capacity

  Required capacity: 2 x AADD $_{(10\ years)}$ = 2 x 1 351.8 Kℓ/d = 2 703.6 Kℓ

  Minus: Available capacity = 1 500.0 Kℓ

  Additional Storage Capacity Required in 2033 = 1 203.6 **Kℓ**

- Supply Pipeline

  Required capacity: PHD $_{(1)}$: 4 x AADD $_{(20\ years)}$ = 4 x 1 775.8 Kℓ/d = 7 103.2 Kℓ/d = 82.2 ℓ/s

  Minus: Available capacity = 30.0 ℓ/s

  Additional Supply Pipeline Capacity Required = 52.2 **ℓ/s**

  (1) PHD = Peak Hour Demand

3 EXISTING SERVICES

3.1 Existing Water Services

There are existing Municipal water services within the site of the WTW. During the detail design of the WTW and the reservoir the re-location of these services will be provided for where needed. The new supply pipeline will be laid adjacent to the existing 200 mm diameter supply pipeline from the Kurland reservoir and WTW to the Kurland Erf 562 development. The existing 200mm diameter supply pipeline follows a route along the service road from the WTW to OP 7226 road, along the OP 7221 road up to the N2 road, crosses the N2 and then along the farm boundaries into Kurland township.

3.2 Existing Sewer

There are existing sewer lines in the vicinity of the sewage pump station at the Kurland Township and these sewer pipelines will be crossed with the supply pipeline by means of open trench excavation.

3.3 Existing Stormwater

The pipeline is expected to cross the Wit River and some streams as indicated in the EIA application. The crossings will be done by means of open trench excavation and then installing a HDPE pipe encased in concrete as per details in **Annexure F**.

3.4 Existing Electrical and Telephone Cables

Certain sections of the proposed pipeline will be installed parallel to an electrical overhead line. The pipeline will also cross overhead electrical and telephone cables at a few places.

3.5 Existing Roads

The proposed supply pipeline crosses both the OP 7226 road, N2 National Road and OP 7221 road. The pipeline crossings will be done by means of horizontal directional drilling as per details in **Annexure F**. Access roads to various farms will also be crossed by the pipelines. These road crossings will be done by normal half width open trench excavations.

3.6 Fences

The pipeline will cross various farm fences and will also be installed parallel to the District Roads OP 7226 and OP 7221 and N2 National Road reserve fences. In most instances the fences do not need to be removed except where the relevant crossings go through the fence, in which case fences will be re-installed.

3.7 Limitations Due to Wayleaves

District Road Engineer (DRE) – Way Leave approval documentation will be submitted to SANRAL and DRE. No approval has been granted yet to construct the new proposed pipelines within the DRE road reserve. The pipelines will have to be constructed on private properties, within the 5m DRE building line (roads ordinance 19 of 1976) and future proposed pipes within the 30m adjacent Municipal building line, overlapping the DRE building line (roads ordinance 19 of 1976).

Road crossings must be done by either horizontal directional drilling or pipe jacking. The proposed pipes must be installed within a sleeve underneath the SANRAL and DRE roads. The length of the sleeves must be the full width of the road reserve. The top of sleeve must be 1m below the road surface. The DRE must be notified of construction activities in advance and a final set of construction drawings provided to them.

Telkom - Way Leave approval documentation will be submitted to Telkom. After site visits conducted the Telkom overhead lines and optic fibre cables are within the road reserves and would thus only be affected when pipe crossing are being done. Plans of existing Telkom services were received from Telkom and these services will be reflected on the tender drawings.

Eskom - Way Leave approval documentation will be submitted to Eskom but approval has not been granted to date. After site visits conducted with Eskom personnel it was indicated that no work may be done closer than 4m with hand and 10m with machinery from their poles.

Municipal - Once appointed the relevant contractor needs to apply for way leave approval from the municipality. All known municipal services have been surveyed and indicated on the tender drawings.

3.8 Land Ownership

The proposed planned pipelines will have to be constructed within private property that falls within the 5m DRE building line (road ordinance 19 of 1976) and larger 30m Municipal building line and 60m SANRAL building line, measured from the road reserve fence. Once the final route of the proposed pipelines has been approved a land surveyor can commence the legal process of registering a services servitude to allow access to Bitou Municipality to operate and maintain the services. No compensation will be applicable to landowners due to the proposed servitude being inside the above-mentioned building lines. This however need to be confirmed by the legal department of the Municipality. The extent of the servitude would be in the order of 5m wide.

4 SITE INVESTIGATIONS

4.1 Geotechnical Investigation

A geotechnical investigation will be conducted on the proposed pipeline routes, reservoir and WTW sites. The test pits for the investigation will be done by hand. The test pits indicated that a certain section of the proposed pipeline routes close to the WTW will have harder material than the rest of the pipeline route. Due to the test pits being done by hand the hard material should be able to be excavated by means of an excavator. Geotechnical Report to be compiled during detail design phase.

4.2 Topographical Survey

A topographical survey has been conducted on the existing WTW site and on the proposed supply pipeline routes from the Kurland WTW to the Kurland Erf 562. The survey will be used to indicate any problem areas with regards to the design of the proposed infrastructure. Existing services will be located as far as possible, surveyed and indicated on the tender drawings.

5 ENVIRONMENTAL APPLICATION

Sharples Environmental Services is busy with the Environmental Application Process in order to obtain Environmental Authorisation for the proposed bulk water infrastructure of the area. The application process includes all the bulk water Infrastructure as planned.

6 PROPOSED SERVICES

6.1 Scope of Water Supply Scheme

6.1.1 Raw Water Source

The additional source capacity required in 2033 is 1 198.5 Kℓ/d (13,9 ℓ/s) – See 2.2.

A 3 km long 160 mm diameter uPVC pipeline was laid in the past from Kurland along the N2 Road towards Keurboom Strand. This was done as a first phase of a scheme to pump treated water from Keurboomstrand Reservoir (1 Mℓ) or Matjiesfontein Reservoir (3 Mℓ) to Kurland Reservoir. An additional length of about 9 km of 200 mm diameter pipeline as well as a pump station will be needed to complete the scheme.

Although the source capacity was calculated for a 10-year period, pipelines are designed for a 20-year period and hence the required capacity in 2043 will be:

1,5 x 1,1 x 1 775.8		=	2 930.1 Kℓ/d
Minus:	Witrivier abstraction	=	600.0 Kℓ/d
	Boreholes in WTW Yard	=	432.0 Kℓ/d
Total		**=**	**1 898.1 Kℓ/d**
		≈	**22.0 ℓ/s**

The Matjiesfontein Reservoir (3 Mℓ) has a bigger capacity than the Keurboomsrivier Reservoir (1 Mℓ) and is situated next to the N2 Road and it is easier accessible. It is therefore suggested that the water is pumped from Matjiesfontein Reservoir rather than from the Keurboomstrand Reservoir. The full water level (FWL) of Matjiesfontein Reservoir is 55 MSL and the FWL of Kurland Reservoir is 288 MSL.

GLS Consultants (GLS) included this scheme in the Water Master Plan (attached under **Annexure E**) for Bitou Municipality and it entails the following:

A new pump station at the Matjiesfontein Reservoir with a delivery of 35 ℓ/s at 185 m head will pump through a 3 080 m long 200 mm diameter uPVC rising main to a new 600 Kℓ reservoir (Matjiesfontein Upper Reservoir) next to the N2 Road. The pump station and reservoir will supply Kurland as well as the future Keurbooms area. At the new 600 Kℓ Matjiesfontein Upper reservoir a new pump station delivering 22 ℓ/s at 195 m head will supply the Kurland Reservoirs through a new 6 100 m long 200 mm diameter uPVC rising main. The new 200 mm diameter rising main will be connected to the existing 3 km long 160 mm diameter uPVC rising main which follows a route along the N2 Road up to the N2 pipeline crossing. At this point the existing 160 mm diameter rising main will feed water through a new 2 050 long uPVC 200mm diameter rising main to the Kurland

Reservoir which will be laid adjacent *(parallel offset to stay outside future SANRAL road reserve)* to the 200mm diameter old AC pipeline (which will be abandoned in place) currently supplying Kurland as shown on the drawings included under **Annexure D.**

6.1.2 Water Treatment Works (WTW)

The additional WTW capacity required in 2033 is 2 230.5 Kℓ/d - See 2.2. The additional water which will be pumped from Matjiesfontein Reservoir will be treated water and will not have to be treated again. The only additional treatment capacity required will therefore be for the borehole water which amounts to 432 Kℓ/d (5 ℓ/s).

Limited space is available on site between the existing structures of the WTW. It is therefore envisaged that the existing WTW be upgraded with an additional capacity of 500 Kℓ/d. The upgraded WTW will handle the same processes as the existing namely coagulation, flocculation, settlement, filtration, chlorination and PH correction. Bitou Municipality is currently in the process of upgrading the WTW Civil Engineering structures with DWS funding made available via the WSIG program. As a Phase 1.1, a motivation was also prepared by the Municipality to apply for extra funding from WSIG to install new Mechanical & Electrical Engineering equipment for the newly upgraded WTW as a Phase 1.2 **(Annexure F3).**

A conceptual technical memo and subsequent detail design report detailing the water treatment upgrade is included in **Annexure F1** and **Annexure F2** respectively.

6.1.3 Interim Water Sources

Groundwater Africa was appointed by Neil Lyners and Associates (RF) (Pty) Ltd to investigate groundwater as a water source option to augment supplies to Kurland Village for the Bitou Municipality. An initial target of 5 – 10 L/s is required for the first phase of a proposed housing development. The target will be reached with the current equipping of the four (4) boreholes within the WTW yard. Should ~25 L/s be available from groundwater sources then it may not be necessary to install a pipeline from the Matjiesfontein Reservoir the third phase of the Erf 562 development.

Kurland is located on the widely used Table Mountain Group (TMG) aquifer system, and there is a slight possibility of obtaining the targeted 25 L/s within a ~5 km radius of the village's Water Treatment Works (WTW). Several boreholes would be required, and in some areas, it may be necessary to treat for iron and manganese.

Due to the fact that these borehole sites are located on private properties and the water will need extensive treatment the potential of additional groundwater is not seen as a viable immediate option to augment the future water supply.

Potential drill sites and further detail regarding the ground water exploration is included under **Annexure C1 & Annexure C2**. These sites will be included in the EIA process though.

6.1.4 *Reservoir*

The additional reservoir capacity required in 2033 is 1 203.6 Kℓ- See 2.2. A reservoir with a capacity of 1 203.6 Kℓ is not a standard size, and it is therefore envisaged that a reservoir with a capacity of 1 500 Kℓ (1.5 Mℓ) is constructed which will be adequate until 2038. The new 1.5 Mℓ reservoir will be constructed directly adjacent to the existing 1 Mℓ and 0,5 Mℓ reservoirs. A total reservoir capacity of 2.7 Mℓ will be available which will satisfy the anticipated storage requirement until 2038.

6.1.5 *Supply Pipeline to Kurland*

The additional capacity required for the supply pipeline to Kurland is 52.2 ℓ/s - See 2.2.

The Water Master Plan Ad-hoc report for Bitou Municipality done by GLS **(Annexure E)** made provision for the following supply pipelines from the Kurland Reservoir to Kurland Township:

From Kurland Reservoir a new 2 560 m long 315 mm diameter uPVC pipeline will be laid adjacent *(parallel offset to stay outside future SANRAL Road Reserve)* to the old 200mm diameter pipeline (which will be abandoned in place), as shown on the drawings included in **Annexure D**. Where the 315 mm diameter uPVC pipeline stops, it will be connected to a new 330 m long 200mm diameter supply pipeline feeding the Kurland Township, which will follow the alignment of the existing Kurland Township supply pipeline. This 330 m long section will just replace the existing 200 mm diameter AC pipeline which is considered old, is deteriorated and will be requiring regular repairs.

The 315 mm diameter uPVC pipeline will also be connected to a new 1200 m long 200 mm diameter uPVC supply pipeline which will be laid from the 315 mm diameter supply pipeline to the development on Erf 562.

6.2 Design Standards

The following design standards will be used for the design of the water infrastructure:

- SABS 1200: Code of Practice for the Design of Civil Engineering Services
- Guidelines for the provision of Engineering Services and Amenities in Residential Township Development (Red Book).
- Guidelines for Human Settlements Planning and Design issued by Council for Science and Industrial Research (CSIR).

6.3 Pipe Size and Class

As part of the detail design for the total rising main masterplan Lyners will do the hydraulic design, surge analysis, water hammer analysis and optimization of the proposed rising main and pump scheme. Standard hydraulic principles as well as the Red Book standards will be used to determine the sizes and classes of the rising mains and pump stations in order to provide sufficient capacity for future development of the area. Optimization exercises will also be conducted to determine which pipe sizes will have the best operational benefits over its lifespan. As a result of the optimization exercise the GLS suggested outside diameter of the rising main may be adjusted slightly. The reason for any change in diameter could be due to the operational cost being less over the lifespan of the pipeline. The operational cost specifically focuses on the energy/electricity costs to pump the water via different size pipelines.

6.4 Thrust Blocks

Concrete thrust blocks will be designed to be installed at all bends and tees to prevent any movement due to pressure forces executed at these nodes. The maximum pressure during operational procedures and the minimum bearing capacity of the in-situ soil material has been used to calculate the size required for the thrust blocks at each turning node.

6.5 Air Valves, Scour and Gate Valves

To minimize the negative effect of air pockets and collection of debris, the number of high and low points along the vertical alignment of the pipeline will be kept to a minimum. Air valves will be installed at all high points and at a minimum of one every 350 m for long straight sections to facilitate the flow of air into and out of the pipes.

Scour valves with accompanying gate valves (as required by Bitou Municipality) will be placed at low points to facilitate the scouring of the pipelines when required. The gate valves can also be used to isolate different sections of the pipeline as required for maintenance.

6.6 Road Crossings

All the road crossings of the National- and District Roads will be performed by installing HDPE pipes by means of horizontal directional drilling. The smaller farm gravel access roads and Kurland internal Municipal roads will be crossed by means of open trench excavation. (See details in **Annexure G**)

7 PRELIMINARY COST ESTIMATE

7.1 Cost Estimate

A preliminary cost estimate was calculated to determine the order size budget required for the proposed works. A separate column indicates the cost that can be assigned to Keurboomstrand:

DESCRIPTION	TOTAL SCHEME	KEURBOOMS PORTION *(5)*	PHASE
SUPPLY SCHEME FROM MATJIESFONTEIN RESERVOIR TO KURLAND RESERVOIR			
Pump station at Matjiesfontein: 35 ℓ/s at 185 m head	R3 000 000.00	R1 500 000.00	Phase 3.1
Rising Main: 3 080 m Long 200 mm diameter uPVC Class 16	R6 776 000.00	R3 388 000.00	Phase 3.1
New 600 Kℓ Matjiesfontein Upper Reservoir	R4 000 000.00	R2 000 000.00	Phase 3.1
Pump station at new 600 Kℓ Reservoir: 22 ℓ/s at 195 m head	R2 600 000.00	N/A	Phase 3.2
Rising Main to Kurland: 6100 m long 200 mm diameter uPVC Class 16 (Before existing 160mm diameter)	R13 420 000.00	N/A	Phase 3.2
Rising Main to Kurland: 2050 m long 200 mm diameter uPVC Class 12 (After existing 160mm diameter)	R4 305 000.00	N/A	Phase 3.2
SUBTOTAL SUPPLY SCHEME FROM MATJIESFONTEIN RESERVOIR	**R34 101 000.00**	**R6 888 000.00**	
REST OF SCHEME FROM KURLAND RESERVOIR TO KURLAND TOWNSHIP			
Upgrade existing 600 Kℓ Water Treatment Works - Civil	R6 800 000-00	N/A	Phase 1.1
Upgrade Kurkland Water Treatment Works - Mechanical & Electrical	R 9 300 720.00	N/A	Phase 1.2
New 1,5 Mℓ Reservoir at the WTW	R7 800 000.00	N/A	Phase 3.3
Supply pipeline: 2 560 m long 315 mm diameter uPVC Class 12	R10 240 000.00	N/A	Phase 3.3
Supply pipeline: 1 200 m long 200 mm diameter uPVC Class 12	R2 520 000.00	N/A	Phase 2
Supply pipeline: 330 m long 200mm diameter uPVC Class 12	R 693 000.00	N/A	Phase 3.3
SUBTOTAL REST OF SCHEME TO KURLAND	**R37 353 720.00**	N/A	
TOTAL SCHEME			
SUBTOTAL (CONSTRUCTION COMPONENT)	**R71 454 720.00**	**R6 888 000.00**	
ESTIMATED PROJECT DURATIONS (MONTHS)	**30 months**	**7 months**	
PROFESSIONAL FEES			
Engineering fees	R7 145 472.00	R688 800.00	
Site supervision	R1 200 000.00	R154 494.31	
Geotechnical investigation	R200 000.00	R25 749.05	
Topographical Survey	R200 000.00	R25 749.05	
Safety Agent	R240 000.00	R30 898.86	
Environmental Control officer	R300 000.00	R38 623.58	
SUBTOTAL (PROFESSIONAL FEES COMPONENT)	**R9 285 472.00**	**R964 314.85**	
TOTAL (CONSTRUCTION COST) + (PROFESSIONAL FEES)			
SUBTOTAL (CONSTRUCTION COSTS + PROFESSIONAL FEES)	R80 740 192.00	R7 852 314.85	
VAT 15%	R12 111 028.80	R1 177 847.23	
TOTAL	**R92 851 220.80**	**R9 030 162.08**	

7.2 Cost Estimate Notes

- *The cost estimates above were based on the indicated construction periods, should the duration increase or decrease the estimate needs to be adjusted accordingly*
- *The cost estimate does not include any costs for registration of servitudes*
- *The estimate does not include additional time related costs for landowner engagement*
- *The estimate includes 20% P&G's and 10% contingencies for each construction item*
- *Portion of total Matjiesfontein Supply Scheme assignable to Keurbooms Upper areas*
- *Borehole and groundwater exploration costs not included*
- *Provision for 10% Professional Engineering Fees*

8 PHASING OF THE WORKS

8.1 PHASE 1 OF ERF 562 HOUSING DEVELOPMENT (ACCOMMODATE ADDITIONAL 200 UNITS ON ERF 562)

The existing Kurland WTW (600 kL/d) has minimal spare capacity and will have no spare capacity when Phase 1 (additional 200 unts) has been fully developed. Refer to 9.1 for more detail on the works.

Phase 1.1 ALREADY FUNDED BY WSIG (CIVIL WORKS)

Phase 1.1 Cost Estimate:	WTW 500 Kℓ/day	R 7 751 994-92
	VAT @ 15%	R 1 162 799-25
		R 8 914 794-15

The associated cost for mechanical and electrical works is an additional cost and is defined and motivated in a separate memorandum available in **Annexure F2** and **Annexure F3**.

Phase 1.2 Cost Estimate:	Mechanical & Electrical for WTW	R 10 509 339-60
	VAT @ 15%	R 1 576 400-94
		R 12 085 740-54

8.2 PHASE 2 OF ERF 562 HOUSING DEVELOPMENT (ACCOMMODATE ADDITIONAL 250 UNITS, 450 UNITS IN TOTAL ON ERF562)

Installing a bulk supply from existing network to Erf 562, refer to 9.2 for more detail on the works.

Phase 2 Cost Estimate:	Bulk Supply 200mm dia	R 2 847 471-57
	VAT @ 15%	R 427 120-74
		R 3 274 592-31

8.3 PHASE 3 OF ERF 562 HOUSING DEVELOPMENT (ACCOMMODATE ADDITIONAL 1630 UNITS, 2080 IN TOTAL ON ERF 562)

All remaining works, refer to 9.3 for more detail on the works, broken up in three sub-phases:

	Total Scheme	Keurbooms Portion
Phase 3.1 Cost Estimate: Miscellaneous	R 15 566 177-92	R 7 852 314-85
VAT @ 15%	R 2 334 926-69	R 1 177 847-23
	R 17 901 104-61	*R 9 030 162-08*

	Total Scheme
Phase 3.2 Cost Estimate: Miscellaneous	R 22 966 214-16
VAT @ 15%	R 3 444 932-12
	R 26 441 146-29

	Total Scheme
Phase 3.3 Cost Estimate: Miscellaneous	R 21 098 99-82
VAT @ 15%	R 3 164 849-07
	R 24 263 842-90

Note:

The cost estimates for the phases includes the proportional direct and indirect costs as shown in the Tender Cost Estimate (Item 7)

9 RECOMMENDATIONS

It is recommended that the scheme be developed in phases as follows (GLS Master Planning references shown in brackets):

9.1 Phase 1: Water Treatment Works (Additional 200 Units)

Phase 1.1 (ALREADY FUNDED BY WSIG):

- The water treatment works civil structures upgraded with an additional capacity of 500 Kℓ/day **(BKW.B1)**
- A new 32 m long 200mm diameter uPVC Class 12 distribution pipe **(BKW1.1)**

Phase 1.2:

- Mechanical and electrical works associated with water treatment works as per design report & motivation included under **Annexure F2** and **Annexure F3 (BKW.B1)**

9.2 Phase 2: Bulk Pipeline Connecting to Erf562 from Existing network (Additional 250 Units)

- A 1 200 m long 200 mm diameter uPVC Class 12 supply pipeline be installed from existing network to Erf 562 **(BKW2.1)**

9.3 Phase 3: Supply Scheme from Matjiesfontein Reservoir (Additional 1630 Units)

Phase 3.1:

- A 35 ℓ/s at 185 m head pump station be constructed at Matjiesfontein Reservoir **(BKW.B3)**
- A 3 080 m long 200 mm diameter uPVC Class 16 Rising Main be installed from Matjiesfontein Reservoir all along the N2 Road to a new 600 Kℓ Matjiesfontein Upper Reservoir **(BKW.B4)**
- A new 600 Kℓ Matjiesfontein Upper reservoir be constructed next to the N2 Road **(BKW.B5)**

Phase 3.2:

- A 22 ℓ/s at 195 head pump station be constructed at the 600 Kℓ Matjiesfontein Upper Reservoir **(BKW.B6)**
- A 6 100 m long 200 mm diameter uPVC Class 16 rising main be laid from the 600 Kℓ Matjies-fontein Upper Reservoir to the existing 160 mm diameter rising main **(BKW.B7)**
- A 2 050 m long 200 mm diameter uPVC Class 10 rising main be laid from the other end of the existing 160 mm diameter rising main to the Kurland Reservoir **(BKW.B8.1b)**

Phase 3.3:

- A new 1,5 Mℓ reinforced concrete Reservoir be constructed next to the existing two reservoirs **(BKW.B9)**
- A 2 560 m long 315 mm diameter uPVC Class 12 supply pipeline be installed from the Kurland Reservoir towards Kurland Township **(BKW1.3)**
- A 330 m long 200 mm diameter uPVC Class 12 supply pipeline from where the 315 mm diameter supply pipeline stops to the Kurland Township close to the Kurland Bottom Reservoir **(BKW1.2)**

If required, we are available to discuss the design with you at your convenience.

Yours faithfully

SIGNED_____________________ON DATE: 6 October 2022
R LOUWRENS, PR TECHNI ENG, FOR LYNERS

SIGNED_____________________ON DATE: 6 October 2022
F VAN ECK, PR ENG, FOR LYNERS

ANNEXURE A

SCHEMATIC LAYOUT OF PROPOSED BULK SERVICES


Kurland 2 Res
1 x 1000 kl
TWL = 288,00m
Kurland Reservoir 3
BKW.B9
1 x 2000 kL
TWL = 288.0m
Kurland 1 Res
1 x 500 kl
TWL = 288,00m
WTP
BKW.B8.4
160Ø
BKW.B8.3
BKW1.3
315 Ø
BKW.B8.1b
200 Ø
WTP
BKW.B1
Detail 3
BKW1.3
315 Ø
BKW.2.1
200 Ø
BKW.1.2
200 Ø
Detail 2
BKW1.2
200Ø
Kurland
Bottom Reservoir
(Decommisioned)
BKW1.1
200Ø
Detail 1
Matjiesfontein
Upper Reservoir
1 x 600 kl
TWL = 217.0m
BKW.B5
BKW.B7
200 Ø
BKW.B6
BKW.B4
200 Ø
Detail 5
See Detail 3
PROPOSED Ø315mm SUPPLY WATER PIPE
FROM WTW TO KURLAND TURN OFF, 2050m
BKW1.3
BKW.B8.1b
PROPOSED Ø200mm RISING MAIN WATER PIPE
FROM KURLAND TURN OFF TO WTW, 620m
PROPOSED Ø315mm SUPPLY WATER PIPE
FROM WTW TO KURLAND TURN OFF, 620m
See Detail 6
PROPOSED Ø200mm SUPPLY WATER PIPE
FROM WTW TO KURLAND TURN OFF, 520m
See
Detail 2
BKW1.3
See
Detail 1
BKW1.2
BKW2.1
PROPOSED Ø200mm SUPPLY WATER PIPE
FROM WTW TO KURLAND TURN OFF, 1140m
Kurland
Erf 562
EXISTING Ø160mm SUPPLY WATER
PIPE TO KURLAND TURN OFF, 2690m
N2 Highway
PROPOSED Ø200mm SUPPLY WATER
PIPE FROM NEW RES TO EX.Ø160, 6100m
BKW.B7
BKW B7
See
Detail 5
N2 Highway
PROPOSED Ø200mm SUPPLY WATER
PIPE FROM EX. RES TO NEW RES, 3100m
BKW.B4
BKW.B3
MATJIESFONTEIN RES
Keurboomstrand
BKW.B8.1b
200 Ø
BKW.B.2
BKW1.3
315 Ø
Note:
Replace old 200 mm
distribution pipeline
BKW1.3
315 Ø
Detail 6

ANNEXURE B

BITOU - WSDP PROJECTED POPULATION AND WATER DEMAND TABLES

Kurland - Input Variables for Water Demand Model

Parameter / Variable	Year	Income Categorization				Business[D]	Other[E]	Total
		High	Medium	Low	Sub- Total			
		Units are presented in brackets with the "Parameter Description" - First Column						
Population[A]	2018	34	1793	3479	5306	-	-	-
	2023	35	1980	4440	6455			
	2028	37	2186	5631	7854			
	2033	39	2413	7103	9556			
	2038	41	2664	8920	11626			
	2043	43	2942	11159	14144			
Growth (%/year)		Growth in Population				Growth in Demand		
	2018-2023	1.00%	2.00%	5.00%	4.00%	1.5%	1.5%	
	2023-2028	1.00%	2.00%	4.87%	4.00%	1.5%	1.5%	
	2028-2033	1.00%	2.00%	4.75%	4.00%	1.5%	1.5%	
	2033-2038	1.00%	2.00%	4.66%	4.00%	1.5%	1.5%	
	2038-2043	1.00%	2.00%	4.58%	4.00%	1.5%	1.5%	
Unit Demand (l/c/d)[B]	2018	140.0	90.0	60.0	-	-	-	-
Average Annual Daily Water Requirement (Kl/d - Water Losses Excluded)	2018	5	161	209	-	5	5	385
	2023	5	178	266		5	5	460
	2028	5	197	338		6	6	551
	2033	5	217	426		6	6	661
	2038	6	240	535		7	7	794
	2043	6	265	670		7	7	955
Water Losses (%)[C]	2018	28.1	28.1	28.1		28.1	28.1	-
	2023	20.0	20.0	20.0		20.0	20.0	
	2028	18.8	18.8	18.8		18.8	18.8	
	2033	17.5	17.5	17.5		17.5	17.5	
	2038	16.3	16.3	16.3		16.3	16.3	
	2043	15.0	15.0	15.0		15.0	15.0	
Average Annual Daily Water Requirement (Kl/d)	2018	7	224	290		7	7	535
	2023	6	223	333		7	7	575
	2028	6	242	416		7	7	679
	2033	7	263	517		8	8	802
	2038	7	286	639		8	8	948
	2043	7	311	788		9	9	1123
Average Peak Month Daily Water Requirement (Kl/d)	2018	8	258	334		8	8	616
	2023	7	256	383		8	8	662
	2028	7	278	478		8	8	780
	2033	8	303	594		9	9	922
	2038	8	329	735		9	9	1091
	2043	8	358	906		10	10	1292
Peak Day Water Requirement (Kl/d)	2018	9	323	417		10	10	**769**
	2023	9	320	479		10	10	**827**
	2028	9	348	598		10	10	**976**
	2033	10	378	743		11	11	**1152**
	2038	10	412	919		12	12	**1363**
	2043	10	448	1132		12	12	**1615**
Total Annual Water Requirement (Kl/year)	2018	2401	81923	105966		2538	2538	**195366**
	2023	2268	81292	121549		2458	2458	**210024**
	2028	2347	88372	151773		2607	2607	**247706**
	2033	2429	96092	188553		2766	2766	**292605**
	2038	2515	104509	233254		2935	2935	**346148**
	2043	2604	113690	287519		3115	3115	**410044**
Peak Month Factor[F]	1.15							
Peak Day Factor[G]	1.25							

Notes : → TO USE THIS SHEET, FILL IN THE VARIABLES IN THE SHADED BLOCKS ABOVE

References:

(A) - Total population based on Census 2011 data. Future estimated growth agreed with Municipality in January 2014.

(B) - Residential unit demands estimated.

(C) - Water Losses: Calculated water losses from July 2018 to June 2019. Estimated 8.1% reduction in water losses over the next five years.

(D) - Commercial and Industrial: Average calculated value from July 2018 to June 2019 treasury data for Business category.

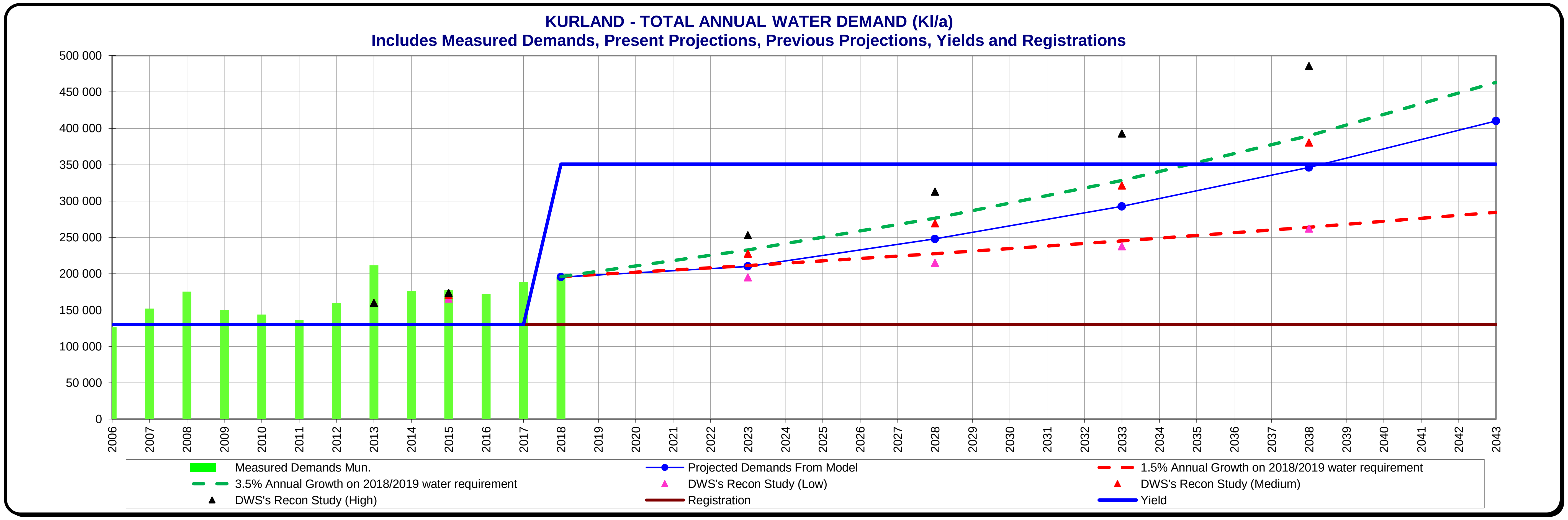
(E) - Others: Average calculated value from July 2018 to June 2019 treasury data for "Other" category.

(F) - Peak Month Factor: Maximum value calculated from July 2014 to June 2019 data.

(G) - Peak Day Factor : Estimated

Kurland Projected Water Requirements, Yields and Registrations (Kl/year)												
Year*	Measured Demands (Raw Water)	Projected Demands from model	Other Projections					Yields				Registration
			1.5% Annual growth on 2018/2019 water requirement	3.5% Annual growth on 2018/2019 water requirement	DWS's Reconciliation Strategy (Apr 2014)			Boreholes		Wit River	Total	Wit River
					Low	Medium	High	Kur 1	Kur 2	Same as Registration		22062027
2006	126 366									130 000	130 000	130 000
2007	152 049									130 000	130 000	130 000
2008	175 330									130 000	130 000	130 000
2009	150 039									130 000	130 000	130 000
2010	143 758									130 000	130 000	130 000
2011	136 679									130 000	130 000	130 000
2012	159 396									130 000	130 000	130 000
2013	211 587				160 000	160 000	160 000			130 000	130 000	130 000
2014	176 099									130 000	130 000	130 000
2015	177 189				166 000	171 000	174 000			130 000	130 000	130 000
2016	171 814									130 000	130 000	130 000
2017	188 610									130 000	130 000	130 000
2018	195 995	195 366	195 995	195 995				94 608	126 144	130 000	350 752	130 000
2023		210 024	211 142	232 781	195 000	227 900	253 000	94 608	126 144	130 000	350 752	130 000
2028		247 706	227 460	276 470	215 000	269 400	313 000	94 608	126 144	130 000	350 752	130 000
2033		292 605	245 039	328 360	237 700	321 400	392 800	94 608	126 144	130 000	350 752	130 000
2038		346 148	263 977	389 989	262 200	380 400	485 800	94 608	126 144	130 000	350 752	130 000
2043		410 044	284 378	463 184				94 608	126 144	130 000	350 752	130 000

Note: * The years in the above table refer to the Municipal Financial Years and is for the period July till June the following year. The measured demand for 2018 is therefore from July 2018 up to June 2019



Kurland - Input Variables for Water Demand Model

Parameter / Variable	Year	Income Categorization				Business[D]	Other[E]	Total
		High	Medium	Low	Sub- Total			
		Units are presented in brackets with the "Parameter Description" - First Column						
Population[A]	2018	37	1963	3808	5807	-	-	-
	2023	39	2167	5330	7536			
	2028	41	2392	7346	9779			
	2033	43	2641	10006	12691			
	2038	45	2916	13507	16468			
	2043	47	3220	18104	21371			
Growth (%/year)		Growth in Population				Growth in Demand		
	2018-2023	1.00%	2.00%	6.96%	5.35%	1.5%	1.5%	
	2023-2028	1.00%	2.00%	6.63%	5.35%	1.5%	1.5%	
	2028-2033	1.00%	2.00%	6.38%	5.35%	1.5%	1.5%	
	2033-2038	1.00%	2.00%	6.18%	5.35%	1.5%	1.5%	
	2038-2043	1.00%	2.00%	6.03%	5.35%	1.5%	1.5%	
Unit Demand (l/c/d)[B]	2018	130.0	80.0	55.0	-	-	-	-
Average Annual Daily Water Requirement (Kl/d - Water Losses Excluded)	2018	5	157	209	-	5	5	381
	2023	5	173	293		5	5	482
	2028	5	191	404		6	6	612
	2033	6	211	550		6	6	780
	2038	6	233	743		7	7	996
	2043	6	258	996		7	7	1274
Water Losses (%)[C]	2018	28.1	28.1	28.1		28.1	28.1	-
	2023	20.0	20.0	20.0		20.0	20.0	
	2028	18.8	18.8	18.8		18.8	18.8	
	2033	17.5	17.5	17.5		17.5	17.5	
	2038	16.3	16.3	16.3		16.3	16.3	
	2043	15.0	15.0	15.0		15.0	15.0	
Average Annual Daily Water Requirement (Kl/d)	2018	7	218	291		7	7	530
	2023	6	217	366		7	7	603
	2028	7	236	497		7	7	754
	2033	7	256	667		8	8	945
	2038	7	279	887		8	8	1189
	2043	7	303	1171		9	9	1499
Average Peak Month Daily Water Requirement (Kl/d)	2018	8	251	335		8	8	610
	2023	7	249	421		8	8	693
	2028	8	271	572		8	8	867
	2033	8	295	767		9	9	1087
	2038	8	320	1020		9	9	1367
	2043	8	348	1347		10	10	1724
Peak Day Water Requirement (Kl/d)	2018	10	314	419		10	10	**762**
	2023	9	311	527		10	10	**867**
	2028	9	339	715		10	10	**1083**
	2033	10	368	959		11	11	**1359**
	2038	10	400	1275		12	12	**1709**
	2043	10	436	1684		12	12	**2154**
Total Annual Water Requirement (Kl/year)	2018	2440	79701	106313		2538	2538	**193530**
	2023	2304	79087	133757		2458	2458	**220063**
	2028	2385	85975	181507		2607	2607	**275080**
	2033	2468	93485	243488		2766	2766	**344973**
	2038	2556	101674	323769		2935	2935	**433869**
	2043	2647	110606	427573		3115	3115	**547056**
Peak Month Factor[F]	1.15							
Peak Day Factor[G]	1.25							

Notes : → TO USE THIS SHEET, FILL IN THE VARIABLES IN THE SHADED BLOCKS ABOVE

References:

(A) - Total population based on Census 2011 data. Future estimated growth agreed with Municipality in January 2014.

(B) - Residential unit demands estimated.

(C) - Water Losses: Calculated water losses from July 2018 to June 2019. Estimated 8.1% reduction in water losses over the next five years.

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(F) - Peak Month Factor: Maximum value calculated from July 2014 to June 2019 data.

(G) - Peak Day Factor : Estimated

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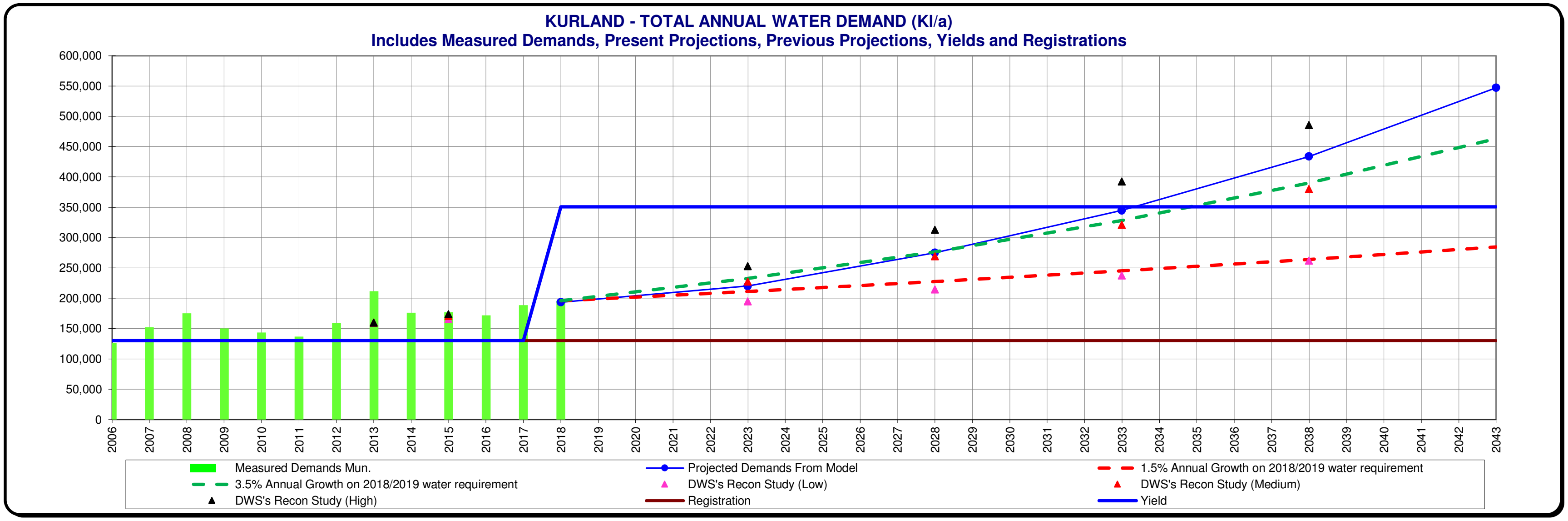
Year*	Measured Demands (Raw Water)	Projected Demands from model	Other Projections					Yields				Registration
			1.5% Annual growth on 2018/2019 water requirement	3.5% Annual growth on 2018/2019 water requirement	DWS's Reconciliation Strategy (Apr 2014)			Boreholes		Wit River	Total	Wit River
					Low	Medium	High	Kur 1	Kur 2	Same as Registration		22062027
2006	126,366									130,000	130,000	130,000
2007	152,049									130,000	130,000	130,000
2008	175,330									130,000	130,000	130,000
2009	150,039									130,000	130,000	130,000
2010	143,758									130,000	130,000	130,000
2011	136,679									130,000	130,000	130,000
2012	159,396									130,000	130,000	130,000
2013	211,587				160,000	160,000	160,000			130,000	130,000	130,000
2014	176,099									130,000	130,000	130,000
2015	177,189				166,000	171,000	174,000			130,000	130,000	130,000
2016	171,814									130,000	130,000	130,000
2017	188,610									130,000	130,000	130,000
2018	195,995	193,530	195,995	195,995				94,608	126,144	130,000	350,752	130,000
2023		220,063	211,142	232,781	195,000	227,900	253,000	94,608	126,144	130,000	350,752	130,000
2028		275,080	227,460	276,470	215,000	269,400	313,000	94,608	126,144	130,000	350,752	130,000
2033		344,973	245,039	328,360	237,700	321,400	392,800	94,608	126,144	130,000	350,752	130,000
2038		433,869	263,977	389,989	262,200	380,400	485,800	94,608	126,144	130,000	350,752	130,000
2043		547,056	284,378	463,184				94,608	126,144	130,000	350,752	130,000

Note: * The years in the above table refer to the Municipal Financial Years and is for the period July till June the following year. The measured demand for 2018 is therefore from July 2018 up to June 2019



ANNEXURE C1

KURLAND GROUNDWATER INVESTIGATION BY GROUNDWATER AFRICA, 25 MAY 2021

Kurland groundwater investigation

25 May, 2021

Ricky Murray
Groundwater Africa
38 Disa Avenue, Kommetjie, 7975
South Africa

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ph: +27 21 783 0245
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GROUNDWATERAFRICA

Contents

1 Introduction

Groundwater Africa was appointed by Neil Lyners and Associates (RF) (Pty) Ltd to investigate groundwater as a water source option to augment supplies to Kurland Village for the Bitou Municipality. An initial target of 5 – 10 L/s is required for the first phase of a proposed housing development and should ~25 L/s be available from groundwater sources then it may not be necessary to install a pipeline from the Keurbooms River for the second phase of the development.

Kurland is located on the widely used Table Mountain Group (TMG) aquifer system, and there is a distinct possibility of obtaining the targeted 25 L/s within a ~5 km radius of the village's Water Treatment Works (WTW). Several boreholes would be required, and in some areas, it may be necessary to treat for iron and manganese.

Groundwater Africa was previously appointed to investigate groundwater options for Kurland (Murray, 2018), and for convenience, two boreholes (GWA-Kur1 & GWA-Kur2) were drilled in the WTW enclosure. The combined yield of these two boreholes was 10 L/s (864 m^3/day). The iron concentration in the first borehole was marginally high at 0.36 mg/L (the second borehole gave 0.12 mg/L), and the manganese concentrations were acceptable in terms of the SANS-241 guidelines (SANS, 2011) at 0.06 and 0.07 mg/L. Iron proved to be a problem in the first borehole, and Mr De Waal from Bitou Municipality suspected that it may be from the steel casing that was used in this borehole, together with the aggressive, low pH groundwater. Due to collapsing ground the borehole was drilled using the Symmetrix method whereby the steel casing is installed as the borehole is drilled (afterwards it was lined with uPVC on the inside of the steel casing). I.e., for future boreholes, if an alternative drilling method is used (like mud-rotary), and steel casing is not needed, iron concentrations may be acceptable without treatment.

Several areas were considered for groundwater exploration (Figure 1), and in the end, the area closest to the WTW was selected for investigation (Figure 2). The areas further away from the WTW come with the additional pipeline and pumping costs, as well as the need for additional servitudes.

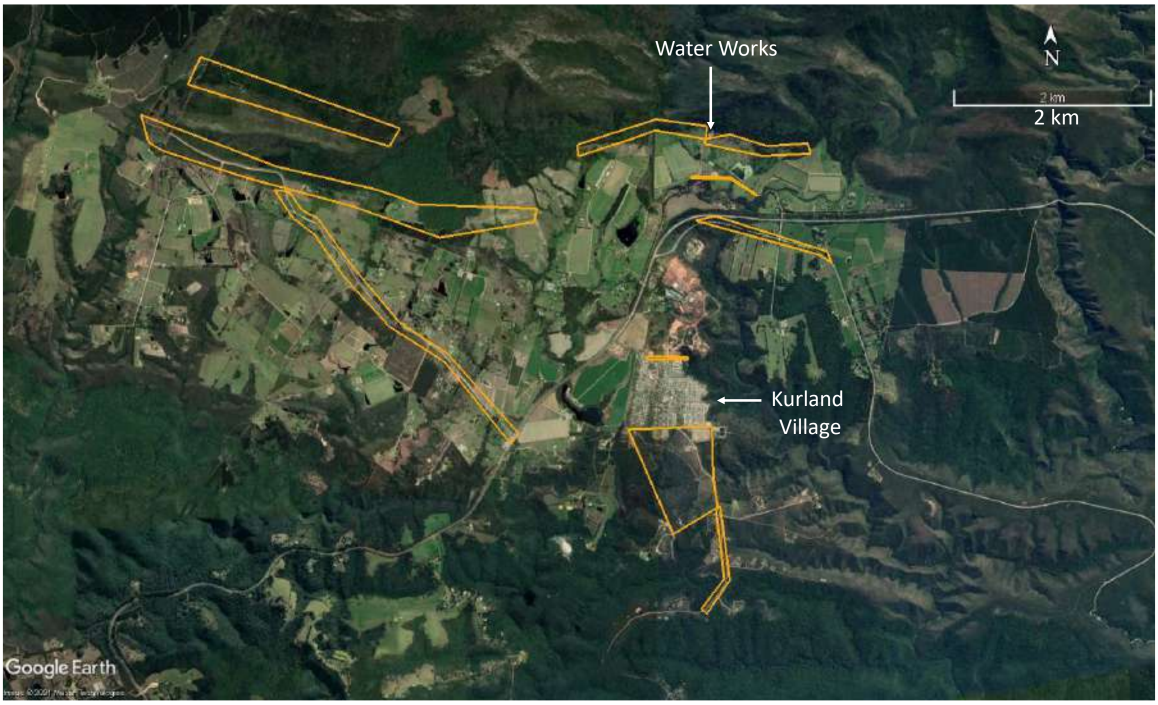

Figure 1. Areas within the TMG aquifer systems considered for groundwater exploration

2 Geophysical surveys and borehole siting

Two resistivity (ERT) surveys were conducted on Erfs 236 and 239 immediately south of the WTW (Figure 2). While the farms are registered under Galegant Inv 73 (Pty) Ltd, Mr “Buster” MacKenzie (ph 082 579 3880) informed us that he is the owner of these farms, and permission to conduct the surveys on them were given by him.

Figure 2. Geophysical (ERT) surveys conducted near the WTW

The host rock in this area are Peninsula Formation quartzites, and the groundwater targets are weathered and fractured zones within this hard-rock formation. While no distinct zone of intense fracturing is evident along this line, the geophysics nonetheless showed that there are areas where weathering is more developed than usual. Three drill sites were identified on Line 1 – the blue circles in Figure 3.

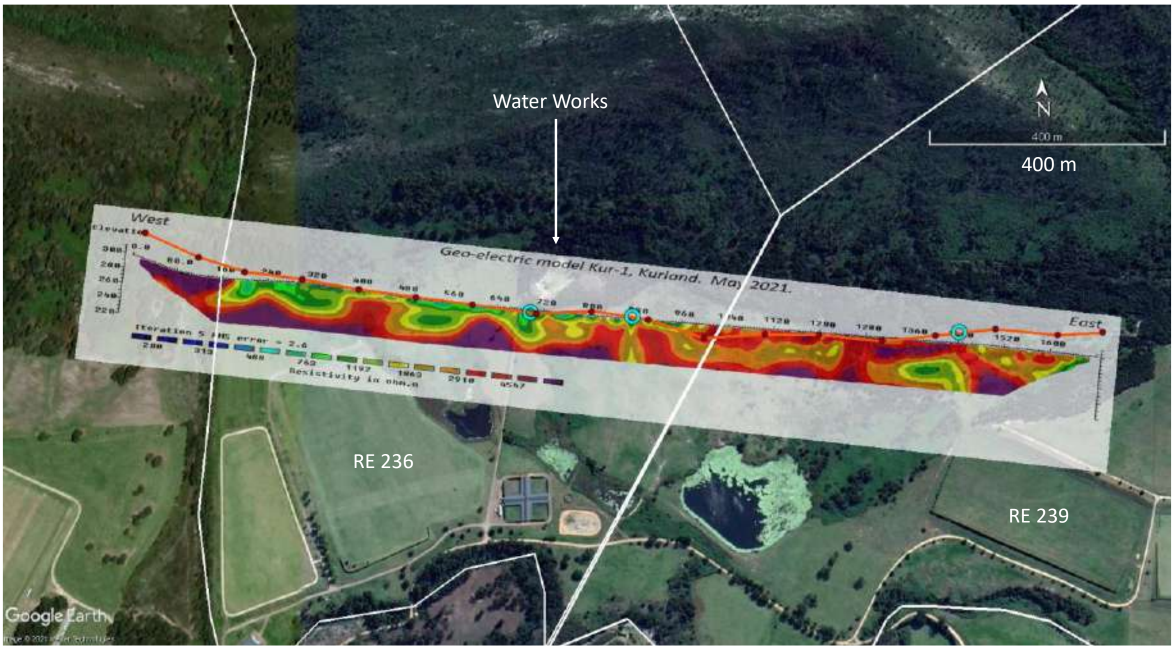

Figure 3. Geophysical survey – Line 1 with potential drill sites

The middle site was uncertain and a second, more detailed survey was run across this area (Figure 4). This did not confirm the anomaly identified in Line 1 and therefore this site should only be considered for drilling as a last resort.

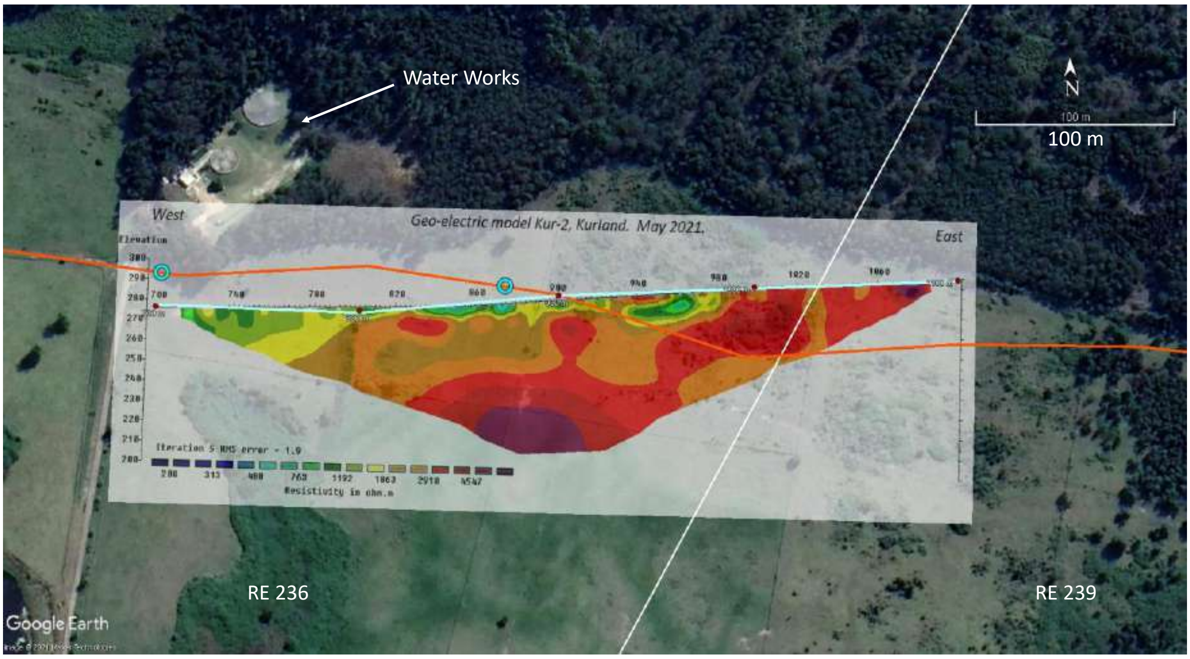

Figure 4. Geophysical survey – Line 2 with potential drill sites

The most promising site appears to be Kur1_690 which is closest to the WTW, with Kur1_1440 as the second most promising side (Figures 5 & 6).

Figure 5. Kur1_690 and Kur1_1440 drill sites

Figure 6. Kur1_690 drill site with existing GWA boreholes inside the WTW

There are other potential drill sites (Figure 7), but they should only be attempted if the Kur1_690 site yields water. Since the Kur1_1440 site is relatively far from the WTW, the recommended drilling process is as follows:

1. Drill Kur1_690.
2. Should this yield water, drill at the 3 alternative sites to the west of this borehole.
3. Should they not yield sufficient water, drill the Kur1_1440 site.
4. If this is also low yielding drill the Kur1_870 site east of the Kur1_690 site.

Table 1 presents all the drill sites.

Figure 7. All potential drill sites

Table 1. Borehole sites

Bh site	Latitude	Longitude	Comments
Priority sites			
Kur1_690	-33.927551°	23.495583°	1st choice and closest to WTW
Kur1_1440	-33.927983°	23.503393°	2nd choice and ~700m from WTW
Alternative sites (to be drilled in the order presented below)			
Kur1_530	-33.927323°	23.493841°	~180 m from WTW
Kur1_330	-33.927018°	23.491759°	~370 m from WTW
Kur1_200	-33.926840°	23.490381°	~500 m from WTW
Kur1_870	-33.927644°	23.497442°	~160 m from WTW

3 Concerns around proximity to the existing municipal boreholes

The preferred drill site (Kur1_690) is about 65 m from the existing borehole GWA-Kur1 (Figure 6). In order to assess whether this relatively close proximity may be a concern, the water level data from the two existing boreholes was downloaded (Figure 8). What the data shows is the following:

- Water level readings started when pumping started on 30 May 2018 and continued until the loggers' memory in GWA-Kur-2 was full on 7 December 2019, and until the logger in GWA-Kur1 was retrieved on 17 September 2019 after the pump had been pulled (due to iron-related concerns).
- Up until November 2018, before the abstraction rate of GWA-Kur1 appears to have been dropped, the two boreholes were performing well in terms of water levels and the aquifer's capacity. The estimated combined yield was ~8 L/s (correspondence between Dr R Murray, Groundwater Africa and Mr F van Eck, 21 September 2018).
- It appears that the yield of GWA-Kur1 was reduced in November 2018, possibly with the aim of reducing the iron-related problem, and from this time onwards, this borehole was effectively "under" pumped. The drawdown water levels continued to rise, while the levels in GWA-Kur2 stabilised.
- While these two boreholes are ~25 m apart, it is evident that in terms of the groundwater resource, the abstraction rate of ~8 L/s posed no problems to the aquifer at large. At this rate, the groundwater resource in this area is probably under-utilised.

Following these observations, it appears as if there would be no problem adding an additional borehole ~65 m from GWA-Kur1.

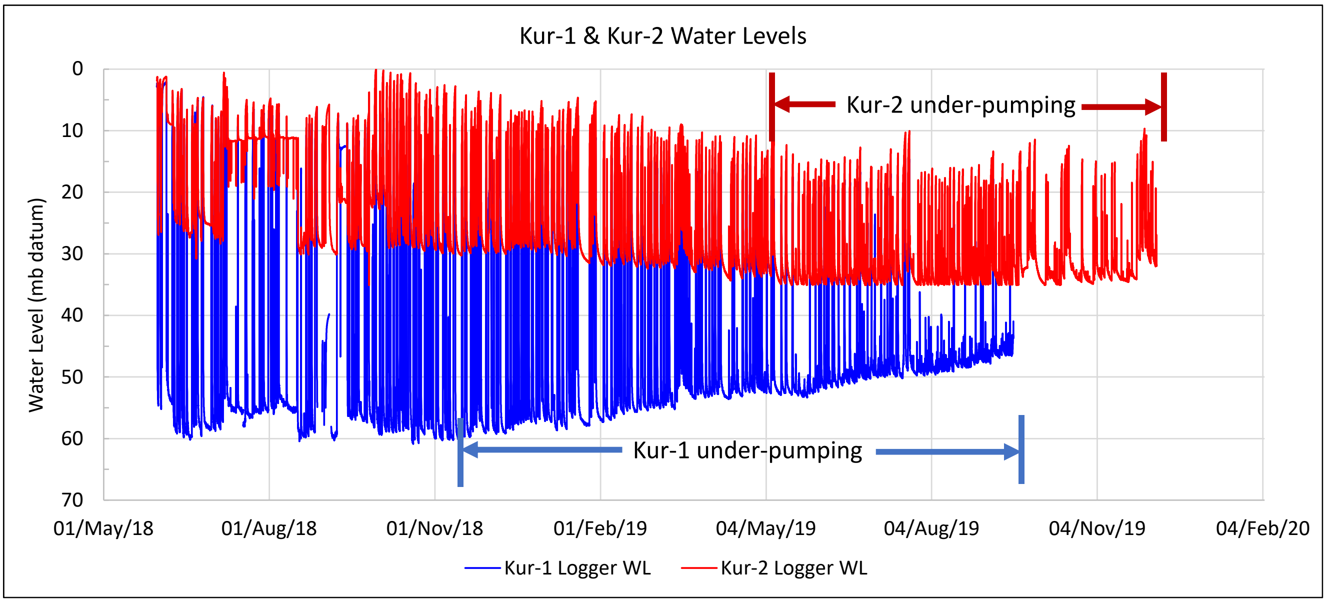

Figure 8. Water level data from existing boreholes GWA-Kur1 & 2

4 Existing groundwater users

No boreholes are recorded in the Department of Water and Sanitation's (DWS) borehole data base, the National Groundwater Archive (NGA) within 10 km of the WTW (the nearest boreholes are just over 10 km away, close to the Keurbooms River mouth). Mr MacKenzie, on whose farm the WTW and geophysical surveys were conducted, has two boreholes, and to his knowledge, there are no other nearby boreholes. Kurland Estates to the south west of the WTW has four boreholes (Figure 9). No other boreholes were found in the Kurland area north of the N2 during the hydrocensus that was conducted at the time of the geophysical surveys.

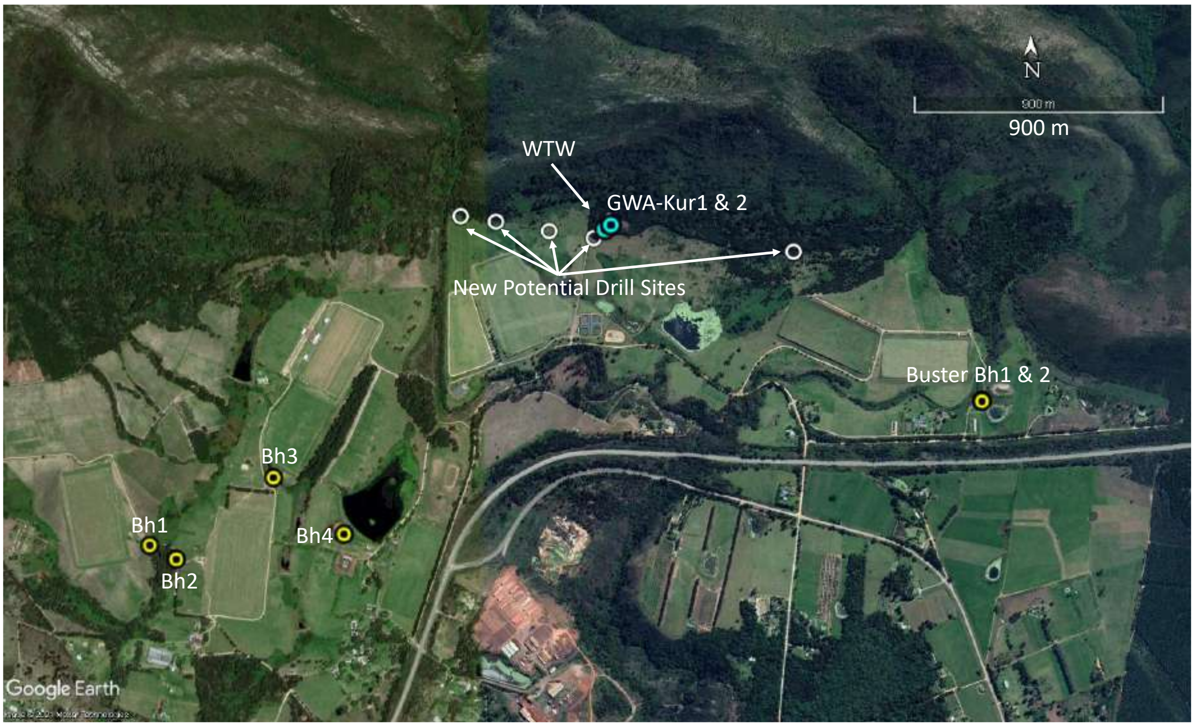

Figure 9. Private boreholes

<u>Buster MacKenzie's boreholes</u>

The two boreholes, Buster Bh1 & Bh2, are two meters apart (Figure 10), and are located 1520 m from the proposed drill site (Kur1_690) near the WTW. The closest proposed borehole (the last recommended site, Kur1_1440), sits 870 m from these boreholes. At these distances, the newly proposed boreholes would not interfere with his use. The details of his boreholes are as follows:

- Buster Bh1: Equipped with electrical submersible pump, but currently not in use. The abstraction rate is not known (by Mr MacKenzie), but the small, 140 mm diameter casing indicates that the yield is low (possibly not more than 2 L/s). When the borehole is in use it discharges to a nearby dam. If the dam is full, which is often the case, the borehole is not needed. The borehole depth is unknown. The rest water level is 8.24 m (May 2021). Co-ordinates: -33.93276°/ 23.51081°.

- Buster Bh2: Borehole is not equipped; the borehole is lined with 140 mm OD uPVC. The borehole depth is 19.45 m. The rest water level is 8.29 m. Co-ordinates: -33.93279°/ 23.51081°

Figure 10. Buster MacKenzie's boreholes

<u>Kurland Estate's boreholes</u>

Kurland Estates has four boreholes, Bh 1 – 4 (Figure 9). Boreholes 3 & 4 are closest to the WTW, and at a distance of ~1 400 m. The fourth proposed new drill site (Kur1_200) is 1 160 m from the nearest private borehole, Bh3, and too far away to affect it.

5 Conclusions and recommendations

The TMG aquifer in and around Kurland Village can supply the required ~25 L/s for future housing developments. This will require several boreholes, and depending on the local geology, some may need to be treated for iron and manganese. The salinities should all fall within the SANS-241 guidelines. There is a reasonable chance that the 1st development phase requiring 5 - 10 L/s can be obtained from boreholes near the WTW. Although no "exceptional" target was located from the geophysical surveys, there is still a fair chance this yield can be obtained from one or more boreholes drilled on the identified sites. The recommendations are as follows:

<u>Phase 1 – close to the WTW:</u>

1. Drill Kur1_690 and assess the yield.
2. Consider drilling the 3 alternative sites to the west of this site (Kur1_530; 330; 200).
3. Should they not yield sufficient water, drill the Kur1_1440 site.
4. If this is also low yielding drill the Kur1_870 site east of the Kur1_690 site.

Should Phase 1 not yield sufficient water, consider Phase 2.

<u>Phase 2 – further from the WTW:</u>

1. Conduct resistivity surveys along lines 1 & 2 at the southern and northern edges of Kurland Village (Figure 11). It is presumed that drilling could take place on municipal land in these areas. The roads would have to be closed for a few hours to conduct the southern line (Line 1). The northern line (Line 2) was not inspected, but it should be possible to run this line just north of the village, with the possibility of drilling within the school ground (at the northern edge of the school property).
2. Should boreholes drilled in these areas not be sufficiently high yielding, assess the other areas shown in Figure 1. While some of these areas may be on municipal land, most are along roads, and permission would be needed to drill in the road reserves, or on private land immediately adjacent to the road reserves (along which the geophysical surveys would be run).

Figure 11. Proposed resistivity surveys in Kurland Village

References

Murray, R. 2018. Bitou Municipality – Kurland Groundwater Investigation. Groundwater Africa report for Bitou Municipality, 9 February 2018.

SANS-241-1:2011. SOUTH AFRICAN NATIONAL STANDARD. Drinking water. Part 1: Microbiological, physical, aesthetic and chemical determinands. Edition 1.SABS Standards Division, Pretoria. ISBN 978-0-626-26115-3.

SANS-241-2. 2011. SOUTH AFRICAN NATIONAL STANDARD. Drinking water. Part 2: Application of SANS 241-1. Edition 1. SABS Standards Division, Pretoria. ISBN 978-0-626-26116-0.

ANNEXURE C2

KURLAND GROUNDWATER INVESTIGATION: YIELD RECOMMENDATIONS FOR FOUR BOREHOLES AT THE KURLAND WATER TREATMENT WORKS, 10 JANUARY 2022

Kurland groundwater investigation: Yield recommendations for the four boreholes at the Kurland Water Treatment Works

10 January, 2022

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GROUNDWATER AFRICA

Contents

1 Executive summary

Water demand

The future water demand for Kurland is estimated to be 19.1 L/s (1.65 Ml/day) and of this, the Wit River is registered for 6.9 L/s (0.6 Ml/day) (GSL, 2021). The additional requirement is thus estimated to be 12.2 L/s (1.05 Ml/day).

Borehole yields

Two boreholes were drilled at the Kurland Water Treatment Works (WTW) in 2017 and 2018 (Murray, 2018) and have been in operation ever since. Two more boreholes were drilled in 2021 (this report), and the combined recommended yield is presented below. While it may be possible to abstract more from these boreholes if all pumps are placed as deep as possible, this is not recommended. It is likely that this would lead to increased iron-related problems like biofouling and clogging, and additional operation and maintenance costs.

It is also important to stress that non-stop pumping must be implemented to minimise the iron-related problems – unlike the abstraction that took place initially (in 2018). The operation in 2021 where "more" continuous abstraction was practiced, is far better in minimising the iron-related problems that have arisen in the first two boreholes drilled, GWA-Kur1 & 2.

Recommended yields for continuous use (24 hrs/day)

Bh Number	Lat. °	Long. °	Depth (m)	1st RWL (m)	RWL date	Rec. PID* (mbgl)	Rec. (L/s)	Max. (L/s)
GWA-Kur1	23.49610	33.92720	265	3.1	15-Jul-2017	68	1.2	2.2
GWA-Kur2	23.49633	33.92706	259	1.6	11-Nov-2017	58	2.7	2.7
GWA-Kur3	23.49590	33.92732	301	12.6*	14-Nov-2021	71	2.3	2.3
GWA-Kur4	23.49598	33.92690	277	12.7*	17-Nov-2021	63	2.0	2.0
Total yield (L/s)							**8.2**	**9.2**
Total Yield (Ml/day)							**0.71**	**0.79**
Total Yield (Mm^3/a)							**0.26**	**0.29**

*PID: Pump intake depth

*1st Rest Water Levels: Taken while the water levels were recovering due to pumping from GWA-Kur1 & 2.

In addition to continuous abstraction rather than on-off abstraction, to minimise the iron-related problems that have arisen since pumping GWA-Kur1 & 2, the pumping water levels should be kept above the first water strikes wherever possible. A shallow water strike (34 m) was encountered at GWA-

Kur2, so in this case the recommended pump intake depth (PID) is just above the second water strike. For GWA-Kur3, the recommended PID (71 m) is again above the second water strike (73 m), but it would be best not to allow the water level to drop below the 1st water strike (55 m).

Borehole operation

In order to operate the pumps continuously, the following practice is advised:

- If the full potential from all boreholes is not required turn one off and rest it, while keeping the others operational.
- If less water is required, turn a 2nd pump off and rest it; etc, for the 3rd and 4th pumps.
- If less water is required over a lengthy period, switch between boreholes, so that all pumps are operated from time to time. It is likely that long-term resting will lead to clogging of the pumps and possible malfunction when needed.
- If no borehole water is required, periodically operate them for several hours to ensure they are not clogged and are operational. This water should be pumped to waste, as it is likely to be turbid and a deep red-brown colour due to precipitated iron.

Groundwater quality

The groundwater is exceedingly fresh with electrical conductivity values in the order of 10 – 15 mS/m. The iron, manganese and turbidity values however exceed the SANS-241 aesthetic recommended limits, and the pH value sits just below the recommended limit. The values below are based on blending the individual boreholes' waters at their recommended abstraction rates.

Average groundwater quality

Determinand	**Units**	**SANS 241-1:2015 RECOMMENDED LIMITS**	**Weighted average based on recommended abstraction rates**
Electrical conductivity at 25°C	mS/m	< 170	11.6
Iron	µg Fe/l	Chronic: < 2000 Aesthetic: < 300	**304**
Manganese	µg Mn/l	Chronic: < 400 Aesthetic: <100	**105**
pH at 25°C	pH units	5.0 - 9.7	**4.7**
Total dissolved solids at 180°C	mg/l	< 1200	75
Turbidity	NTU	Operational <1 Aesthetic <5	**2.9**

Of concern is that the iron values in boreholes GWA-Kur1 & 2 have virtually doubled since they were sampled in 2017 after drilling. Non-stop pumping at the recommended rates is recommended for the management of this iron-related problem. The turbidity values have, however, dropped in GWA-Kur1 & 2:

	2017	**2021**
GWA-Kur1 Iron (mg/L):	0.36	0.63
GWA-Kur2 Iron (mg/L):	0.12	0.22
GWA-Kur1 Turbidity (NTU):	20.1	6.5
GWA-Kur2 Turbidity (NTU):	3.2	1.0

Groundwater monitoring

Due to the need to maximise groundwater supply from the existing four boreholes, a telemetry system should be installed whereby the following data is made available on an internet-based system so that it can be monitored remotely:

- Water levels in mbgl taken every hour
- Flow rates in L/s – average taken every hour

This data needs to be reviewed by a hydrogeologist during the initial operation period (for about 3 months) in order to review the yields and modify them accordingly. After this, the data should be reviewed annually and the yields again reviewed and optimised. Correctly installed piezometer tubes must be installed at the time of pump installations (see the monitoring section in this report).

The following determinands should be checked on a monthly basis:

- Electrical conductivity
- Iron
- Manganese

Water shortfall

- Demand: 19.1 L/s
- Wit River: 6.9 L/s
- Boreholes: 8.2 – 9.2 L/s
- Total supply potential: 15.1 – 16.1 L/s
- Additional requirement: 3 - 4 L/s

Recommendations to meet the shortfall

A geophysical survey was conducted immediately “below” (south) of the WTW in the private lands of Mr Mackenzie (Murray, 2021) and six drilling sites were identified. The sites should be drilled in the order mentioned below.

Potential drilling sites

Borehole sites

Bh site	Latitude	Longitude	Comments
Priority sites			
Kur1_690	-33.927551°	23.495583°	closest to WTW
Kur1_530	-33.927323°	23.493841°	~180 m from WTW
Alternative sites (to be drilled in the order presented below)			
Kur1_330	-33.927018°	23.491759°	~370 m from WTW
Kur1_200	-33.926840°	23.490381°	~500 m from WTW
Kur1_1440	-33.927983°	23.503393°	~700m from WTW
Kur1_870	-33.927644°	23.497442°	~160 m from WTW

2 Introduction

Groundwater Africa was appointed by Neil Lyners and Associates (RF) (Pty) Ltd to investigate groundwater as a water source option to augment supplies to Kurland Village for the Bitou Municipality.

The work undertaken to date has been:

1. Assessing potential groundwater sources within a reasonable radius of Kurland. This was followed by geophysical surveys immediately below (south of) the Water Treatment Works (WTW) on the property of Mr "Buster" Mackenzie. Two sites were prioritised with four alternatives (Murray, May 2021).

2. Drilling two more boreholes within the WTW ground after it was decided to establish if additional water could be obtained by "spreading the load" between four boreholes instead of the existing two boreholes in this confined space (this report).

<u>Demand</u>

The water demand figures presented are taken from the GSL Consulting report dated 18 August 2021 – Section 1.3.4 Bulk Supply. The target demand is taken from the statement: "Taking into consideration the re-analysis of the water demand, the future AADD for the Kurland system is calculated at ± 1,65 ML/d" (Table 1).

Table 1. Target demand and groundwater requirements (figures taken from GSL Consulting, 2021)

	Yield		**Comments**
	kL/day	**L/s**	
Existing sources			
Wit River	600	6.9	WARMS registered rate
Boreholes (Kur1 & Kur2)	430	5.0	"Safe yield"
Total	**1030**	**11.9**	
Future AADD	1650	19.1	Average Annual Daily Demand
Additional requirement	620	7.2	
Total groundwater requirement	**1050**	**12.2**	

Based on the information supplied, it appears as if the total groundwater requirements to meet foreseeable needs is 12.2 L/s (1.1 Ml/day).

3 Drilling results

Two additional boreholes were drilled inside the WTW enclosure – GWA-Kur3 and GWA-Kur4 (Figure 1). The results are summarised together with the existing two boreholes in Table 2.

Figure 1. Kurland municipal boreholes

Table 2. Drilling results

Bh No	Year drilled	Co-ords	Depth (m)	Casing ID (mm)	Main water strikes (m)	Final blow yield (L/s)	EC (mS/m)
GWA-Kur1	2017	-33.92721° 23.49607°	265	uPVC ~128 mm	70; 141; 217; 244; 265	6	10
GWA-Kur2	2018	-33.92707° 23.49630°	259	uPVC ~148 mm	34; 60; 75; 104; 184; 259	14	10
GWA-Kur3	2021	-33.92732° 23.49590°	301	uPVC ~155 mm	55; 73; 91; 107; 126; 185; 244; 256	8.5	11
GWA-Kur4	2021	-33.92690° 23.49598°	277	uPVC ~155 mm	64-79; 91-96; 104-106; 114; 123-126; 212; 240; 261	8	11

4 Test pumping

4.1 Introduction

AB Pumps were contracted to do step- and constant discharge tests (CDT) on the two new boreholes, and to do a simultaneous test on all four boreholes. Since piezometer tubes had to be placed down to pump depths, both pumps were pulled and on inspection were found to be encrusted with iron oxides. This was particularly bad on the Kur2 pump, and significantly better on the Kur1 pump (which was apparently a more recent installation). Both pumps were sent to ABC Pumps in Gqeberha for cleaning and repairs (in the case of Kur2's pump). During this period the water supply for Kurland was river water only. Heavy rain ensued, and the river pumps could not be used, so AB Pumps' pumps were used to supply the village in between testing. Coupled to this was the problem that the flow rates of the two existing holes were uncertain, and that when they were operational again, their supply had to be disconnected so that their yields could manually be measured. There is only a shared flow meter (Magflow) – the manual flow meter on the one borehole is out of order. Nonetheless, whenever water was needed for the village supply, it was pumped into the mixing chamber rather than pumping the water to waste.

Figure 2 shows the full time series of water level data during this period. Some of the abstraction was for testing and some for water supply to Kurland.

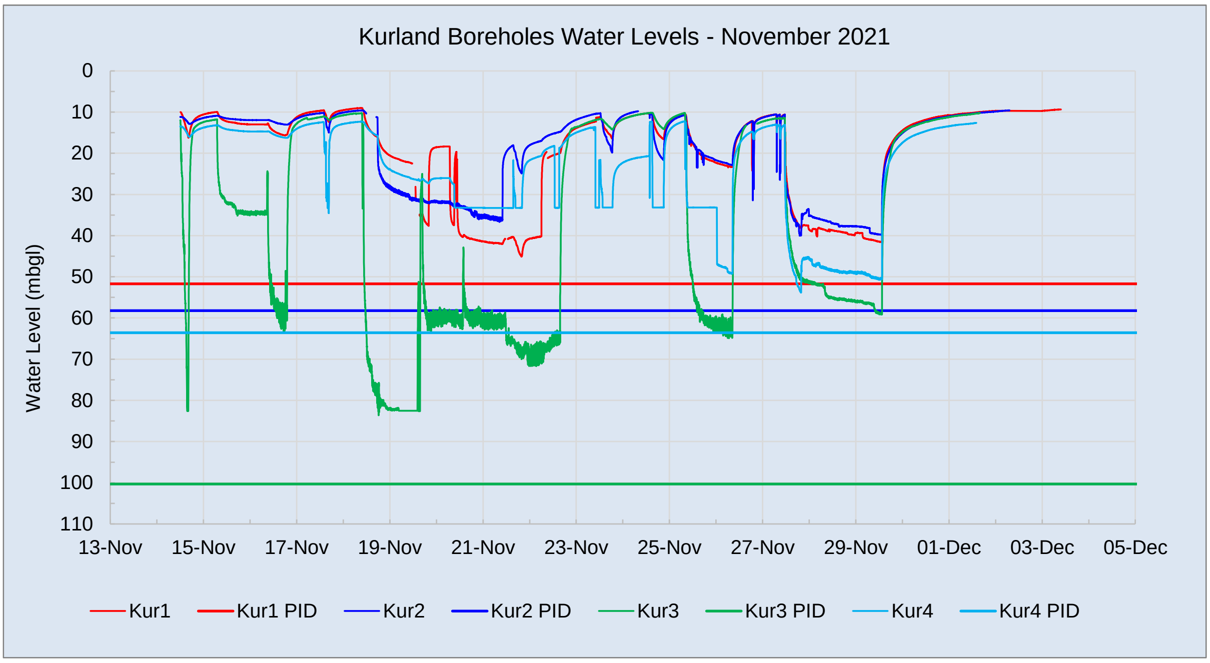

Figure 2. Water levels during the test pumping period (PID = pump intake depth)

Figures 3 – 6 present the water levels of individual boreholes.

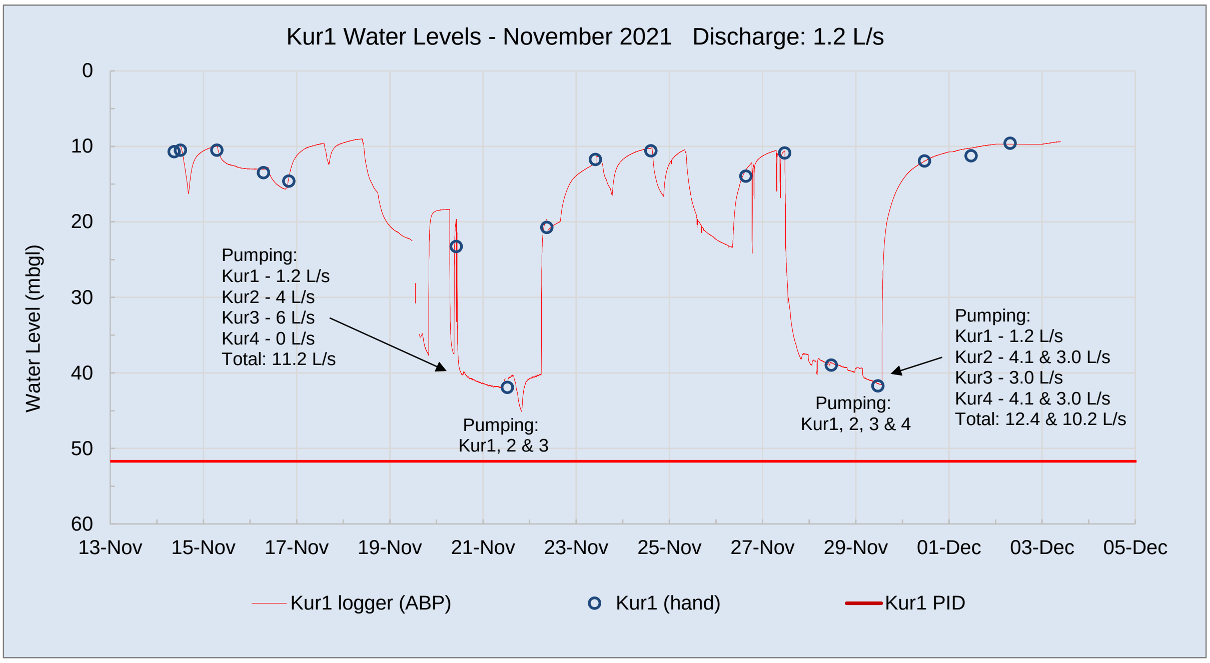

Figure 3. GWA-Kur1 water levels

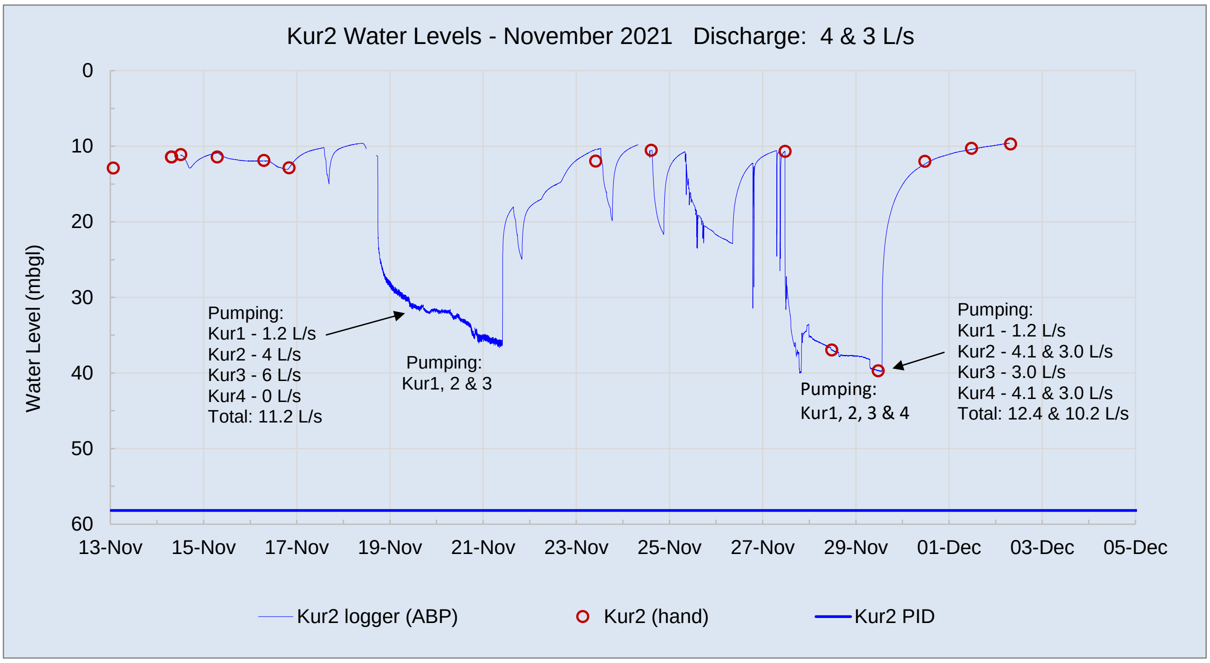

Figure 4. GWA-Kur2 water levels

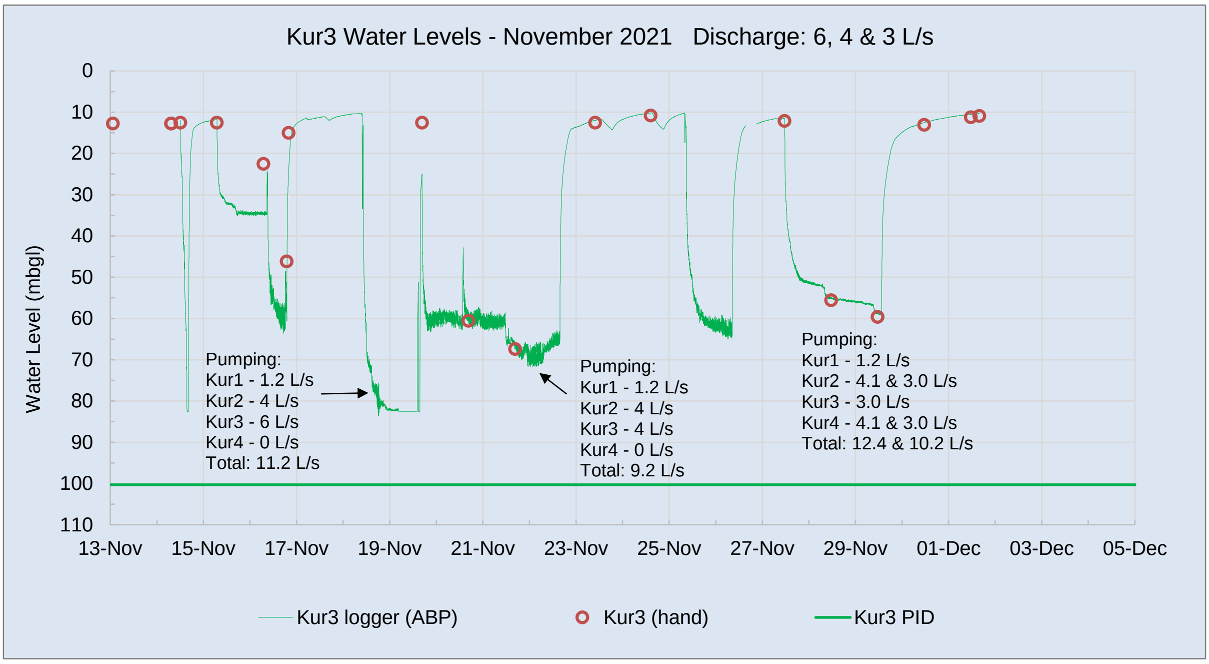

Figure 5. GWA-Kur3 water levels

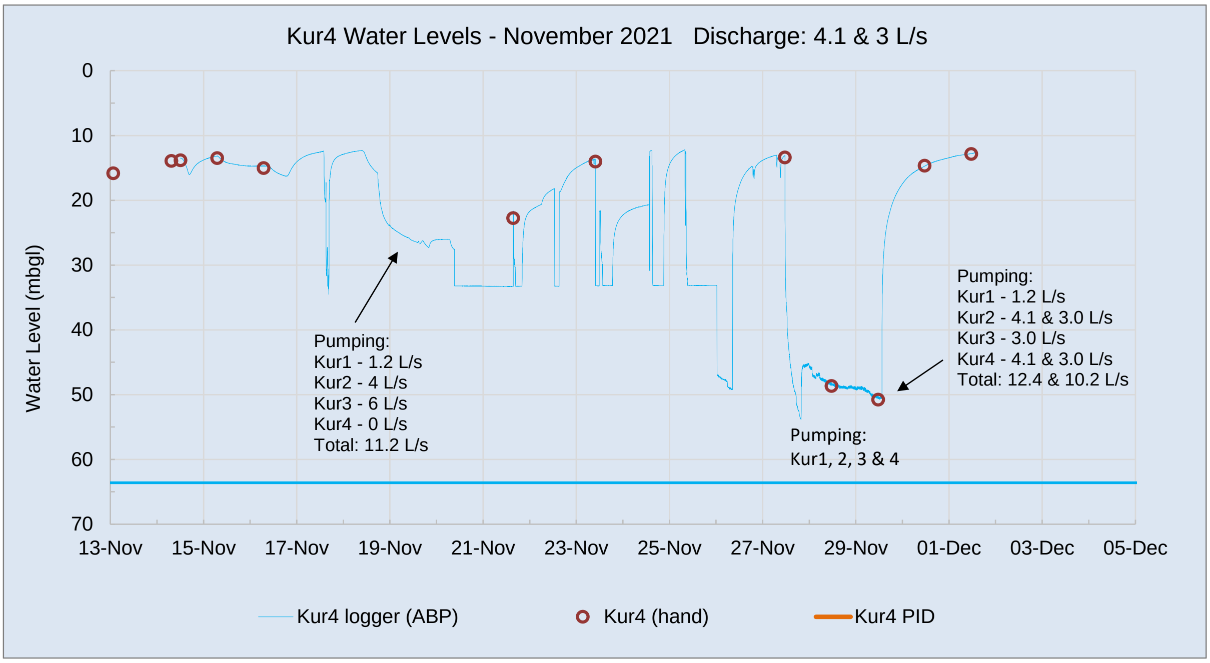

Figure 6. GWA-Kur4 water levels

4.2 GWA-Kur3 pumping tests

A step- and several CDTs were conducted on Kur3 (Figures 7 - 8). Some of the CDTs were conducted while other boreholes were also operating.

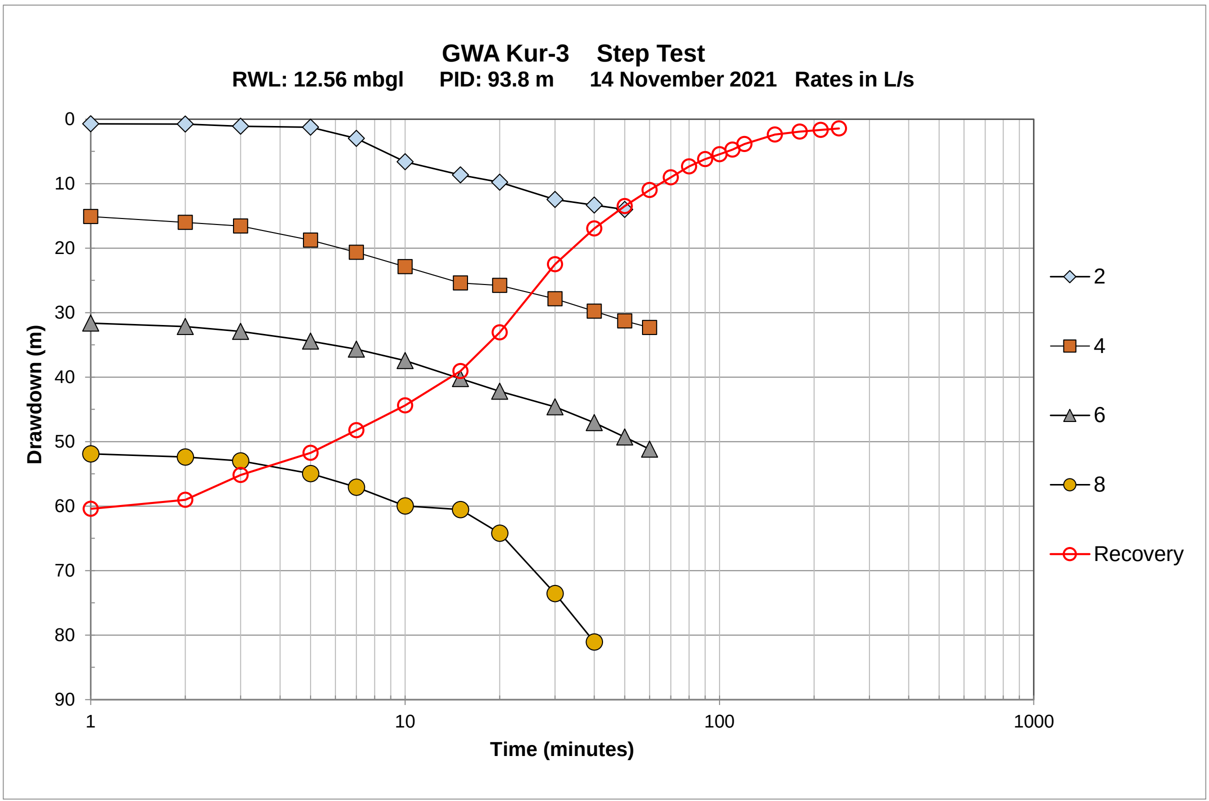

Figure 7. GWA-Kur3 step test

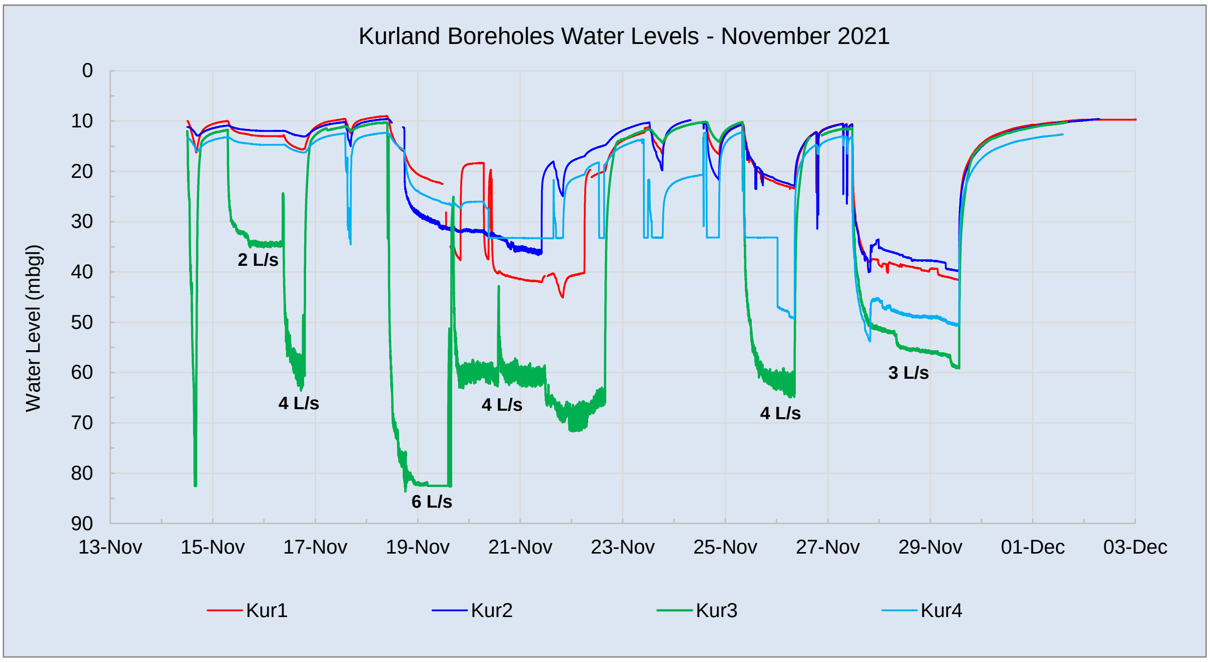

Figure 8. GWA-Kur3 constant discharge tests (some run together with other boreholes)

4.3 GWA-Kur4 pumping tests

Three step tests were conducted on this borehole (Figures 9 - 12):

- After drilling and prior to gravel packing. A significant amount of sand was pumped at 2 L/s and even more at 4 L/s. The test was stopped.
- After partial gravel packing the hole. This produced the same results as above.
- After fully gravel packing the hole. No sand was pumped at 2 L/s and 4 L/s and the water was clear; some sand was pumped at 5 L/s and the water was turbid.

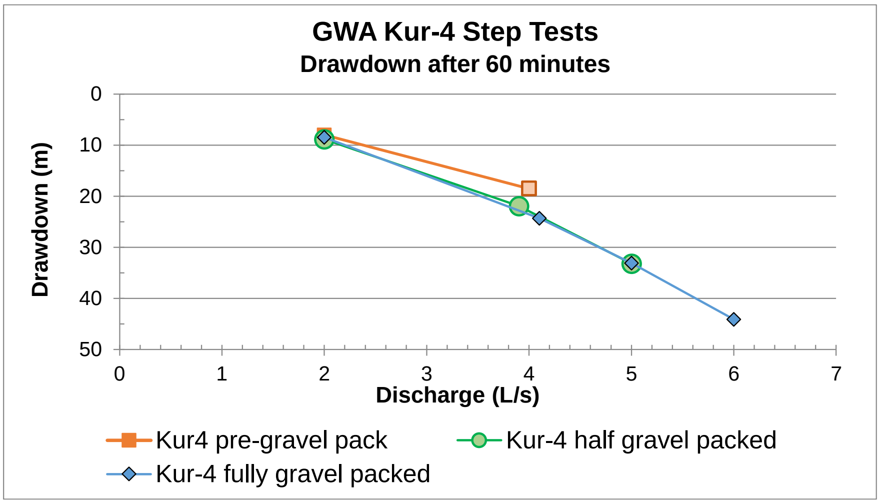

Figure 9. GWA-Kur4 comparison of step tests

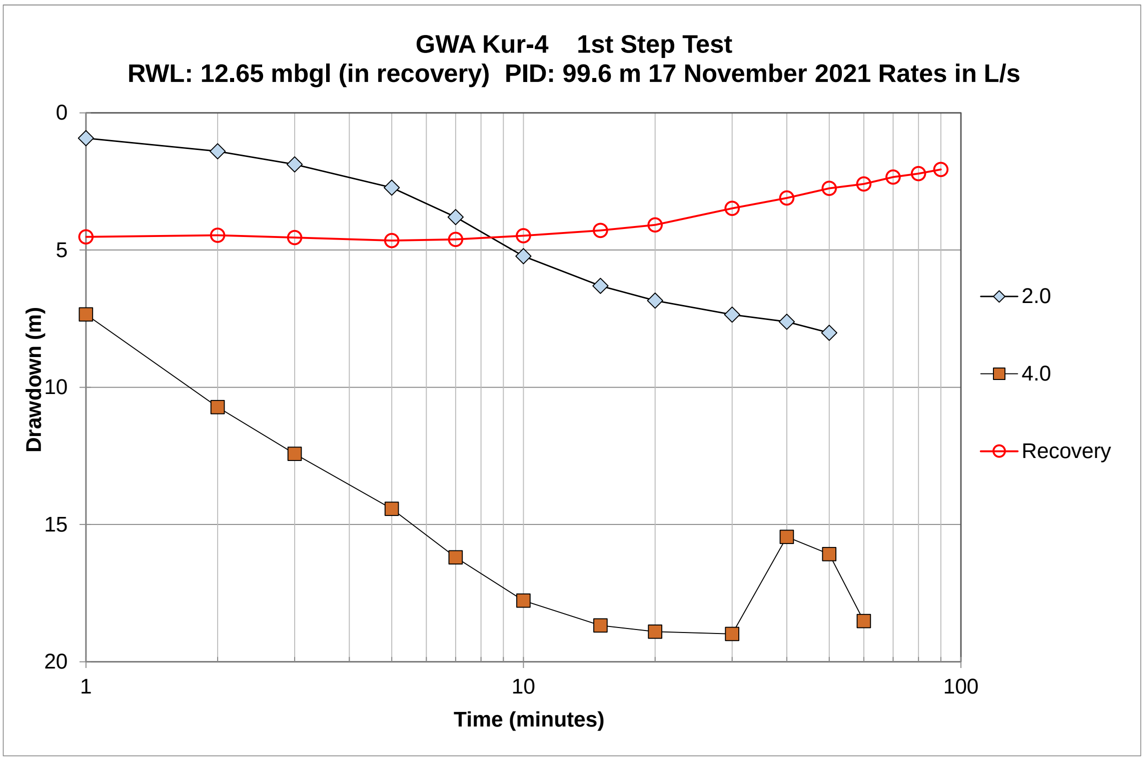

Figure 10. GWA-Kur4 1st step test

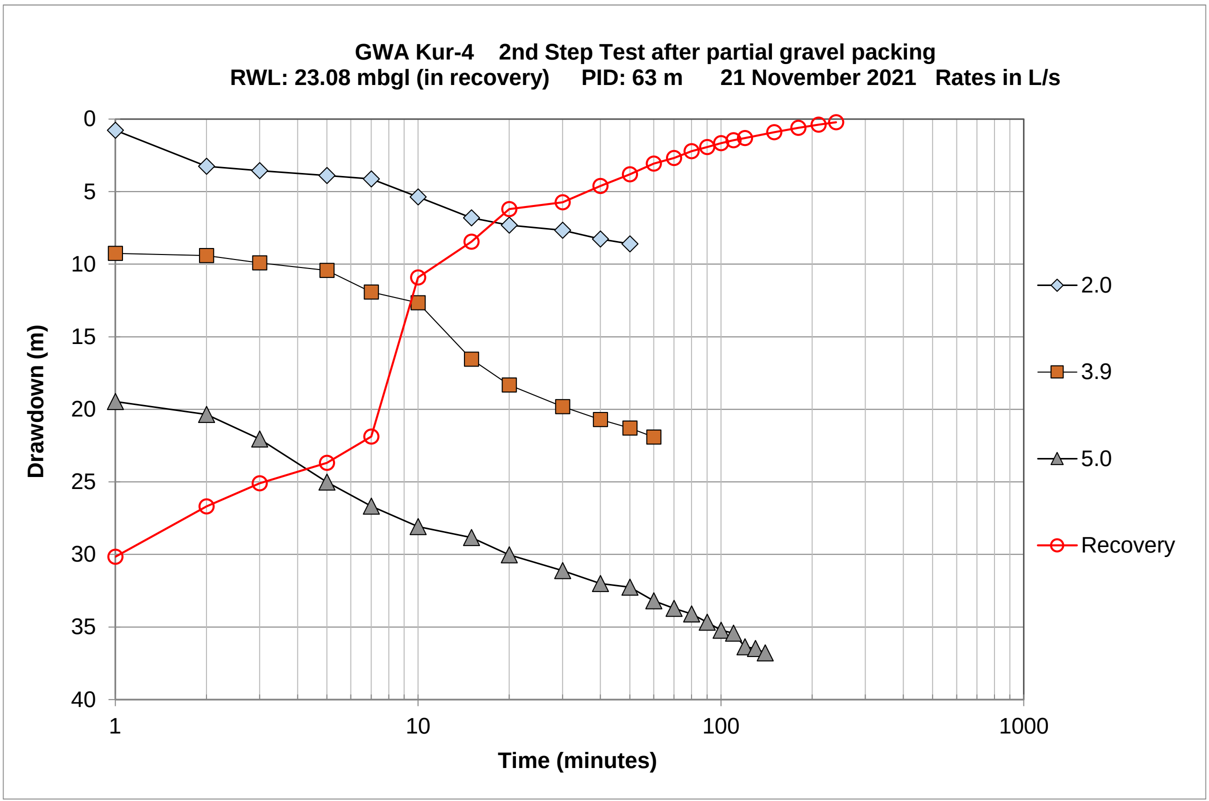

Figure 11. GWA-Kur4 2nd step test

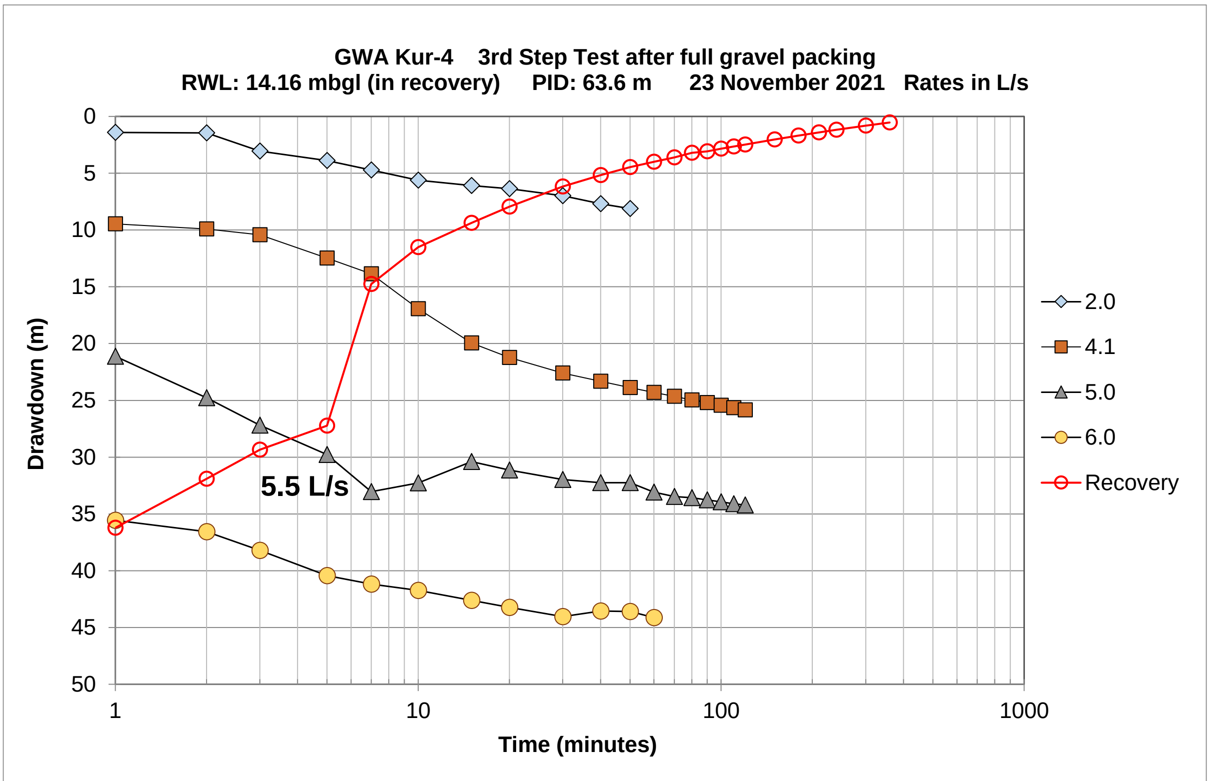

Figure 12. GWA-Kur4 3rd step test

The following CDTs were run on this borehole (Figure 13):

- 1st (24 Nov 2021): 6.0 L/s for 6 hours
- 2nd (25 Nov 2021): 4.0 L/s for 1 day together with GWA-BP4
- 3rd (27 Nov 2021): 4.0 and then 3.0 L/s – simultaneous test for 3000 minutes (2.1 days)

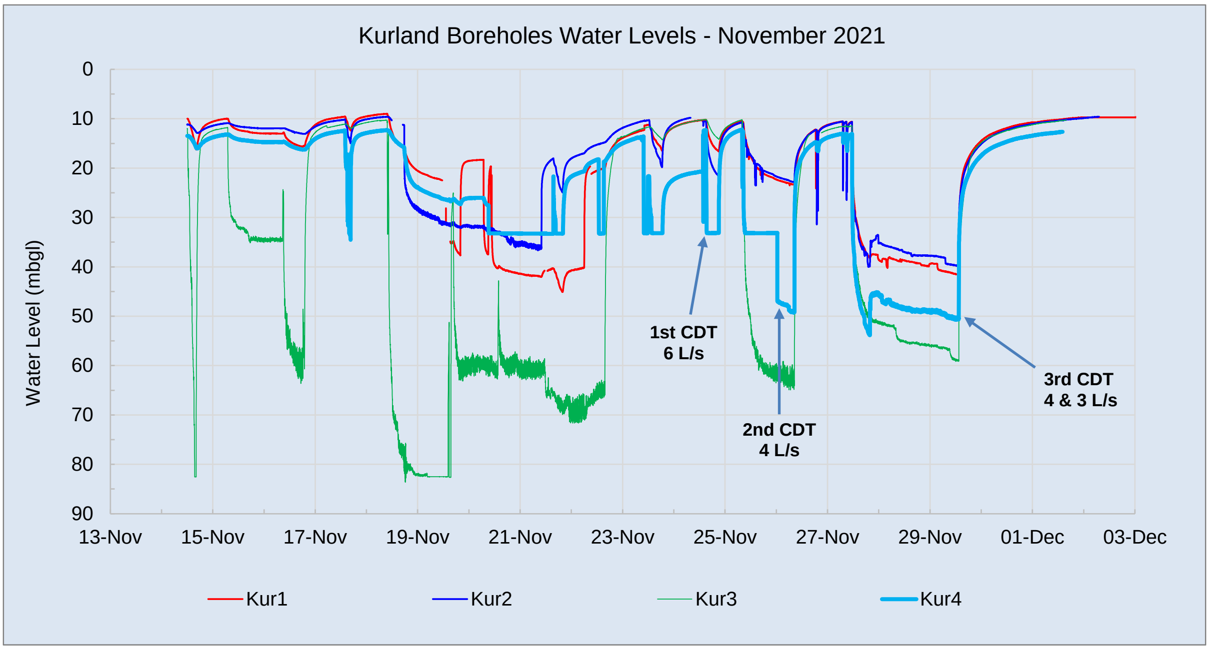

Figure 13. GWA-Kur4 constant discharge tests (some run together with other boreholes)

4.4 The simultaneous pumping test – All 4 boreholes

After the village's water supplies were sorted out by turning back to the river supply, a CDT was run with all four boreholes for 3000 minutes or 2.1 days (Figures 14 - 16). The yields were modified after 8 hours of pumping due to excessive drawdowns which trended towards pump intake depths:

- Start: Total yield – 12.4 L/s
- GWA-Kur2 dropped from 4.1 to 3.0 L/s
- GWA-Kur4 dropped from 4.1 to 3.0 L/s
- Total yield after 8 hours – 10.2 L/s

From this test it evident that the wellfield cannot be operated at 12.4 L/s, and at 10.2 L/s water levels will likely be drawn to pump depths.

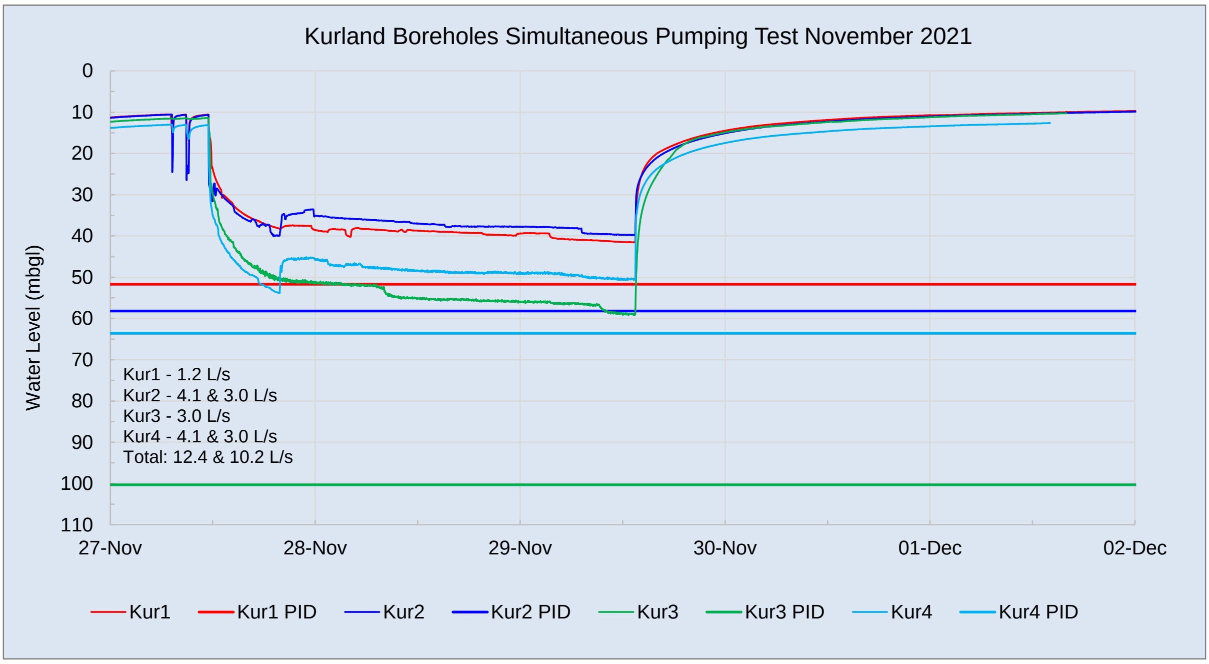

Figure 14. Simultaneous constant discharge test

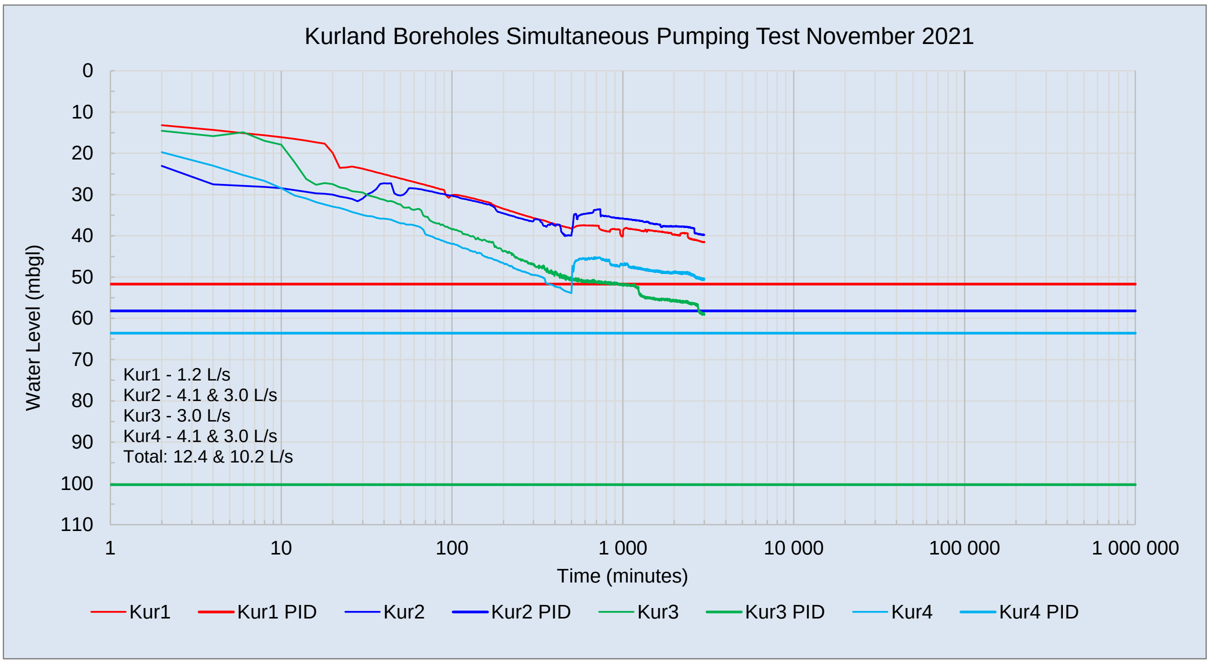

Figure 15. Simultaneous constant discharge test – log time (1 year ~500 000 minutes)

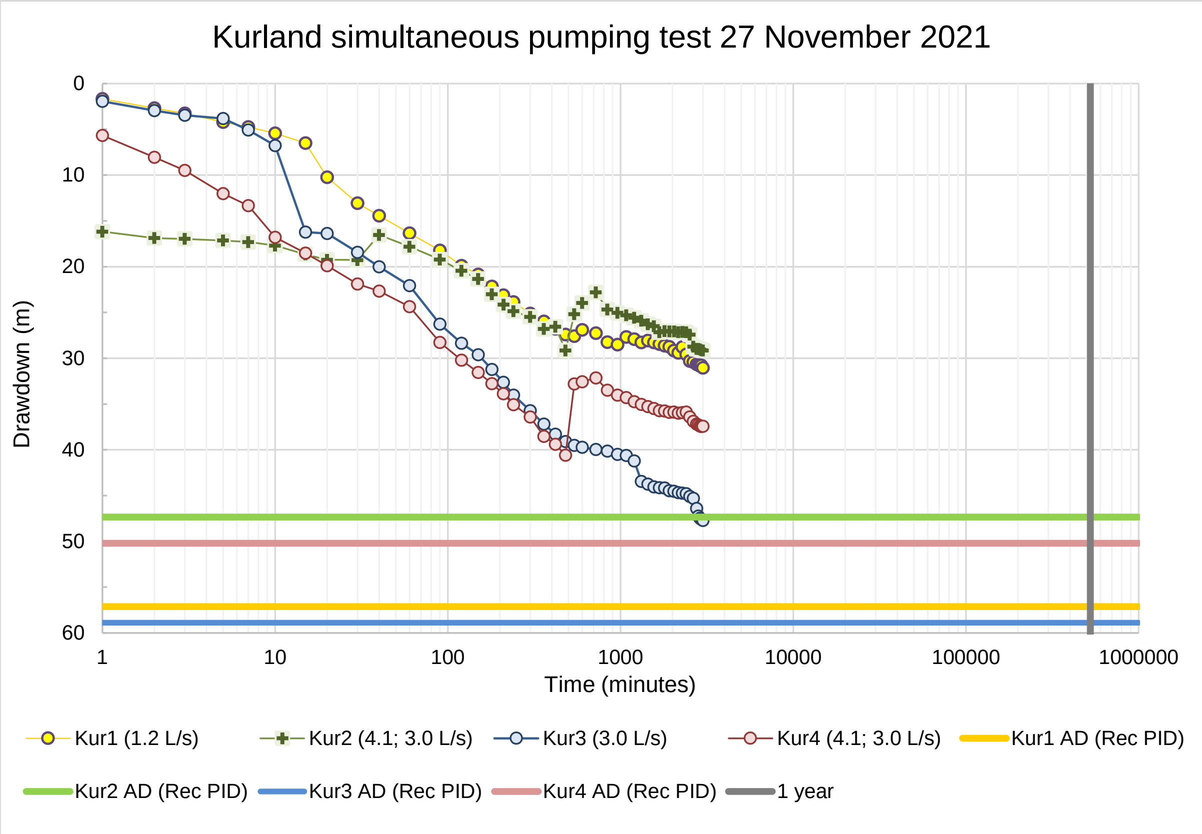

Figure 16. Simultaneous constant discharge test – log time showing the drawdowns in relation to the recommended pump intake depths (all levels are below starting water levels, and not mbgl)

4.5 Wellfield modelling

The data from the simultaneous pumping test was modelled using the Theis Wellfield Model, modified from the C-J Wellfield Model (Murray, et al, 2012). After calibrating the model to the water level and abstraction data, the boreholes were run continuously for a year at different rates and the drawdown values noted. The model takes the aquifer transmissivity and storage coefficients into account. It does not take recharge into account – it is assumed that during the year the aquifer will be replenished from rainfall (with one or more rainfall/recharge events). From this analysis the yield of all four boreholes appears to be about 8.2 L/s, and possibly 9.2 L/s (Table 3).

Table 3. Modelling results

Borehole	Longitude	Latitude	S-value	T [m2/d]	Q [L/s]	t [days]	Available Drawdown [m]	Actual Drawdown [m]	Simulated Drawdown [m]	Difference [m]
Calibration over 2 days										
Kur1	23.49610	-33.92720	0.003	11	1.2	2	58	30.85	30.88	0.03
Kur2	23.49633	-33.92706	0.003	23	3.0	2	48	29.04	28.89	-0.15
Kur3	23.49590	-33.92732	0.006	8.6	3.0	2	61	47.48	47.69	0.21
Kur4	23.49598	-33.92690	0.003	13	3.0	2	50	37.39	37.23	-0.16
Total/Average					**10.2**			**36.19**	**36.18**	**-0.02**
Modelled over 365 days at Recommended rates (start water level ~10 mbgl)										
Kur1	23.49610	-33.92720	0.003	11	1.2	365	58		49.6	
Kur2	23.49633	-33.92706	0.003	23	2.7	365	48		47.3	
Kur3	23.49590	-33.92732	0.006	8.6	2.3	365	61		60.4	
Kur4	23.49598	-33.92690	0.003	13	2.0	365	50		50.2	
Total/Average					**8.2**				**51.9**	
Modelled over 365 days at High rates (start water ~5 mbgl)										
Kur1	23.49610	-33.92720	0.003	11	2.2	365	63		62.8	
Kur2	23.49633	-33.92706	0.003	23	2.7	365	53		53.1	
Kur3	23.49590	-33.92732	0.006	8.6	2.3	365	66		66.5	
Kur4	23.49598	-33.92690	0.003	13	2.0	365	55		55.7	
Total/Average					**9.2**				**59.5**	

5 Yield recommendations

5.1 Yield recommendations

Table 4 presents the recommended pumping rates for continuous (24 hr/day) abstraction. While it may be possible to abstract more from these boreholes if all pumps are placed as deep as possible, this is not recommended. It is likely that this would lead to increased iron-related problems and additional operation and maintenance costs. GWA-Kur2's pump was relatively new (E de Waal, *pers comm*) – within months (not years) it required cleaning and parts to be replaced. Pumping at higher rates will only exacerbate this problem.

It is also important to stress that non-stop pumping must be implemented. It is possible that the iron-related problems arose from the on-off pumping when the boreholes were initially operated in 2018 (Figure 17). This type of operation can initiate and exacerbate iron biofouling and clogging (Parsons, 2021). The operation in 2021 (Figure 18), where "more" continuous abstraction was practiced, is far better in minimising the iron-related problems that have arisen in GWA-Kur1 & 2.

Table 4. Recommended yields for continuous use (24 hrs/day)

Bh Number	Lat. °	Long. °	Depth (m)	1st RWL (m)	RWL date	Rec. PID* (mbgl)	Rec. (L/s)	Max. (L/s)
GWA-Kur1	23.49610	33.92720	265	3.1	15-Jul-2017	68	1.2	2.2
GWA-Kur2	23.49633	33.92706	259	1.6	11-Nov-2017	58	2.7	2.7
GWA-Kur3	23.49590	33.92732	301	12.6*	14-Nov-2021	71	2.3	2.3
GWA-Kur4	23.49598	33.92690	277	12.7*	17-Nov-2021	63	2.0	2.0
Total yield (L/s)							**8.2**	**9.2**
Total Yield (Ml/day)							**0.71**	**0.79**
Total Yield (Mm^3/a)							**0.26**	**0.29**

*PID: Pump intake depth

*1st Rest Water Levels: These were taken while the water levels were recovering due to pumping from GWA-Kur1 & 2. The true RWLs of GWA-Kur1, 2 & 3 are very similar, ie all ~1 mbgl. GWA-Kur4 is about 2 – 3 m above the other boreholes, so it's true RWL would be ~2.5 - 3.5 mbgl.

In addition to continuous abstraction rather than on-off abstraction, to minimise the iron-related problems that have arisen since pumping GWA-Kur1 & 2, the pumping water levels should be kept above the first water strikes wherever possible. A shallow water strike (34 m) was encountered at GWA-Kur2, so in this case the recommended pump intake depth (PID) is just above the second water strike

(Table 5). For GWA-Kur3, the recommended PID (71 m) is again above the second water strike (73 m), but it would be best to not allow the water level to drop below the 1st water strike (55 m).

Table 5. Pump intake depths and 1st two water strikes

Bh Number	Natural RWL (m)	Rec. PID (mbgl)	1st water strike (mbgl)	1st water strike yield (L/s)	2nd water strike (mbgl)	2nd water strike yield (L/s)
GWA-Kur1	~0.5 m	68	70	0.5	141	1.1
GWA-Kur2	~0.5 m	58	**34**	0.9	60	0.7
GWA-Kur3	~0.5 m	71	**55**	0.5	73	0.7
GWA-Kur4	~2.5 m	63	64	1.2	91	0.6

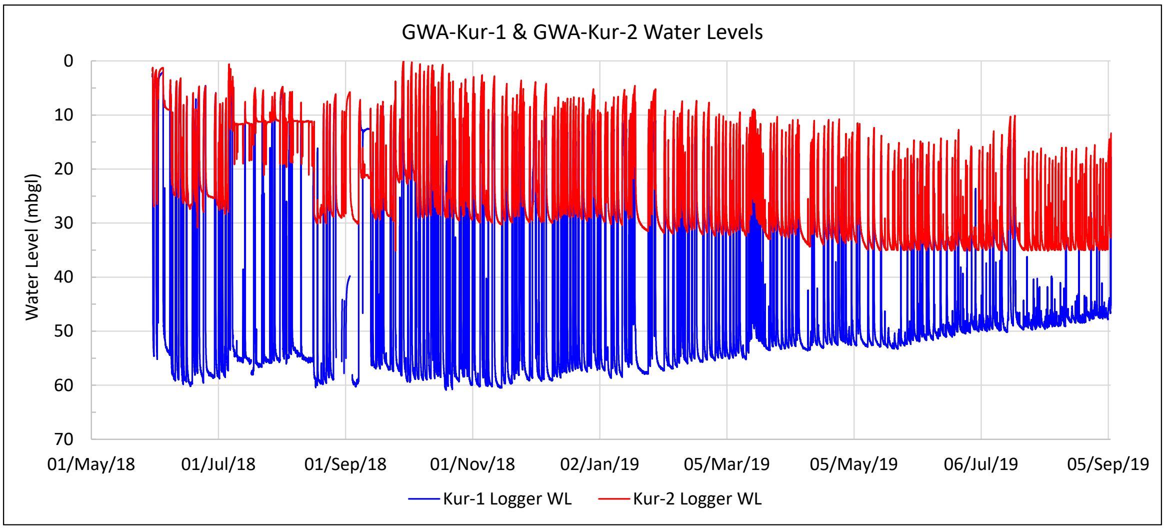

Figure 17. The on- off-pumping in 2018 and 2019 that must be avoided in order to minimise iron-related problems like biofouling and clogging

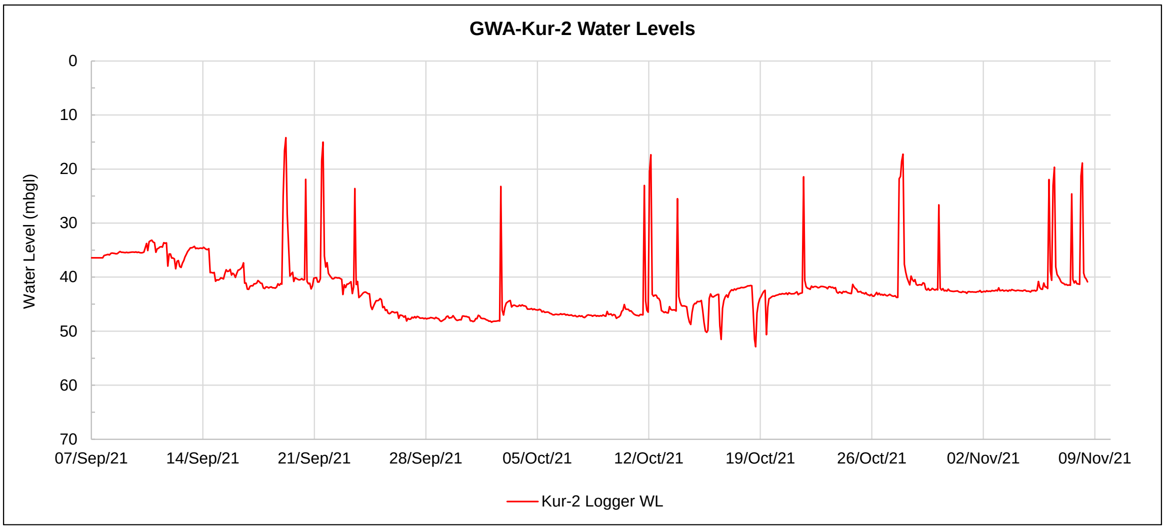

Figure 18. The “more” continuous use in 2021 that is preferable to minimising iron-related problems like biofouling and clogging

5.2 Operating principles

In order to operate the pumps continuously, the following practice is advised:

- If the full potential from all boreholes is not required turn one off and rest it, while keeping the others operational.
- If less water is required, turn a 2nd pump off and rest it; etc, for pumps the 3rd and 4th pumps.
- If less water is required over a lengthy period, switch between boreholes, so that all pumps are operated from time to time. It is likely that long-term resting will lead to clogging of the pumps and possible malfunction when needed.
- If no borehole water is required, periodically operate them for several hours to ensure they are not clogged and are operational. This water should be pumped to waste, as it is likely to be turbid and a deep red-brown colour due to precipitated iron.

6 Water quality

At the end of the 2-day simultaneous CDT, samples were collected from all four boreholes (Table 7 and Appendix 2). Table 6 presents the values assuming they were blended at the recommended abstraction rates given in Table 4. While the salinity values are exceedingly low (EC of ~12 mS/m), the iron, manganese and turbidity values exceed the SANS-241 aesthetic recommended limits and the pH value (4.7) sits just below the recommended limit.

Of concern is that the iron values in boreholes GWA-Kur1 & 2 have virtually doubled since they were sampled in 2017 after drilling (Table 8). Non-stop pumping at the recommended rates is recommended for the management of this iron-related problem. Over this period, the turbidity values have dropped, and the manganese values have risen slightly:

	2017	2021
GWA-Kur1 Iron (mg/L):	0.36	0.63
GWA-Kur2 Iron (mg/L):	0.12	0.22
GWA-Kur1 Turbidity (NTU):	20.1	6.5
GWA-Kur2 Turbidity (NTU):	3.2	1.0
GWA-Kur1 Manganese (mg/L):	0.06	0.08
GWA-Kur2 Manganese (mg/L):	0.07	0.09

Table 6. Average groundwater quality from 2021 (Talbot & Talbot Laboratory)

Determinand	Units	SANS 241-1:2015 RECOMMENDED LIMITS	Average	Weighted Average based on recommended abstraction rates
Electrical conductivity at 25°C	mS/m	< 170	11.5	11.6
Iron	µg Fe/l	Chronic: < 2000 Aesthetic: < 300	**348**	**304**
Manganese	µg Mn/l	Chronic: < 400 Aesthetic: <100	**102**	**105**
pH at 25°C	pH units	5.0 - 9.7	**4.9**	**4.7**
Total dissolved solids at 180°C	mg/l	< 1200	75	75
Turbidity	NTU	Operational <1 Aesthetic <5	**3.5**	**2.9**

Note: The values above are based on blending the individual boreholes' waters at their recommended abstraction rates.

Table 7. Groundwater quality from 2021 (Talbot & Talbot Laboratory)

Determinand	Unit	GWA-Kur1	GWA-Kur2	GWA-Kur3	GWA-Kur4
Coliphages	PFU/10mℓ	0	0	0	0
Total Organic Carbon	mg C/ℓ	1.1	0.92	1.2	0.79
Sodium	mg Na/ℓ	13.2	15.1	10.4	11.2
Aluminium	µg Al/ℓ	16.8	112	68	41
Arsenic	µg As/ℓ	<1	<1	<1	1.5
Boron	µg B/ℓ	12.5	10.3	9.4	9.0
Barium	µg Ba/ℓ	3.4	3.2	3.3	3.8
Cadmium	µg Cd/ℓ	<1	1.1	<1	2.4
Copper	µg Cu/ℓ	2.0	21	8.3	10.6
Iron	µg Fe/ℓ	629	222	211	329
Mercury	µg Hg/ℓ	<1	<1	<1	<1
Manganese	µg Mn/ℓ	77	89	157	84
Nickel	µg Ni/ℓ	1.5	7.6	4.3	8.2
Lead	µg Pb/ℓ	<1	<1	<1	<1
Antimony	µg Sb/ℓ	<1	<1	<1	<1
Selenium	µg Se/ℓ	<1	1.5	<1	<1
Uranium	µg U/ℓ	<1	<1	<1	<1
Zinc	µg Zn/ℓ	17.4	45	58	73
Total Chromium	µg Cr/ℓ	11.3	11.8	11.2	12.5
Chloride	mg Cl/ℓ	22	23	18.9	19.4
Cyanide	µg CN/ℓ	<20	<20	<20	<20
Colour (True)	mg Pt-Co/ℓ	<10	<10	<10	<10
Electrical Conductivity at 25°C	mS/m	11.7	13.9	9.8	10.7
Fluoride	mg F/ℓ	<0.06	<0.06	<0.06	0.06
Ammonia	mg N/ℓ	<1.5	<1.5	<1.5	<1.5
Nitrate	mg N/ℓ	<0.25	<0.25	<0.25	<0.25
Nitrite	mg N/ℓ	<0.05	<0.05	<0.05	<0.05
Combined Nitrate + Nitrite (sum of Ratios)	-	<0.12	<0.12	<0.12	<0.12
Turbidity	NTU	6.5	1.0	1.0	5.4
pH at 25°C	pH units	6.0	4.4	4.6	4.5
Total Phenols	µg/ℓ	<2	<2	<2	<2
Sulphate	mg SO_4/ℓ	4.99	9.78	3.82	4.36
Total Dissolved Solids at 180°C	mg/ℓ	79	84	74	63

Table 8. Groundwater quality from 2017 (Talbot & Talbot Laboratory)

Determinand	**Units**	**SANS 241-1:2015 RECOMMENDED LIMITS**	**11107/17**	**017231/17**
			KUR BH01 18.07.17 09:00	**KUR BH02 14.11.17 07:00**
Aluminium	µg Al/l	< 300	74	56
Ammonia	mg N/l	< 1.5	<0.22	<0.22
Antimony	µg Sb/l	< 20	<1	<1
Arsenic	µg As/l	< 10	<1	<1
Barium	µg Ba/l	< 700	3.88	3.1
Boron	µg B/l	< 2400	11.9	52
Cadmium	µg Cd/l	< 3	<1	<1
Chloride	mg Cl/l	< 300	21	21
Colour	mg Pt-Co/l	< 15	13	<1
Copper	µg Cu/l	< 2000	9.39	19
Cyanide	µg CN/l	Not specified	<20	<20
Electrical conductivity at 25°C	mS/m	< 170	10	9.9
Fluoride	µg F/l	< 1500	80	140
Free chlorine	mg Cl2/l	< 5	<0.1	<0.1
Iron	µg Fe/l	Chronic: < 2000 Aesthetic: < 300	**364**	115
Lead	µg Pb/l	<10	<1	<1
Manganese	µg Mn/l	Chronic: < 400 Aesthetic: <100	59	73
Mercury	µg Hg/l	< 6	<1	<1
Monochloramine	mg/l	< 3	<0.1	<0.1
Nickel	µg Ni/l	< 70	2.87	4.2
Nitrate	mg N/l	< 11	<0.1	<0.1
Nitrite	mg N/l	< 0.9	<0.1	<0.1
Combined Nitrate + Nitrite (sum of Ratios)	-	<1	<0.12	<0.12
pH at 25°C	pH units	5.0 - 9.7	5.3	4.9
Selenium	µg Se/l	< 40	<1	<1
Sodium	mg Na/l	< 200	13	11.9
Sulphate	mg SO4/l	Acute: < 500 Aesthetic: < 250	3.22	8.12
Total chromium	µg Cr/l	< 50	1.31	<1
Total dissolved solids at 180°C	mg/l	< 1200	66	66
Turbidity	NTU	Operational <1 Aesthetic <5	**20.1**	3.2
Uranium	µg U/l	< 30	1.24	<1
Zinc	µg Zn/l	< 5000	86	38

7 Monitoring recommendations

It is not normal practice to place four boreholes so close to one another. The reason for this was to maximise the groundwater potential from within the WTW property before having to drill outside the WTW where a water use agreement would be required with the landowner. In order to maximise the yields of these boreholes is essential that they are monitored on an on-going basis. In this regard, it is recommended that a telemetry system be installed whereby the following data is made available on an internet-based system so that it can be monitored remotely:

- Water levels in mbgl taken every hour
- Flow rates in L/s – average taken every hour

This data needs to be reviewed by a hydrogeologist during the initial operation period (for about 3 months) in order to review the yields and modify them accordingly. After this, the data should be reviewed annually and the yields again reviewed and optimised. If the pumps/boreholes show an increased drawdown at any stage, it may be due to iron related problems, and this will need to be investigated. The pumps and possibly the boreholes may then require cleaning and servicing.

In order to cater of a data logger, all boreholes must be equipped with a piezometer tube:

- 35 mm Class 10 HDPE piezometer tube.
- Cable tied every 3 m.
- Capped at the base with LDPE caps (that fit inside the HDPE pipes), cable tied to the pipe. A 25 mm LDPE cap fits inside the 32 mm HDPE pipe.
- HDPE pipes to be perforated over the bottom 10 m with 5 mm drilled holes spaced every 15 cm, each one at 90 degrees to the last.
- HDPE pipe to be secured at the top with Plasson adaptor or similar (the HDPE shrinks and can slide down under the base plate if not secured above).

In addition to the yield and water level data requirements, the following determinands should be checked on a monthly basis:

- Electrical conductivity
- Iron
- Manganese
- Turbidity

A valve must be located at the borehole in order to collect samples at each borehole and in order to pump to waste if a borehole has been standing (to avoid iron-rich red/brown water entering the WTW).

8 Recommendations for additional groundwater supplies

Following the drilling of the four boreholes in the WTW property, the water shortfall is estimated to be:

- Demand: 19.1 L/s
- Wit River: 6.9 L/s
- Boreholes: 8.2 – 9.2 L/s
- Total supply potential: 15.1 – 16.1 L/s
- Additional requirement: 3 - 4 L/s

The TMG aquifer in and around the WTW can supply the required future demand of 19 L/s. Assuming an additional 4 L/s is required to meet this demand, it is likely that this can be achieved with two more production boreholes.

During this project, a geophysical survey was conducted immediately “below” (south) of the WTW in the private lands of Mr Mackenzie (Murray, 2021) and six drilling sites were identified (Figure 19 and Table 9). Although no “exceptional” target was located from the geophysical surveys, there is a reasonable chance the additional ~4 L/s can be obtained from one or two boreholes drilled at the identified sites. The recommendations are as follows:

1. Drill Kur1_690 and Kur1_530 and assess their yields.
2. Should these be insufficient, drill Kur1_330 and Kur1_200.
3. Should they not yield sufficient water, drill the Kur1_1440 site.
4. If this is also low yielding drill the Kur1_870 site.

Figure 19. Potential drill sites

Table 9. Borehole sites

Bh site	Latitude	Longitude	Comments
Priority sites			
Kur1_690	-33.927551°	23.495583°	closest to WTW
Kur1_530	-33.927323°	23.493841°	~180 m from WTW
Alternative sites (to be drilled in the order presented below)			
Kur1_330	-33.927018°	23.491759°	~370 m from WTW
Kur1_200	-33.926840°	23.490381°	~500 m from WTW
Kur1_1440	-33.927983°	23.503393°	~700m from WTW
Kur1_870	-33.927644°	23.497442°	~160 m from WTW

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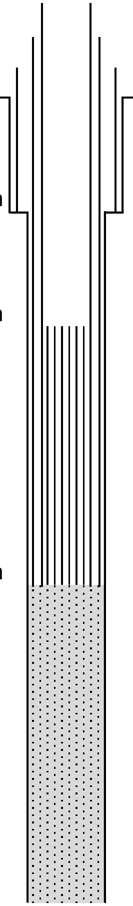
Appendix 1. Borehole Logs

Bitou Municipality Kurland Groundwater Exploration

Bh No:	**GWA-Kur1**		
Location:	Kurland Water Works	**Depth:**	265 m
Lat/Long:	-33.927210° / 23.496070°	**Air-lift yield:**	6 L/s
Drill Date:	Jul 2017	**RWL:**	3.09 m 15 July 2017

Drilling Sizes	**Casing Sizes**		**Water Strikes**	**Geology**	
0 - 30 m 219 mm (Symmetrix)	0 - 30 m 219 mm OD 4.5 mm WT steel	30 m	30 m: Seep	0 - 30 m	Scree consisting of quartzite rock fragments
30 - 150 m 165 mm	0 - 150 m 152 mm OD steel 3 mm WT ID: 146 mm	66 m		31 - 265 m	Quartzite, mostly white (and some grey layers) with layers of pale (beize/cream), soft shale. Quartzites are weathered and fracture stained in places.
	0 - 150 m 140 mm OD uPVC 6 mm WT ID: ~127 mm Plain 0 - 66 m Perforated 66 - 150 m	Plain steel 0 - 150 m Perforated uPVC 66 - 150 mm	70 m: 0.5 L/s 141 m: 2.6 L/s		
150 - 265 m 165 mm	150 - 265 m Open hole backfilled with 29 mm gravel	150 m Coarse gravel 150 - 265 m	217 m: 3.8 L/s 244 m: 4.4 L/s 265 m: 6 L/s		

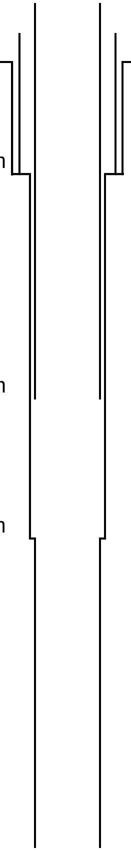


EOH: 265 m

WT = wall thickness
Not to scale

Bitou Municipality Kurland Groundwater Exploration

Bh No:	**GWA-Kur2**		
Location:	Kurland Water Works	**Depth:**	259 m
Lat/Long:	-33.927069° / 23.496303°	**Air-lift yield:**	14 L/s
Drill Date:	Feb 2018	**RWL:**	1.64 m 11 November 2017



Drilling Sizes	Casing Sizes		Water Strikes	Geology	
0 - 10 m 254 mm (Symmetrix)	0 - 10 m; 279 mm OD, WT 4.5 mm steel			0 - 11 m 12 - 23 m 24 - 33 m	Sand and debris material / scree Sandstone debris Highly fractured quartzite
10 - 30 m 219 mm (Symmetrix)	10 - 30 m; 219 mm OD, WT 4.5 mm steel	30 m	34 m: 0.9 L/s	34 - 259 m	Quartzite, white up to 78 m and highly fracture stained at 75 m. Quartzite - grey from 79 - 134 m, fracture stained at 104 and 115 m. Sandstone/ quartzite, weathered, white and beize from 135 - 259 m. Fracture stained in places, eg 180 - 187 m, 200 m, 240 m & at EOH.
30 - 121 m 185 mm	0 - 76 m 160 mm OD uPVC 6 mm WT ID: ~147 mm Plain: 0 - 76 m Casing resting on rock/ collapsed zone at 76 m	Plain uPVC 0 - 76 m 76 m	60 m: 1.6 L/s 75 m: 3.4 L/s		
	Open hole	Open hole 121 m	104 m: 4.9 L/s		
121 m - 259 m 165 mm	Open hole	Open hole	184 m: 5.6 L/s		
		EOH: 259 m	259 m: 14 L/s		

WT = wall thickness
Not to scale

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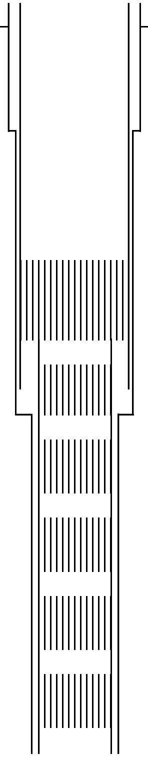
Bitou Municipality Kurland WTW Boreholes - 2021

Bh No:	**GWA-Kur-3**				
Location:	**Kurland Reservoir**	**Depth:**	301 m	**Final EC:**	11 mS/m
Lat/Long:	-33.92732/ 23.49590	**Air-lift yield:**	8.5 L/s	**Logged by:**	Ruan van Jaarsveld
Drill Date:	24-Aug-21	**RWL:**	Not Measured		

Drilling Diameters	Casing Diameters (mm)	Casing Depths (m)	Water Strikes (m)
0 - 19 m 273 mm Odex air rotary	0 - 19 m 273 mm OD 4.5 mm WT steel	Steel plain 19 m	
19 - 121 m: 230 mm Air rotary	0 - 115 m 177 mm OD 10-11 mm WT uPVC	177 mm OD uPVC Plain: 0 - 63 m	
	Perforations: 63 - 109 m	177 mm OD uPVC Perforated: 63 - 109	55 m, 0,5 L/s 73 m, 1.2 L/s 91 m, 1.7 L/s
		177 mm OD uPVC Plain: 109 - 115 m	107 m, 2.6 L/s (18 mS/m)
	Drop set: 110 - 300 m 140 mm OD 7 mm WT uPVC	121 m	
121-301 m: 176 mm air rotary		140 mm OD uPVC Alternating plain and perforated	126 m, 3 L/s (22 mS/m)
	Perforations: 117-123, 129-135, 141-147, 153-158, 164-170, 176-188, 200-206, 212-218, 224-229, 235-247, 253-265, 271-277, 283-289 m		185 m, 3.9 L/s (13 mS/m) 244 m, 7 L/s (12 mS/m) 256 m, 8.5 L/s (11 mS/m)
WT = wall thickness Not to scale			



EOH: 301 m

Depth (m)	Geology
0 - 1 m	Brown sandy soil with large rock fragments, unconsolidated (alluvium)
1 - 5 m	Orange quartzite rock fragments and sandy soil, colour due to iron oxide leaching stains, unconsolidated (alluvium)
5 -7 m	Yellow quartzite rock fragments and sandy soil, colour due to iron oxide leaching stains, unconsolidated (alluvium)
7 - 8 m	Dark brown sandy/clay soil with minor yellow quartzite rock fragments, unconsolidated (alluvium)
8 - 13 m	Yellow quartzite rock fragments and sandy soil, colour due to iron oxide leaching stains, unconsolidated (alluvium)
13 - 30 m	Pale grey quartzite rock fragments deposited with minor sand, unconsolidated (alluvium)
30 - 43 m	Dark brown sandy soil with minor pale grey quartzite rock fragments, unconsolidated (alluvium)
43 - 53 m	Pale grey quartzite with yellow tint, high iron oxide weathering stains, well fractured (2-4 cm fragments)
53 - 112 m	Dark grey quartzite, highly fractured with occasional mylonite (2-5 cm fragments)
112 - 115 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains, well jointed (1-2 cm fragments)
115 - 119 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains, well jointed, minor fracture zone (1-4 cm fragments)
119 - 125 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains, well jointed (1-2 cm fragments)
125-129 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains and fracture stains, well jointed, fracture zone (1-4 cm fragments)
129 - 151 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains, very minor jointed (1-2 cm fragments)
151 - 155 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains, well jointed, minor fracture zone (1-4 cm fragments)
155 - 184 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains, very minor jointed (1-2 cm fragments)
184 - 188 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains and fracture stains, well jointed, fracture zone (1-4 cm fragments)
188 - 199 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains, well jointed (1-2 cm fragments)
199 - 202 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains, well jointed, minor fracture zone (1-4 cm fragments)
202 - 233 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains, very minor jointed (1-2 cm fragments)
233 -246 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains, well jointed, minor fracture zone (1-3 cm fragments)
246 - 253 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains, well jointed (1-2 cm fragments)
253 -265 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains and fracture stains, well jointed, fracture zone (1-4 cm fragments)
265 - 272 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains, well jointed (1-2 cm fragments)
272 - 301 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains, very minor jointed (1-2 cm fragments)

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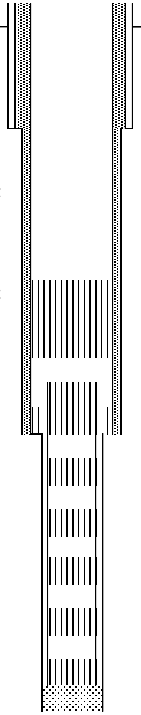
Bitou Municipality Kurland WTW Boreholes - 2021

Bh No:	**GWA-Kur-4**				
Location:	**Kurland Reservoir**	**Depth:**	277 m	**Final EC:**	11 mS/m
Lat/Long:	-33.92689/ 23.49604	**Air-lift yield:**	8 L/s	**Logged by:**	Ruan van Jaarsveld
Drill Date:	11-Oct-21	**RWL:**	Not Measured		



Drilling Diameters	**Casing Diameters (mm)**	**Casing Depths (m)**	**Water Strikes (m)**	**Depth (m)**	**Geology**
0 - 21 m	0 - 21 m	Gravel packed		0 - 1 m	Brown sandy soil with large rock fragments, unconsolidated (alluvium)
273 mm	273 mm OD	0 - 124 m		1 - 5 m	Orange quartzite rock fragments and sandy soil, colour due to iron oxide leaching stains, unconsolidated (alluvium)
Odex air rotary	4.5 mm WT steel			5 -7 m	Yellow quartzite rock fragments and sandy soil, colour due to iron oxide leaching stains, unconsolidated (alluvium)
		Steel plain 21 m		7 - 24 m	Dark brown sandy/clay soil with minor yellow quartzite rock fragments, unconsolidated (alluvium)
	0 - 124 m				
21 - 121 m:	177 mm OD			24 - 31 m	Grey to dark grey quartzite, broken ground (1-5 cm fragments)
223 mm Air rotary	10-11 mm WT uPVC	177 mm OD uPVC:		31 - 43 m	Pale grey quartzite with yellow tint, high iron oxide weathering stains, well fractured (2-4 cm fragments)
	Casing pushed past	Plain: 0 - 65 m		43 - 49 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains and fracture stains, well jointed, fracture zone (3-6 cm fragments)
	step			49 - 55 m	Grey quartzite, with iron oxide weathering stains, well jointed, minor fracture zone 53 m (2-4 cm fragments)
	Perforations:			55 - 85 m	Dark grey quartzite, highly fractured with occasional mylonite (2-5 cm fragments)
	65-83 m, 89-100 m,	177 mm OD uPVC:	64-79 m, 1.2 L/s		
	106-124 m	Perforated: 65 -83 m			
			91-96 m, 1.8 L/s	85-127 m	Dark grey quartzite, well jointed with minor fracture zones at 91-96, 104-106 and 123-126 (2-4 cm fragments)
		Perforated: 89 - 100 m	104-106 m		
			114 m, 4.4 L/s		
	Drop set:	Perforated 106 -124 m	123-126 m		
121-277 m:	115 - 269.9 m			127-157 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains, well jointed (1-2 cm fragments)
186 mm Air rotary	140 mm OD			157-163 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains and fracture stains, well jointed, fracture zone (1-4 cm fragments)
	7 mm WT uPVC			163-211 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains, well jointed (1-2 cm fragments)
	Perforations:		212 m, 5.5 L/s	211-214 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains, well jointed, minor fracture zone (1-4 cm fragments)
	115-127 , 139-175 ,			214-240 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains, very minor jointed (1-2 cm fragments)
	187-192, 198-210,	140 mm OD uPVC			
	216-222, 228-240,	Alternating plain			
	246-263 m	and perforated	240 m, 7 L/s	240-246 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains, well jointed, minor fracture zone (1-3 cm fragments)
				246-261 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains, well jointed (1-2 cm fragments)
WT = wall thickness			261 m, 8 L/s	261-271 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains and fracture stains, well jointed, fracture zone (1-4 cm fragments)
Not to scale		Collapsed: 269.9-277 m		271-277 m	Pale grey quartzite, with yellow tint, iron oxide weathering stains, well jointed (1-2 cm fragments)

EOH: 277 m

GROUNDWATERAFRICA

Appendix 2. Water quality

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Analytical Results

Methods	Determinands	Units	029519/21 P2587 KUR1 KURLAND 13:10 29.11.2021
Chemical			
84	Sodium	mg Na/ℓ	13.2
83A	Aluminium	µg Al/ℓ	16.8
83A	Arsenic	µg As/ℓ	<1
83A	Boron	µg B/ℓ	12.5
83A	Barium	µg Ba/ℓ	3.4
83A	Cadmium	µg Cd/ℓ	<1
83A	Copper	µg Cu/ℓ	2.0
83A	Iron	µg Fe/ℓ	629
83A	Mercury	µg Hg/ℓ	<1
83A	Manganese	µg Mn/ℓ	77
83A	Nickel	µg Ni/ℓ	1.5
83A	Lead	µg Pb/ℓ	<1
83A	Antimony	µg Sb/ℓ	<1
83A	Selenium	µg Se/ℓ	<1
83A	Uranium	µg U/ℓ	<1
83A	Zinc	µg Zn/ℓ	17.4
83A	Total Chromium	µg Cr/ℓ	11.3
16G	Chloride	mg Cl/ℓ	22
135	Cyanide*	µg CN/ℓ	<20
40A	Colour (True)*	mg Pt-Co/ℓ	<10
2A	Electrical Conductivity at 25°C	mS/m	11.7
18G	Fluoride	mg F/ℓ	<0.06
64G	Ammonia	mg N/ℓ	<1.5
65Gc	Nitrate	mg N/ℓ	<0.25
65Gb	Nitrite	mg N/ℓ	<0.05
Calc.	Combined Nitrate + Nitrite (sum of Ratios)*	-	<0.12
4	Turbidity	NTU	6.5
1	pH at 25°C	pH units	6.0

Methods	Determinands	Units	029519/21 P2587 KUR1 KURLAND 13:10 29.11.2021
Chemical			
133	Total Phenols*	µg/ℓ	<2
67G	Sulphate	mg SO_4/ℓ	4.99
41	Total Dissolved Solids at 180°C	mg/ℓ	79
Microbiological			
-	*Coliphages**	PFU/10mℓ	0#
Organics			
104	Total Organic Carbon*	mg C/ℓ	1.1

Talbot Laboratories (Pty) Ltd

Analytical Results

Methods	Determinands	Units	029520/21 P2587 KUR2 KURLAND 13:08 29.11.2021
Chemical			
84	Sodium	mg Na/ℓ	15.1
83A	Aluminium	µg Al/ℓ	112
83A	Arsenic	µg As/ℓ	<1
83A	Boron	µg B/ℓ	10.3
83A	Barium	µg Ba/ℓ	3.2
83A	Cadmium	µg Cd/ℓ	1.1
83A	Copper	µg Cu/ℓ	21
83A	Iron	µg Fe/ℓ	222
83A	Mercury	µg Hg/ℓ	<1
83A	Manganese	µg Mn/ℓ	89
83A	Nickel	µg Ni/ℓ	7.6
83A	Lead	µg Pb/ℓ	<1
83A	Antimony	µg Sb/ℓ	<1
83A	Selenium	µg Se/ℓ	1.5
83A	Uranium	µg U/ℓ	<1
83A	Zinc	µg Zn/ℓ	45
83A	Total Chromium	µg Cr/ℓ	11.8
16G	Chloride	mg Cl/ℓ	23
135	Cyanide*	µg CN/ℓ	<20
40A	Colour (True)*	mg Pt-Co/ℓ	<10
2A	Electrical Conductivity at 25°C	mS/m	13.9
18G	Fluoride	mg F/ℓ	<0.06
64G	Ammonia	mg N/ℓ	<1.5
65Gc	Nitrate	mg N/ℓ	<0.25
65Gb	Nitrite	mg N/ℓ	<0.05
Calc.	Combined Nitrate + Nitrite (sum of Ratios)*	-	<0.12
4	Turbidity	NTU	1.0
1	pH at 25°C	pH units	**4.4**

Methods	Determinands	Units	029520/21 P2587 KUR2 KURLAND 13:08 29.11.2021
Chemical			
133	Total Phenols*	µg/ℓ	<2
67G	Sulphate	mg SO_4/ℓ	9.78
41	Total Dissolved Solids at 180°C	mg/ℓ	84
Microbiological			
-	*Coliphages**	PFU/10mℓ	0#
Organics			
104	Total Organic Carbon*	mg C/ℓ	0.92

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Analytical Results

Methods	Determinands	Units	029521/21 P2587 KUR3 KURLAND 13:10 29.11.2021
Chemical			
84	Sodium	mg Na/ℓ	10.4
83A	Aluminium	µg Al/ℓ	68
83A	Arsenic	µg As/ℓ	<1
83A	Boron	µg B/ℓ	9.4
83A	Barium	µg Ba/ℓ	3.3
83A	Cadmium	µg Cd/ℓ	<1
83A	Copper	µg Cu/ℓ	8.3
83A	Iron	µg Fe/ℓ	211
83A	Mercury	µg Hg/ℓ	<1
83A	Manganese	µg Mn/ℓ	157
83A	Nickel	µg Ni/ℓ	4.3
83A	Lead	µg Pb/ℓ	<1
83A	Antimony	µg Sb/ℓ	<1
83A	Selenium	µg Se/ℓ	<1
83A	Uranium	µg U/ℓ	<1
83A	Zinc	µg Zn/ℓ	58
83A	Total Chromium	µg Cr/ℓ	11.2
16G	Chloride	mg Cl/ℓ	18.9
135	Cyanide*	µg CN/ℓ	<20
40A	Colour (True)*	mg Pt-Co/ℓ	<10
2A	Electrical Conductivity at 25°C	mS/m	9.8
18G	Fluoride	mg F/ℓ	<0.06
64G	Ammonia	mg N/ℓ	<1.5
65Gc	Nitrate	mg N/ℓ	<0.25
65Gb	Nitrite	mg N/ℓ	<0.05
Calc.	Combined Nitrate + Nitrite (sum of Ratios)*	-	<0.12
4	Turbidity	NTU	1.0
1	pH at 25°C	pH units	**4.6**

Methods	Determinands	Units	029521/21 P2587 KUR3 KURLAND 13:10 29.11.2021
Chemical			
133	Total Phenols*	µg/ℓ	<2
67G	Sulphate	mg SO_4/ℓ	3.82
41	Total Dissolved Solids at 180°C	mg/ℓ	74
Microbiological			
-	*Coliphages**	PFU/10mℓ	0#
Organics			
104	Total Organic Carbon*	mg C/ℓ	1.2

Talbot Laboratories (Pty) Ltd

Analytical Results

Methods	Determinands	Units	029522/21 P2587 KUR4 KURLAND 13:10 29.11.2021
Chemical			
84	Sodium	mg Na/ℓ	11.2
83A	Aluminium	µg Al/ℓ	41
83A	Arsenic	µg As/ℓ	1.5
83A	Boron	µg B/ℓ	9.0
83A	Barium	µg Ba/ℓ	3.8
83A	Cadmium	µg Cd/ℓ	2.4
83A	Copper	µg Cu/ℓ	10.6
83A	Iron	µg Fe/ℓ	329
83A	Mercury	µg Hg/ℓ	<1
83A	Manganese	µg Mn/ℓ	84
83A	Nickel	µg Ni/ℓ	8.2
83A	Lead	µg Pb/ℓ	<1
83A	Antimony	µg Sb/ℓ	<1
83A	Selenium	µg Se/ℓ	<1
83A	Uranium	µg U/ℓ	<1
83A	Zinc	µg Zn/ℓ	73
83A	Total Chromium	µg Cr/ℓ	12.5
16G	Chloride	mg Cl/ℓ	19.4
135	Cyanide*	µg CN/ℓ	<20
40A	Colour (True)*	mg Pt-Co/ℓ	<10
2A	Electrical Conductivity at 25°C	mS/m	10.7
18G	Fluoride	mg F/ℓ	0.06
64G	Ammonia	mg N/ℓ	<1.5
65Gc	Nitrate	mg N/ℓ	<0.25
65Gb	Nitrite	mg N/ℓ	<0.05
Calc.	Combined Nitrate + Nitrite (sum of Ratios)*	-	<0.12
4	Turbidity	NTU	5.4
1	pH at 25°C	pH units	4.5

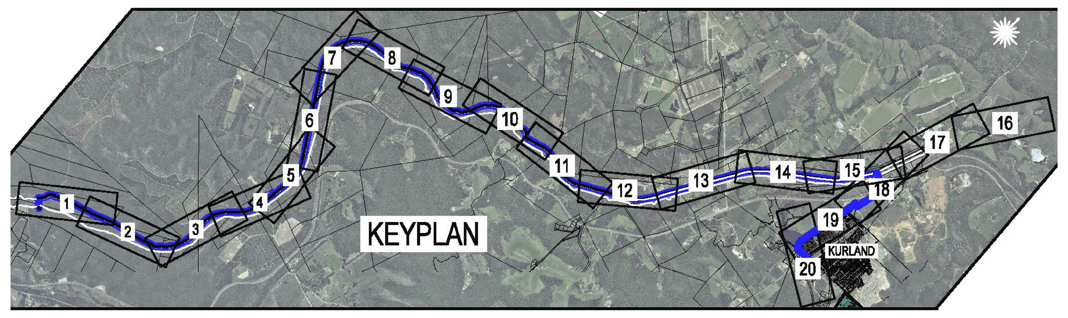
Methods	Determinands	Units	029522/21 P2587 KUR4 KURLAND 13:10 29.11.2021
Chemical			
133	Total Phenols*	µg/ℓ	<2
67G	Sulphate	mg SO_4/ℓ	4.36
41	Total Dissolved Solids at 180°C	mg/ℓ	63
Microbiological			
-	*Coliphages**	PFU/10mℓ	0#
Organics			
104	Total Organic Carbon*	mg C/ℓ	0.79

ANNEXURE D

LAYOUT PLANS OF PIPELINES

LEGEND

ITEM	EXISTING	PROPOSED
PROPOSED Ø200mm BULK WATER SUPPLY PIPE		(blue line)
N2 ROAD RESERVE FOR FUTURE ROAD ALIGNMENT		(green line)
N2 ROAD RESERVE FOR EXISTING ROAD ALIGNMENT	(red line)	



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6600

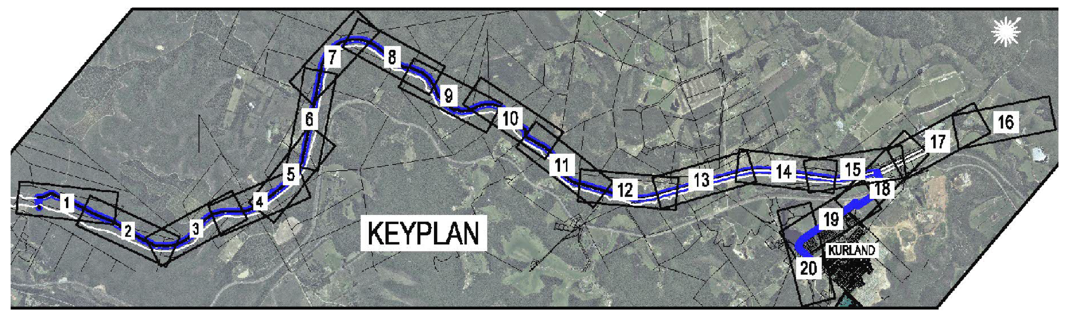
PROJECT
KURLAND BULK WATER SUPPLY PIPELINE

TITLE
BULK WATERT PIPELINE LAYOUT:
MATJIESFONTEIN RESERVOIR TO KURLAND RESERVOIRS

SCALE 1:1000
SHEET 1 OF 21
CONTRACT No. -
PROJECT No. C20028G
DRAWING No. C20028G - 01
REV A
DATE OF FIRST ISSUE: -

LEGEND

ITEM	EXISTING	PROPOSED
PROPOSED Ø200mm BULK WATER SUPPLY PIPE		(blue line)
N2 ROAD RESERVE FOR FUTURE ROAD ALIGNMENT		(green line)
N2 ROAD RESERVE FOR EXISTING ROAD ALIGNMENT	(red line)	



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PROJECT
KURLAND BULK WATER SUPPLY PIPELINE

TITLE
BULK WATERT PIPELINE LAYOUT:
MATJIESFONTEIN RESERVOIR TO KURLAND RESERVOIRS

SCALE	SHEET
1:1000	2 OF 20
CONTRACT No.	PROJECT No.
-	C20028G
DRAWING No.	REV
C20028G - 02	
DATE OF FIRST ISSUE: -	

LEGEND

ITEM	EXISTING	PROPOSED
PROPOSED Ø200mm BULK WATER SUPPLY PIPE		(blue line)
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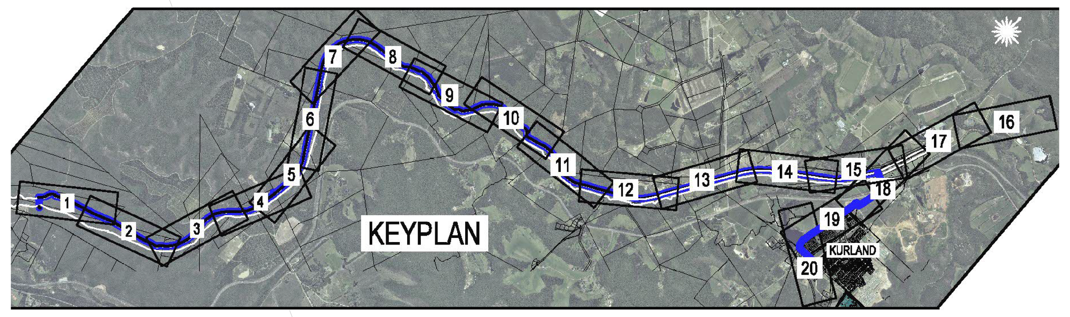
N2 ROAD RESERVE FOR EXISTING ROAD ALIGNMENT	(red line)	



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PROJECT
KURLAND BULK WATER SUPPLY PIPELINE

TITLE
BULK WATERT PIPELINE LAYOUT:
MATJIESFONTEIN RESERVOIR TO KURLAND RESERVOIRS

SCALE	SHEET
1:1000	3 OF 20
CONTRACT No. -	PROJECT No. C20028G
DRAWING No. C20028G - 03	REV
DATE OF FIRST ISSUE: -	

LEGEND

ITEM	EXISTING	PROPOSED
PROPOSED Ø200mm BULK WATER SUPPLY PIPE		(blue line)
N2 ROAD RESERVE FOR FUTURE ROAD ALIGNMENT		(green line)
N2 ROAD RESERVE FOR EXISTING ROAD ALIGNMENT	(red line)	

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PROJECT
KURLAND BULK WATER SUPPLY PIPELINE

TITLE
BULK WATERT PIPELINE LAYOUT:
MATJIESFONTEIN RESERVOIR TO KURLAND RESERVOIRS

SCALE	SHEET
1:1000	4 OF 20
CONTRACT No.	PROJECT No.
-	C20028G
DRAWING No.	REV
C20028G - 04	

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LEGEND

ITEM	EXISTING	PROPOSED
PROPOSED Ø200mm BULK WATER SUPPLY PIPE		(blue line)
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N2 ROAD RESERVE FOR EXISTING ROAD ALIGNMENT	(red line)	

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KURLAND BULK WATER SUPPLY PIPELINE

TITLE
BULK WATERT PIPELINE LAYOUT:
MATJIESFONTEIN RESERVOIR TO KURLAND RESERVOIRS

SCALE	SHEET
1:1000	5 OF 20
CONTRACT No. -	PROJECT No. C20028G
DRAWING No. C20028G - 05	REV
DATE OF FIRST ISSUE: -	

LEGEND

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PROPOSED Ø200mm BULK WATER SUPPLY PIPE		(blue line)
N2 ROAD RESERVE FOR FUTURE ROAD ALIGNMENT		(green line)
N2 ROAD RESERVE FOR EXISTING ROAD ALIGNMENT	(red line)	

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KURLAND BULK WATER SUPPLY PIPELINE

TITLE

BULK WATERT PIPELINE LAYOUT:
MATJIESFONTEIN RESERVOIR TO KURLAND RESERVOIRS

SCALE	SHEET
1:1000	6 OF 20
CONTRACT No.	PROJECT No.
-	C20028G

DRAWING No. C20028G - 06
REV

DATE OF FIRST ISSUE: -

LEGEND

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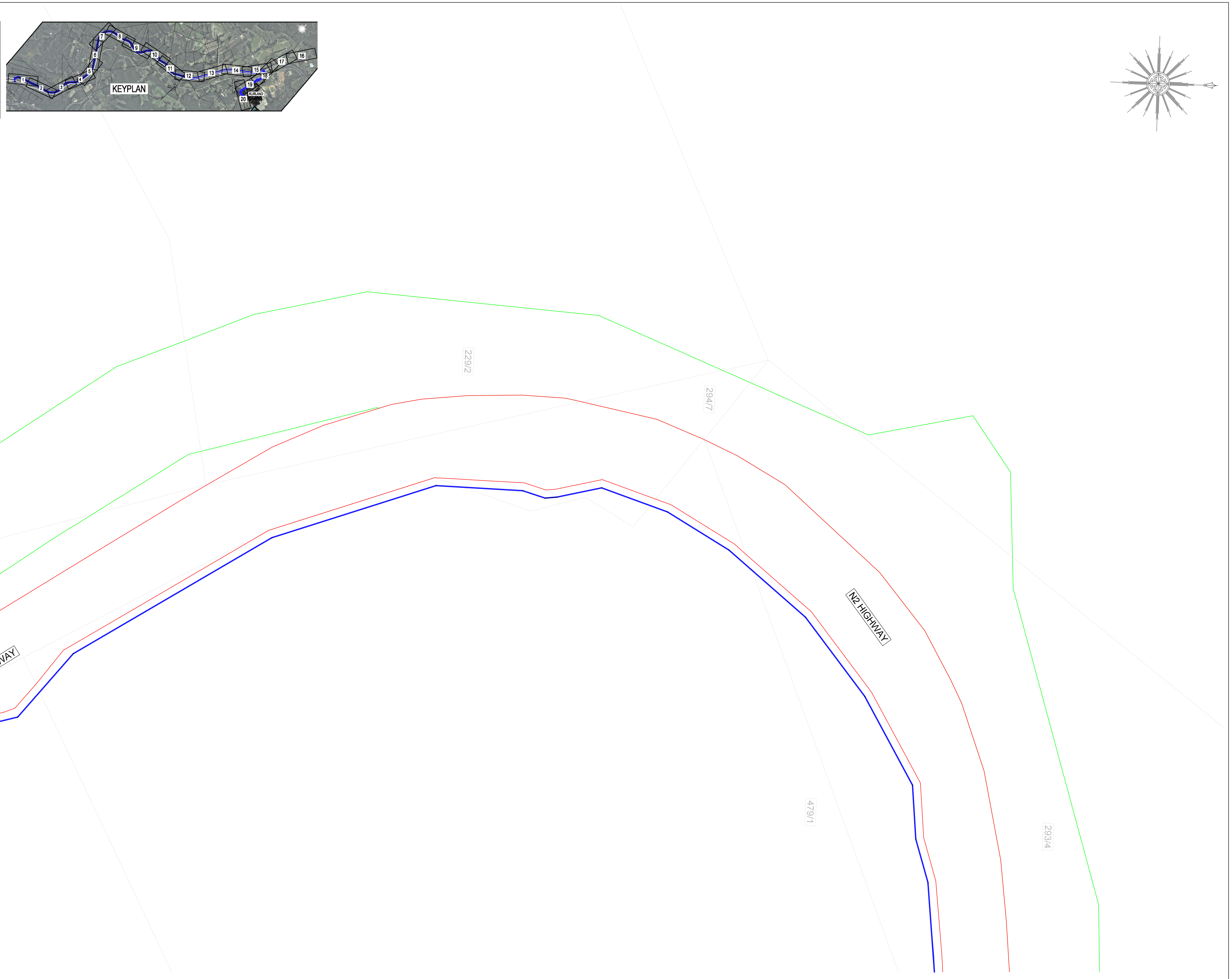
N2 ROAD RESERVE FOR EXISTING ROAD ALIGNMENT	(red line)	



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KURLAND BULK WATER SUPPLY PIPELINE

TITLE
BULK WATERT PIPELINE LAYOUT:
MATJIESFONTEIN RESERVOIR TO KURLAND RESERVOIRS

SCALE	SHEET
1:1000	7 OF 20
CONTRACT No.	PROJECT No.
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DATE OF FIRST ISSUE: -	

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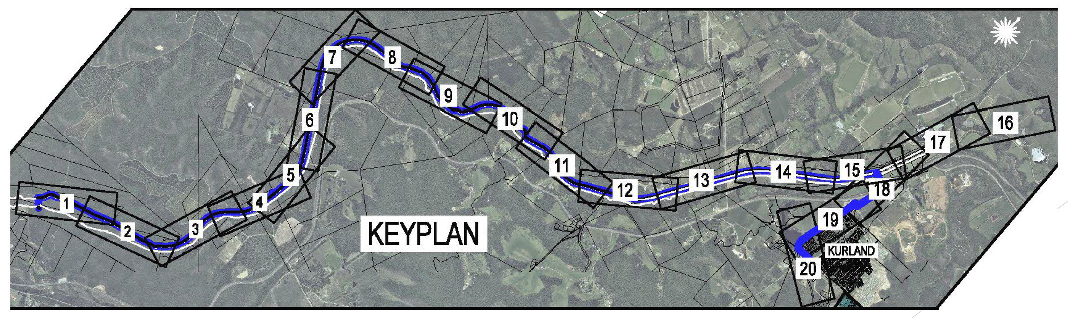
N2 ROAD RESERVE FOR EXISTING ROAD ALIGNMENT	(red line)	



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PROJECT

KURLAND BULK WATER SUPPLY PIPELINE

TITLE

BULK WATERT PIPELINE LAYOUT:
MATJIESFONTEIN RESERVOIR TO KURLAND RESERVOIRS

SCALE	SHEET
1:1000	8 OF 20
CONTRACT No.	PROJECT No.
-	C20028G

DRAWING No.: C20028G - 08
REV: A
DATE OF FIRST ISSUE: -

LEGEND		
ITEM	EXISTING	PROPOSED
PROPOSED Ø200mm BULK WATER SUPPLY PIPE		(blue line)
N2 ROAD RESERVE FOR FUTURE ROAD ALIGNMENT		(green line)
N2 ROAD RESERVE FOR EXISTING ROAD ALIGNMENT	(red line)	

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PROJECT

KURLAND BULK WATER SUPPLY PIPELINE

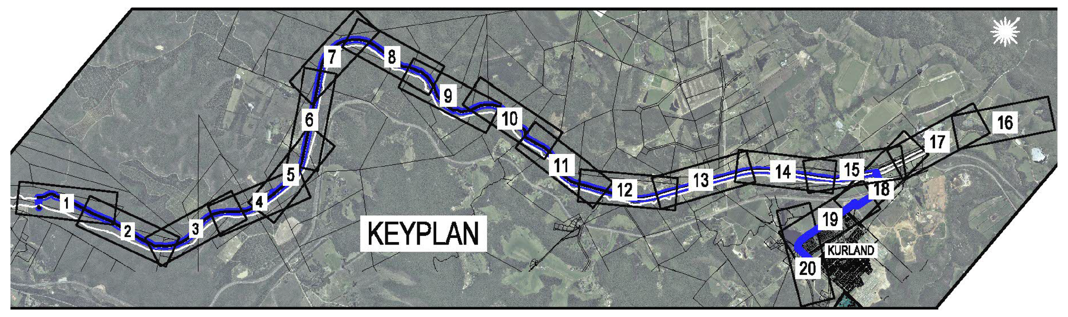
TITLE

BULK WATERT PIPELINE LAYOUT:
MATJIESFONTEIN RESERVOIR TO KURLAND RESERVOIRS

SCALE	SHEET
1:1000	9 OF 20
CONTRACT No.	PROJECT No.
-	C20028G
DRAWING No.	REV
C20028G - 09	A
DATE OF FIRST ISSUE: -	

LEGEND

ITEM	EXISTING	PROPOSED
PROPOSED Ø200mm BULK WATER SUPPLY PIPE		blue line
N2 ROAD RESERVE FOR FUTURE ROAD ALIGNMENT		green line
N2 ROAD RESERVE FOR EXISTING ROAD ALIGNMENT	red line	



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PROJECT

KURLAND BULK WATER SUPPLY PIPELINE

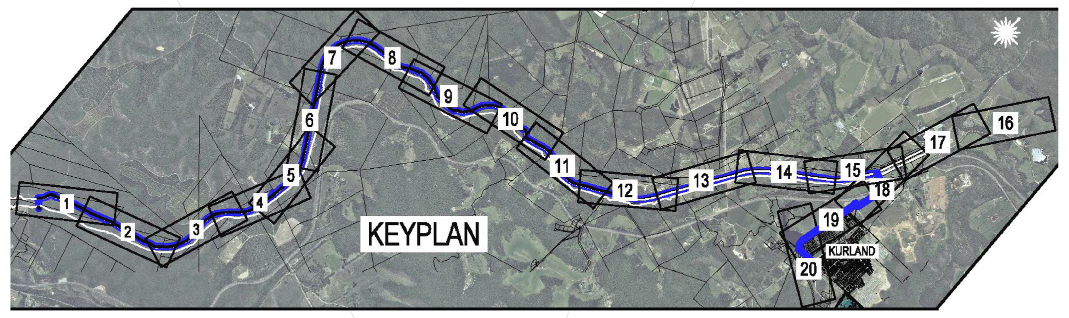
TITLE

BULK WATERT PIPELINE LAYOUT:
MATJIESFONTEIN RESERVOIR TO KURLAND RESERVOIRS

SCALE	SHEET
1:1000	10 OF 20
CONTRACT No.	PROJECT No.
-	C20028G
DRAWING No.	REV
C20028G - 10	A

DATE OF FIRST ISSUE: -

LEGEND		
ITEM	EXISTING	PROPOSED
PROPOSED Ø200mm BULK WATER SUPPLY PIPE		(blue line)
N2 ROAD RESERVE FOR FUTURE ROAD ALIGNMENT		(green line)
N2 ROAD RESERVE FOR EXISTING ROAD ALIGNMENT	(red line)	



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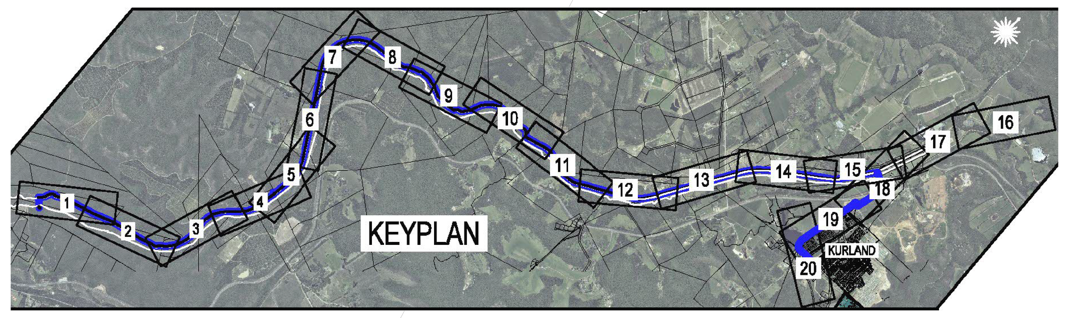
PROJECT
KURLAND BULK WATER SUPPLY PIPELINE

TITLE
BULK WATERT PIPELINE LAYOUT:
MATJIESFONTEIN RESERVOIR TO KURLAND RESERVOIRS

SCALE 1:1000
SHEET 11 OF 20
CONTRACT No. -
PROJECT No. C20028G
DRAWING No. C20028G - 11
REV A
DATE OF FIRST ISSUE: -

LEGEND

ITEM	EXISTING	PROPOSED
PROPOSED Ø200mm BULK WATER SUPPLY PIPE		(blue line)
N2 ROAD RESERVE FOR FUTURE ROAD ALIGNMENT		(green line)
N2 ROAD RESERVE FOR EXISTING ROAD ALIGNMENT	(red line)	



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PROJECT
KURLAND BULK WATER SUPPLY PIPELINE

TITLE
BULK WATERT PIPELINE LAYOUT:
MATJIESFONTEIN RESERVOIR TO KURLAND RESERVOIRS

SCALE: 1:1000	SHEET: 12 OF 20
CONTRACT No. -	PROJECT No. C20028G
DRAWING No. C20028G - 12	REV
DATE OF FIRST ISSUE: -	

LEGEND

ITEM	EXISTING	PROPOSED
PROPOSED Ø200mm BULK WATER SUPPLY PIPE		(blue line)
N2 ROAD RESERVE FOR FUTURE ROAD ALIGNMENT		(green line)
N2 ROAD RESERVE FOR EXISTING ROAD ALIGNMENT	(red line)	

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PROJECT
KURLAND BULK WATER SUPPLY PIPELINE

TITLE
BULK WATERT PIPELINE LAYOUT:
MATJIESFONTEIN RESERVOIR TO KURLAND RESERVOIRS

SCALE	SHEET
1:1000	13 OF 20
CONTRACT No.	PROJECT No.
-	C20028G
DRAWING No.	REV
C20028G - 13	A
DATE OF FIRST ISSUE: -	

LEGEND

ITEM	EXISTING	PROPOSED
PROPOSED Ø200mm BULK WATER SUPPLY PIPE		(blue line)
N2 ROAD RESERVE FOR FUTURE ROAD ALIGNMENT		(green line)
N2 ROAD RESERVE FOR EXISTING ROAD ALIGNMENT	(red line)	

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PROJECT
KURLAND BULK WATER SUPPLY PIPELINE

TITLE
BULK WATERT PIPELINE LAYOUT:
MATJIESFONTEIN RESERVOIR TO KURLAND RESERVOIRS

SCALE	SHEET
1:1000	14 OF 20
CONTRACT No. -	PROJECT No. C20028G
DRAWING No. C20028G - 14	REV
DATE OF FIRST ISSUE: -	

LEGEND

ITEM	EXISTING	PROPOSED
PROPOSED Ø200mm BULK WATER SUPPLY PIPE		(blue line)
PROPOSED Ø315mm BULK WATER SUPPLY PIPE		(blue line)
N2 ROAD RESERVE FOR FUTURE ROAD ALIGNMENT		(green line)
N2 ROAD RESERVE FOR EXISTING ROAD ALIGNMENT	(red line)	
PROPERTY CADASTRAL	(pink line)	

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PROJECT
KURLAND BULK WATER SUPPLY PIPELINE

TITLE
BULK WATERT PIPELINE LAYOUT:
MATJIESFONTEIN RESERVOIR TO KURLAND RESERVOIRS

SCALE	SHEET
1:1000	15 OF 19
CONTRACT No.	PROJECT No.
-	C20028G
DRAWING No.	REV
C20028G - 15	A

DATE OF FIRST ISSUE: -

LEGEND

ITEM	EXISTING	PROPOSED
PROPOSED Ø200mm BULK WATER SUPPLY PIPE		
PROPOSED Ø315mm BULK WATER SUPPLY PIPE		
N2 ROAD RESERVE FOR FUTURE ROAD ALIGNMENT		
N2 ROAD RESERVE FOR EXISTING ROAD ALIGNMENT		
PROPERTY CADASTRAL		

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KURLAND BULK WATER SUPPLY PIPELINE

TITLE
BULK WATERT PIPELINE LAYOUT:
MATJIESFONTEIN RESERVOIR TO KURLAND RESERVOIRS

SCALE	SHEET
1:1000	16 OF 19
CONTRACT No. -	PROJECT No. C20028G
DRAWING No. C20028G - 16	REV A
DATE OF FIRST ISSUE: -	

LEGEND

ITEM	EXISTING	PROPOSED
PROPOSED Ø200mm BULK WATER SUPPLY PIPE		blue dash-dot line
PROPOSED Ø315mm BULK WATER SUPPLY PIPE		blue dash-dot line
N2 ROAD RESERVE FOR FUTURE ROAD ALIGNMENT		green line
N2 ROAD RESERVE FOR EXISTING ROAD ALIGNMENT	red line	
PROPERTY CADASTRAL	pink line	

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PROJECT
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TITLE
BULK WATERT PIPELINE LAYOUT:
MATJIESFONTEIN RESERVOIR TO KURLAND RESERVOIRS

SCALE	SHEET
1:1000	17 OF 19
CONTRACT No. -	PROJECT No. C20028G
DRAWING No. C20028G - 17	REV A
DATE OF FIRST ISSUE: -	

LEGEND

ITEM	EXISTING	PROPOSED
PROPOSED Ø200mm BULK WATER SUPPLY PIPE		
PROPOSED Ø315mm BULK WATER SUPPLY PIPE		
N2 ROAD RESERVE FOR FUTURE ROAD ALIGNMENT		
N2 ROAD RESERVE FOR EXISTING ROAD ALIGNMENT		
PROPERTY CADASTRAL		

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PROJECT
KURLAND BULK WATER SUPPLY PIPELINE

TITLE
BULK WATERT PIPELINE LAYOUT:
MATJIESFONTEIN RESERVOIR TO KURLAND RESERVOIRS

SCALE	SHEET
1:1000	18 OF 19
CONTRACT No.	PROJECT No.
-	C20028G
DRAWING No.	REV
C20028G - 18	A

DATE OF FIRST ISSUE: -

LEGEND

ITEM	EXISTING	PROPOSED
PROPOSED Ø200mm BULK WATER SUPPLY PIPE		
PROPOSED Ø315mm BULK WATER SUPPLY PIPE		
N2 ROAD RESERVE FOR FUTURE ROAD ALIGNMENT		
N2 ROAD RESERVE FOR EXISTING ROAD ALIGNMENT		
PROPERTY CADASTRAL		

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PROJECT
KURLAND BULK WATER SUPPLY PIPELINE

TITLE
BULK WATERT PIPELINE LAYOUT:
MATJIESFONTEIN RESERVOIR TO KURLAND RESERVOIRS

SCALE 1:1000
SHEET 19 OF 19
CONTRACT No. -
PROJECT No. C20028G
DRAWING No. C20028G - 19
REV A
DATE OF FIRST ISSUE: -

ANNEXURE E

GLS MASTER PLANNING

1 September 2022

The Director: Engineering Services
Bitou Municipality
Private Bag X1002
Plettenberg Bay
6600

Attention: Ms Franclyn Lucy Samuel

Dear Madam

DEVELOPMENT OF ERF 562 KURLAND, PLETTENBERG BAY: CAPACITY ANALYSIS OF THE BULK WATER & SEWER SERVICES

The request by Mr Francois van Eck of Lyners Consulting Engineers and Project Managers regarding comments on the bulk water and sewer supply to the proposed development (residential development on Erf 562, Kurland) refers. This report constitutes an update to the report dated 17 September 2021.

This report should inter alia be read in conjunction with the Bitou Municipality Water Master Plan dated June 2020 and the Bitou Sewer Master Plan dated June 2020.

Future development area P096 was conceptually taken into consideration for the master plans for the water and sewer networks.

1 WATER DISTRIBUTION SYSTEM

1.1 Distribution zone

The master plan indicated that the proposed development should be accommodated in the Kurland reservoir distribution zone. The existing water system has insufficient capacity to accommodate the development and a phased approach was considered, as stipulated below:

- Phase 1: 200 units
- Phase 2: Additional 250 units (450 units in total)
- Phase 3: Fully developed (2 080 units in total)

The proposed connection for Phase 1 is to the existing 75 mm Ø water reticulation pipe in Geelhout Street. Phase 1 will require the implementation of master plan item BKW1.1. To accommodate Phase 2 the implementation of master plan item BKW2.1 is required. The master plan items and connection points are shown in Figure 1 attached.

Mater plan items BKW1.1 and BKW2.1 are considered network upgrades. To accommodate development beyond Phase 2, new bulk infrastructure is required and is discussed in section 1.4 of this report.

The proposed development is situated inside the water priority area.

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13 Elektron Street, Techno Park, Stellenbosch, 7600 | PO Box 814, Stellenbosch, 7599
Reg no: 2007/003039/07
www.gls.co.za

Directors: HA Baartman, AG Hingeston, JJ Streicher

1.2 Water demand

The water analysis for the master plan was performed with a total annual average daily demand (AADD) for the proposed development of 675 kL/d (future area P096 in the latest water master plan).

For the re-analysis, the water demand and fire flow for the proposed development was calculated as follows:

- 2 080 Residential units @ 0,45 kL/unit/d = 936 kL/d
- Fire flow criteria (low risk) = 15 L/s @ 10 m

1.3 Present situation

1.3.1 Reticulation network

The existing water system has insufficient capacity to accommodate the domestic flow of the proposed development whilst complying with the minimum pressure requirements as set out in the master plan (20 – 24 m). The implementation of master plan item BKW1.1 is required for Phase 1 and the implementation of master plan item BKW2.1 is required for Phase 2 of the proposed development.

To accommodate further development beyond Phase 2, new bulk infrastructure is required and is discussed in section 1.4 of this report.

1.3.2 Fire flow

The existing water system has insufficient capacity to comply with the fire flow criteria as set out in the master plan. However, the implementation of mater plan items BKW1.1 (Phase 1) and BKW2.1 (Phase 2) will make sufficient provision to meet the fire flow requirements (15 L/s @ 10 m) for the respective phases.

1.3.3 Reservoir capacity

The criteria for the total reservoir volume used in the Bitou Municipality Water Master Plan is 48 hours of the AADD (of the reservoir supply zone).

An analysis of water demand readings used for the water master plan (June 2020) showed that the AADD of the Kurland reservoir distribution zone was 540 kL/d (excluding the proposed development). The increased AADD for each phase is shown below:

- Phase 1: 630 kL/d
- Phase 2: 743 kL/d
- Phase 3: 1 476 kL/d

The current capacity of the existing Kurland reservoirs is 1,5 ML, which results in reservoir storage capacity for each phase as shown below:

- Phase 1: 57 hours of the AADD
- Phase 2: 48 hours of the AADD
- Phase 3: 24 hours of the AADD

The reservoir storage is therefore sufficient for the implementation of Phase 1 and Phase 2.

Additional storage capacity will have to be acquired for development beyond Phase 2 and will be dependent on the risk of non-supply of water. Refer to section 1.3.4 of this report.

1.3.4 Bulk supply

Investigation of, and comments on the sufficiency of the existing water sources, the raw water bulk supply system or the capacity of the existing water treatment plants are beyond the scope of this report. The following information regarding the Kurland water sources and treatment capacity is however relevant to this report:

The source of bulk water for Kurland is the Wit River where Bitou Municipality has a WARMS (Water Use Authorisation and Registration Management System) registration volume of 600 kL/d. Water abstracted from the Wit River is pumped through a 0,7 km 150 mm Ø pipeline to the Kurland Water Treatment Plant (WTP). Raw water supply is also augmented from two boreholes close to the Kurland WTP. The safe yield of the boreholes is 430 kL/d. The Kurland WTP has a capacity of 600 kL/d.

The existing Kurland reservoir distribution zone has an AADD of 540 kL/d. The increased AADD for each phase is shown below:

- Phase 1: 630 kL/d
- Phase 2: 743 kL/d
- Phase 3: 1 476 kL/d

The Kurland WTP, has minimal spare capacity in the existing scenario and will have no spare capacity when Phase 1 has been established. It is proposed that the Kurland WTP is upgraded to a future capacity of ± 1,1 ML/d to accommodate the supply from the groundwater sources. The capacity (expressed in a factor of AADD) of the Kurland WTP, after upgrading, for each phase is shown below:

- Phase 1 = (1,1 ÷ 0,63) ML/d = 1,75 x AADD
- Phase 2 = (1,1 ÷ 0,74) ML/d = 1,48 x AADD
- Phase 3 = (1,1 ÷ 1,48) ML/d = 0,74 x AADD

It is clear from the calculated peak factors that additional bulk water would be required to fully develop Erf 562 (Phase 3). The water master plan makes provision for the future deficit to be supplied from the Plettenberg Bay system via a connection from the Matjiesfontein reservoir.

Taking into consideration the re-analysis of the water demand, the future AADD for the Kurland system is calculated at ± 1,65 ML/d. At a peak factor of 1,65 x the AADD, the future treatment capacity for the water master plan is calculated at ± 2,7 ML/d. As stated above the treatment plant can only be extended to a capacity of ± 1,1 ML/d due to limited water recourses. The future deficit, therefore, calculates to ± 1,6 ML/d (18,8 L/s).

The water master plan makes provision for upgrading of the bulk system to provide treated water from the Matjiesfontein reservoir to the Kurland up to a flow rate of 17 L/s. This is only marginally below the newly calculated 18,8 L/s required flow rate. The minor shortfall in the water master plan is deemed acceptable for the time being as the availability of additional raw water sources in the Kurland area is being investigated. The successful acquisition of additional raw water sources will reduce the required flow rate from the Plettenberg Bay system. Therefore, to avoid oversizing the required bulk infrastructure (up to, and from Matjiesfontein reservoir to Kurland) the master plan was left unchanged, allowing a flow rate of 17 L/s.

The Kurland system is operated as a single zone, supplied from the Kurland reservoirs.

1.4 Implementation of the master plan

The master plan items discussed below are shown in Figure 2 attached.

The existing system has insufficient capacity to accommodate the development and a phased approach was considered to manage the required upgrades to the existing water system. The phases considered are shown below:

- Phase 1: 200 units
- Phase 2: Additional 250 units (450 units in total)
- Phase 3: Fully developed (2 080 units in total)

Phase 1

The existing Kurland WTP (600 kL/d) has minimal spare capacity and will have no spare capacity when Phase 1 has been fully developed. Therefore, the upgrading of the existing Kurland WTP should be prioritised (master plan item BKW.B1). Additionally, the implementation of master plan item BKW1.1 is required to accommodate Phase 1 in the existing water system.

- BKW.B1: Upgrade capacity of Kurland WTP to 1,1 ML/d = R 9 317 000 *
- BKW1.1: 32 m x 200 mm Ø new distribution pipe = R 99 000 *

Total = R 9 141 000 *

Phase 2

The implementation of master plan item BKW2.1 is required to accommodate Phase 2 in the existing water system.

- BKW2.1: 1 010 m x 200 mm Ø new distribution pipe = R 1 812 000 *

Phase 3 (development beyond Phase 2)

The implementation of master plan items BKW1.2 and BKW1.3 are the minimum requirements for development beyond Phase 2. The master plan items will ensure the minimum pressure requirements (20 - 24 m) as set out in the water master plan are met. After the implementation of master plan items BKW1.2 and BKW1.3, the only constraint for development beyond Phase 2 is the available bulk supply and reservoir storage.

- BKW1.2: 350 m x 200 mm Ø replace existing pipeline (old) = R 632 000 *
- BKW1.3: 2 055 m x 315 mm Ø replace existing pipeline (old) = R 8 230 000 *

Total = R 8 862 000 *

Development beyond Phase 2 will result in the existing reservoir storage dropping below the 48 hours of the AADD benchmark and the Kurland WTP capacity will drop to below 1,5 x the AADD. As mentioned in section 1.3.4 of this report, the investigation of, and comments on the sufficiency of the existing water sources, the raw water bulk supply system or the capacity of the existing water treatment plants are beyond the scope of this report. Therefore, the exact future water demand which will trigger the required bulk upgrades needs to be determined through the risk of non-supply of water (beyond the scope of this report). However, to provide support the following table was generated and shows the calculated reservoir storage and WTP capacity for the development beyond Phase 2.

Number of Units	AADD (kL/d) *	Reservoir Storage ** (hours of AADD)	WTP Capacity *** (x AADD)
450	743	48	1,5
546	786	46	1,4
680	846	43	1,3
837	917	39	1,2
1 022	1 000	36	1,1
1 244	1 100	33	1,0

* Includes the existing system demand of 540 kL/d
** Calculated using the existing Kurland reservoir storage (1,5 ML)
*** Assumes master plan item BKW.B1 has been implemented - Kurland WTP capacity = 1,1 ML/d

Due to the relatively high risk of non-supply of water, it is recommended to maintain a minimum reservoir storage of 48 hours of the AADD. Therefore the implementation of master plan item BKW.B9 (future 2.0 ML Kurland reservoir) is recommended when more than 450 units have been established on Erf 562. Master plan item BKW.B9 has been increased from 1,5 ML to 2.0 ML to accommodate the increase in the ultimate demand due to the re-analysis.

- BKW.B9: 2.0 ML Future Kurland reservoir = R 8 008 000 *

Note: Master plan item BKW.B9 has been sized for the ultimate demand, taking into consideration additional future development within the Kurland area. Therefore, phasing of master plan item BKW.B9 can be considered, subsequent to approval from Bitou Municipality. Considering the proposed development (2 080 units) on Erf 562, an additional storage of 1,5 ML will be required.

When the Kurland WTP has reached capacity the following master plan items are required to upgrade/establish the bulk supply from the Matjiesfontein reservoir to the Kurland reservoirs.

- BKW.B3: New Ps to Matjiesfontein Upper reservoir (30 L/s) = R 2 630 000 *
- BKW.B4: 3 090 m x 200 mm Ø new bulk pipe = R 8 391 000 *
- BKW.B5: 0,6 ML Future Matjiesfontein Upper reservoir = R 3 654 000 *
- BKW.B6: New PS to Kurland reservoir (20 L/s) = R 2 278 000 *
- BKW.B7: 8 357 m x 200 mm Ø new bulk pipe = R 22 716 000 *
- BKW.B8: Items required to connect to existing system = R 5 051 000 *

Total = R 44 720 000 *

In addition to the above, the following master plan items are required to upgrade the bulk supply from the Town reservoirs to the Matjiesfontein reservoir. It should be noted that the following master plan items are sized for the ultimate scenario and take into consideration the future development in the Wittedrift, Green Valley, Matjiesfontein and Keurbooms distribution zones.

- BPW.B40: 31 m x 160 mm Ø new bulk pipe = R 76 000 *
- BPW.B39: 925 m x 355 mm Ø new bulk pipe = R 3 800 000 *
- BPW.B67: 2 670 m x 355 mm Ø new bulk pipe = R 10 612 000 *
- BPW.B47: 2 800 m 315 mm Ø new bulk pipe = R 8 983 000 *

Total = R 23 471 000 *

Take note that the routes of the proposed pipelines are schematically shown in Figure 2, but have to be finalised subsequent to detail pipeline route investigations.

(* Including P & G, Contingencies and Fees, but excluding VAT - Year 2020/21 Rand Value. This is a rough estimate, which does not include major unforeseen costs).

2 SEWER NETWORK

2.1 Drainage area

The proposed development is located just south of the Kurland town. The development does not fall in an existing drainage area and new infrastructure is required to include the development into the existing Kurland sewer system. The Future Kurland PS no.K1 drainage area is proposed in the sewer master plan to accommodate the proposed development. A new drainage area, Future Kurland PS no. K2 drainage area, will also be required to accommodate sewage from the eastern portion of the development.

No feasible interim solution exists as the proposed development drains to the south, away from any existing infrastructure. The implementation of the master plan is therefore required to accommodate the sewer flows from the proposed development as discussed in section 2.4 of this report.

Sewage from the Kurland drainage areas is pumped to the Kurland Waste Water Treatment Plant (WWTP). The Kurland WWTP has an existing treatment capacity of 500 kL/d.

The development is inside the sewer priority area.

2.2 Sewer flow

Future development area P096 was conceptually taken into consideration for the sewer master plan. The peak day dry weather flow (PDDWF) for development on Erf 562 (in the June 2020 sewer master plan) was calculated at 519.0 kL/d.

For this re-analysis, the PDDWF for the proposed development was calculated as 718.0 kL/d.

2.3 *Present situation*

The proposed development does not fall within an existing drainage area and therefore the master plan will have to be implemented to include the development into the proposed Future Kurland PS no. K1 drainage area. A new drainage area, Future Kurland PS no. K2, will also be required to accommodate sewage from the eastern portion of the development. The implementation of the master plan is discussed in section 2.4 of this report.

Sewage from the proposed development will be pumped to the Kurland Wastewater Treatment Plant (WWTP). The Kurland WWTP has an existing treatment capacity of 500 kL/d and the existing PDDWF (as calculated in June 2020) was 372 kL/d. The Kurland WWTP will require upgrading to accommodate the proposed development.

2.4 Implementation of the master plan

As mentioned in the above sections, the development does not fall in an existing drainage area and new infrastructure is required to include the development in the existing Kurland sewer system. The master plan proposed abandoning the existing Kurland PS no.1 and redirect flow from the upstream drainage area to a future pump station (Future PS K1). The abandoning of the existing Kurland PS no.1 is not a high priority as the pump station still has sufficient capacity for the existing scenario. The abandoning of the pump station is proposed to reduce the number of pump stations required in the future Kurland system. Therefore, if required in the interim, the western portion of the development can operate as a separate drainage area.

A new drainage area, Future Kurland PS no. K2, will also be required to accommodate sewage from the eastern portion of the development.

The required network upgrades and pump stations are not influenced by the phasing discussed in section 1 of this report as the upgrades are required regardless of the sewer demand. However, the upgrading of the Kurland WWTP is dependent on the phasing discussed in section 1.

The analysis of the Kurland WWTP capacity is beyond the scope of this report. However, the following table was generated and shows the calculated capacity (with regards to PDDWF) for the existing Kurland WWTP (500 kL/d) for each phase:

Phase	Total number of Units	PDDWF (kL/d) *	WWTP Capacity ** (x PDDWF)
1	200	441	1,13
2	450	527	0,95
3	2080	1 089	0,46

* Includes the existing sewer demand of 372 kL/d
** Based on the existing Kurland WWTP capacity of 500 kL/d

Considering the above table, the upgrading of the existing Kurland WWTP is proposed for development beyond Phase 1. The PDDWF for the future Kurland system is calculated at ± 1 250 kL/d. It is therefore proposed that the capacity of the existing Kurland WWTP is upgraded from the current 500 kL/d to a future capacity of 1 500 kL/d.

The following master items are required to accommodate the proposed development and are shown in Figure 3 attached:

- BKS.B1: Upgrade existing Kurland WWTP (1 500 kL/d) = R 25 060 000 *
- BKS.B2: Abandon existing Kurland PS no.1 = R 216 000 *
- BKS.B3: Abandon existing Kurland PS no.1 rising main = R 0 *
- BKS2.1: 25 L/s new pump station (Future PS K1) = R 2 104 000 *
- BKS2.2: 1270 m x 160 mm Ø new rising main = R 1 596 000 *
- BKS2.3: 1270 m x 200 mm Ø new outfall sewer = R 2 371 000 *
- BKS2.4: 3,5 L/s new pump station (Future PS K1) = R 1 055 000 *
- BKS2.5: 500 m x 90 mm Ø new rising main = R 440 000 *

Total = R 32 842 000 *

(* Including P & G, Contingencies and Fees, but excluding VAT - Year 2020/21 Rand Value. This is a rough estimate, which does not include major unforeseen costs).

Take note that the routes of the proposed pipelines are schematically shown in Figure 3, but have to be finalised subsequent to detail pipeline route investigations.

3 CONCLUSION

The developer of Erf 562 in Kurland will be liable for the payment of a Development Contribution (as calculated by Bitou Municipality) for bulk water and sewer infrastructure as per Council Policy.

The existing water system has insufficient capacity to accommodate the development (fully developed) and a phased approach was considered.

- Phase 1: 200 units
- Phase 2: Additional 250 units (450 units in total)
- Phase 3: Fully developed @ 2 080 units

The water demand (AADD) for the proposed development is calculated at 936 kL/d.

The implementation of master plan item BKW1.1 is required for Phase 1 and the implementation of master plan item BKW2.1 is required for Phase 2 of the proposed development. However, the upgrading of the existing Kurland WTP should also be prioritised (master plan item BKW.B1) as the WTP will have no spare capacity once Phase 1 has been fully developed.

The implementation of master plan items BKW1.1 (Phase 1) and BKW2.1 (Phase 2) will make sufficient provision to meet the fire flow requirements (15 L/s @ 10 m) for the respective phases.

The reservoir storage is sufficient for the implementation of Phase 1 and Phase 2.

Whilst the implementation of master plan items BKW1.2 and BKW1.3 are the minimum requirements for development beyond Phase 2, careful consideration should be given to the available bulk water supply. Due to the relatively high risk of non-supply of water, it is recommended to maintain a minimum reservoir storage of 48 hours of the AADD. Therefore the implementation of master plan item BKW.B9 (future 2.0 ML Kurland reservoir) is recommended when more than 450 units have been established on Erf 562.

The existing raw water sources in the Kurland area is 1,1 ML/d and the future AADD for the Kurland system is calculated at ± 1,65 ML/d. The water master plan proposed upgrading the existing Kurland WTP to 1,1 ML/d and securing the deficit bulk water requirement for Kurland from the Plettenberg Bay water system through the upgrading of the bulk system to provide treated water from the Matjiesfontein reservoir to the Kurland reservoirs. The implementation of these master plan items will be required when the future Kurland WTP (1,1 ML) has reached capacity and are stipulated in section 1.4 of this report.

The proposed development is located to the south of the Kurland town. The development does not fall in an existing drainage area and new infrastructure is required to include the development into the existing sewer system.

The sewer demand (PDDWF) for the proposed development is calculated at 718 kL/d.

The master plan proposed that the development is accommodated in the proposed Future PS K1 drainage area. It is proposed that the existing Kurland PS no.1 is abandoned and sewage from the existing Kurland PS no. 1 drainage area is redirected to the future pump station (Future PS K1). A new drainage area, Future Kurland PS no.K2 will also be required to accommodate sewage from the eastern portion of the development.

Sewage from the proposed development will be pumped to the Kurland WWTP. The Kurland WWTP has an existing treatment capacity of 500 kL/d and will require upgrading to accommodate the proposed development. The upgrading of the Kurland WWTP is proposed for development beyond Phase 1.

The required sewer master plan items are stipulated in section 2.4 of this report.

We trust that you find this of value.

Yours sincerely,

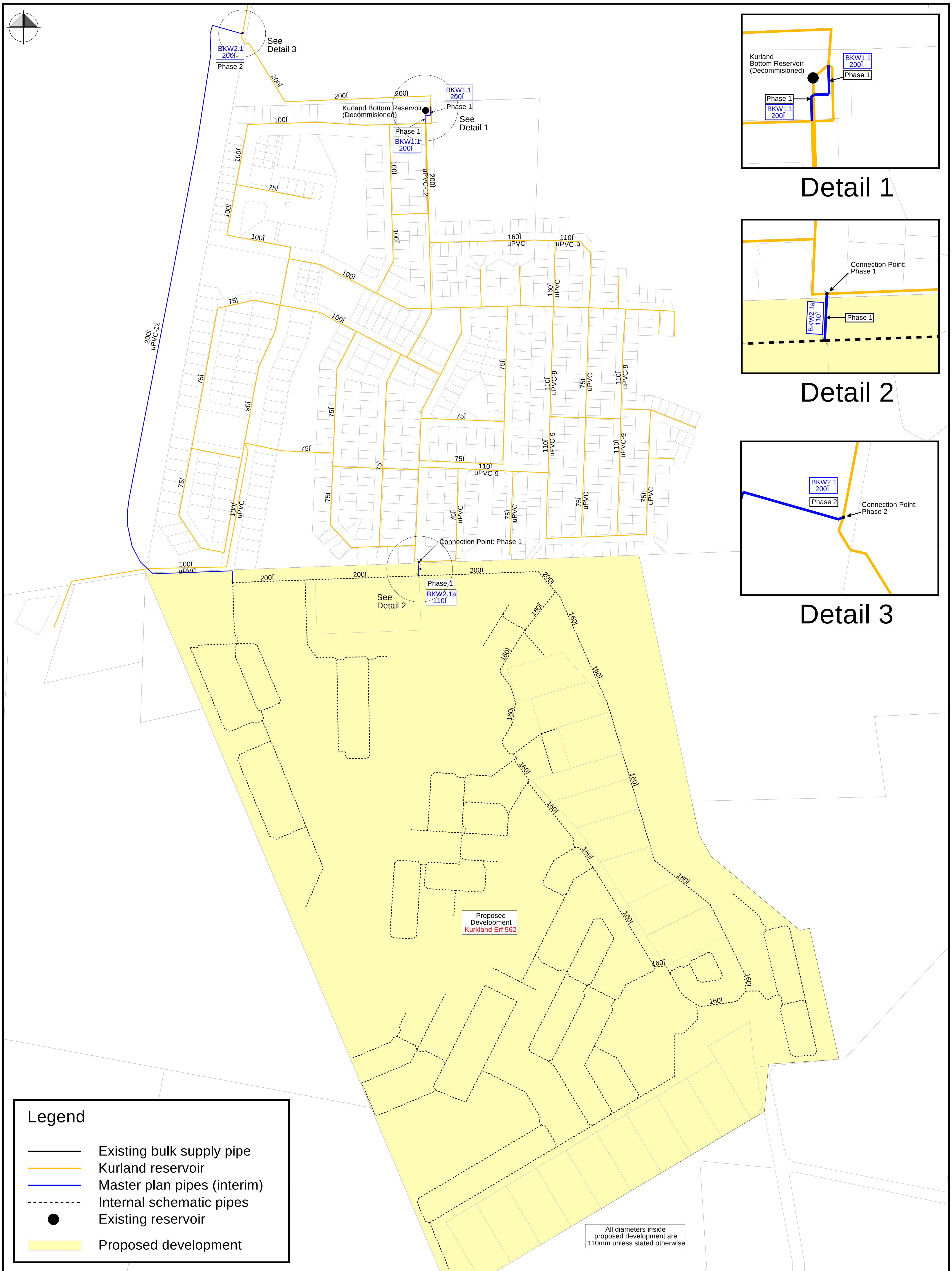
GLS CONSULTING (PTY) LTD
REG. NO.: 2007/003039/07

PduPlessis

Per: PC DU PLESSIS

cc. Lyners Consulting Engineers and Project Managers
149 Park Road
George
6530

Attention: Mr Francois van Eck



September 2021

Development of Erf 562, Kurland

0 37.5 75 150 300 m

Scale 1:5000

Figure 1

Proposed Development

Bitou - Erf 562

Existing Water System

Figure 2
Proposed Development
Bitou - Erf 562
Water master plan

ANNEXURE F1

TECHNICAL MEMO FOR KURLAND WATER TREATMENT WORKS BY IX ENGINEERS FEBRUARY 2021

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TECHNICAL MEMORANDUM

DATE 2021/02/24		**Ref No:**	07492-00-WW-TEM-0001
TO	Francois van Eck (Lyners)	**EMAIL**	francois@lyners.co.za
FROM	Theunis Duminy Sonél van Wageningen	**EMAIL**	theunis.d@ixengineers.co.za sonel.vw@ixengineers.co.za

KURLAND WATER TREATMENT WORKS: THE EXSITING WTW AND RECOMMENDED UPGRADING TO ENABLE ACCOMODATION OF ESTIMATED FUTURE RAW WATER AND FLOW

1. INTRODUCTION

Lyners consulting engineers approached Theunis Duminy of iX engineers to assist with the investigation and recommendation of both a capacity- as well as a process upgrades that would enable the Kurland Water Treatment Works (WTW) to successfully receive and treat the raw water from the different sources (groundwater and surface water) to the community of Kurland in the form of sustainably safe drinking water.

This Technical Memo touches on some of the envisaged requirements that would have to be included before proposing an appropriate upgrade intervention.

2. THE EXISTING KURLAND WATER TREATMENT WORKS

The existing **KURLAND WTW** is a small water treatment plant, with a treatment capacity of 0.6Ml/d. There seems to have been 3 modules added in a piecemeal manner, with the current process train comprising of chemical dosing, coagulation, flocculation, settling, filtration, stabilisation and disinfection. The plant consists of the following process units:

- **CHEMICAL DOSING**
    - Surface water chemical dosing (Module 2): Soda-ash and aluminium sulphate is added to the raw water to aid both stabilisation and flocculation. While feasible to add as coagulant, this approach is currently not used, but it can be easily effected via a manually adjustable diaphragm dosing pump. No information is available on the mixing device at the two dosing points on the raw water feed line, and it is assumed that mixing orifices have been fitted to the main water line immediately after the soda-ash and alum dosing points to allow for in-line mixing of the chemicals.
    - Groundwater chemical dosing (Module 3): Initially, the facility was provided for chemical dosing of groundwater. However, given the relatively good water quality initially supplied from boreholes, the system was reconfigured to cater for groundwater to only pass through the rapid gravity filtration unit, whereafter it was disinfected with chlorine gas. However, it is understood that the groundwater quality from both boreholes have deteriorated significantly and that dissolved iron is becoming a risk that requires additional treatment.
- **FLOCCULATION / COAGULATION / SETTLING**
    - Flocculation/Coagulation (Module 2): The circular flocculator is a low energy, mechanically mixed unit which enables the chemical solution to mix with the raw water from surface sources to promote floc growth.

- Plate settler (Module 1): Currently this unit does not function as originally intended (flocculation/coagulation/settling) and is only used to provide additional retention time upstream of the additional rectangular concrete settling tank. The plate settling tank is still provided with a battery of inclined plates through which the raw water flows in an upward direction, but floc carryover is evident.

  Water enters the unit directly after flowing through the mechanically mixed, flocculation unit, with the lamella plates supposedly contributing additional surface area. A single sludge outlet pipe was provided for disposal of sludge.

- Rectangular settling tank (Module 2): This tank serves as the main facility for settling of flocs and the separation of settled sludge from the clarified water. The clarified water is directed to the gravity filter, with the existing configuration also allowing for (currently decommissioned) direct abstraction to pressure filtration.

- **FILTRATION**
  - Rapid gravity filtration plant (Module 1): After passing through the rectangular settling tank, the clarified surface water gravitates into the circular, rapid gravity filtration unit. Groundwater supply from the two boreholes (1 decommissioned, the other functioning at less than 50% yield), is currently fed directly from the borehole rising main onto the circular, rapid gravity filtration unit.

    The rapid gravity filtration unit allows for the manual backwashing of the filter for cleaning purposes, with sequential air and water backwash capability being provided by a horizontal, centrifugal backwash pump and a positive displacement, rotary-lobe blower.

    Backwash water is discharged into the dewatering sump via a 200mm diameter outlet pipe, for discharge back to the nearby surface source.
  - Decommissioned surface water (Module 2) pressure filter (1 off): downstream of the rectangular settling tank, a dedicated pump was provided to pass settled water through a dedicated pressure filter before disinfection.
  - Decommissioned groundwater (Module 3) pressure filters (3 off): the boreholes would have pumped directly through a set of 3 pressure filters before disinfection.

- **DISINFECTION**
  - Chlorination (Module 2): This disinfection facility consists of one cylinder mounted vacuum gas chlorinator unit dosing directly into the clearwater feed to the reservoir.

- **WASTE HANDLING**
  - Backwash water and sludge disposal (Module 1): Backwash water from the filter unit(s) together with sludge discharge from the settling tank(s) collect in the dewatering sump. No backwash recovery system is in place to minimize water losses. Settled sludge is discharged to the sewer for final disposal.

3. EXISTING UNIT TREATMENT PROCESSES

The existing plant is at its hydraulic capacity and does not seem to function well due to deteriorating water quality. It is understood that the raw water quality deteriorated slightly over time but has always been susceptible to water quality fluctuation and difficult to settle the light organic floc.

Given this problematic raw water, a piecemeal upgrading history and a process train lacking a coherent and integrated design philosophy, it is clear that the facility will not be adequate for treatment of additional flows to the required potable Standards.

A high-level Process Flow Diagram (PFD) of the existing works is provided in Figure 1 below:

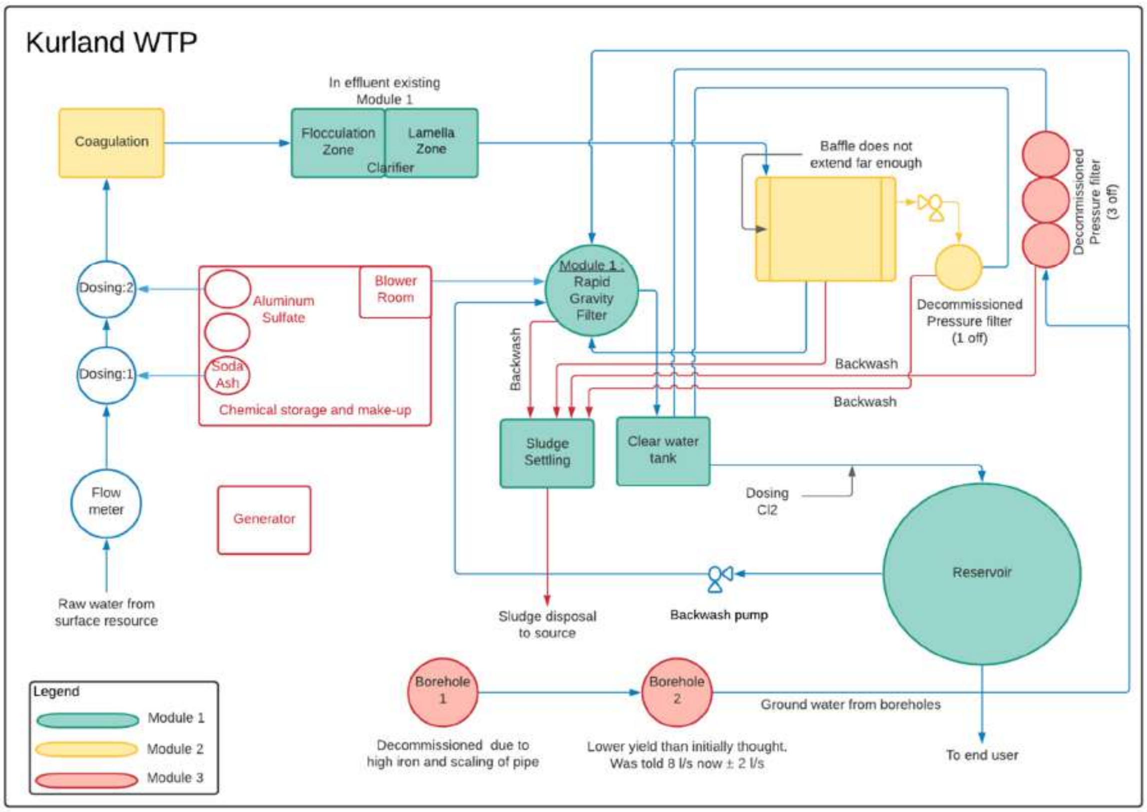

Figure 1: Process flow diagram of the Kurland potable water treatment plant

The increased treatment capacity, currently estimated to increase from 0.6 Ml/d to 1.2 Ml/d, will require a coherent upgrade to enable the supply of potable water to an estimated increased future population. However, the raw water source providing this additional water is currently unknown. Since the form of the upgrade needs to cater for the raw water to be handled, it would be irresponsible to recommend an upgrade at this time without a proper understanding of the raw water quality to be treated.

This Technical Memorandum therefore provides comment on the installed infrastructure and sets out the feasibility of a similar technology upgrade should it be appropriate for the new raw water resource.

Table 1: Estimated design basis of existing process units

Unit	Capacity	Comment
Chemical dosing (serving Modules 1, 2 and 3)		
Soda-ash mixing tank	450 litre	Soda-ash solution is manually prepared from ± 10% dry Soda-ash (40 kg bags) and chlorinated water in the mechanically mixed Soda-ash tank. Soda-ash solution is then dosed into the raw water feed pipe via a manually adjustable diaphragm dosing pump
Alum mixing tank	450 litre	Alum solution is manually prepared from ± 10% dry Alum (40 kg bags) and chlorinated water in the to the mechanically mixed Alum tank. Alum solution is then dosed into the raw water feed pipe via a manually adjustable diaphragm dosing pump to achieve the best (historically proven) flocculation
Polymer solution		Polymer solution can be taken directly from the polymer supply container via a manually adjustable diaphragm dosing pump to aid in the flocculation process **(if necessary)** by dosing into the raw water feed pipe.
Flocculation unit (Serving Modules 1 and 2)		
LDPE Tank	10 m^3	LDPE tank with slow speed, vertical mounted mechanical mixer
Flocculation zone of OEM clarifier (Serving Modules 1 and 2)		
Tank	0.8m w x 1m l x 3m d	Mid steel tank with inlet, outlet and drain connections. Not currently used as settler, serves to provide additional flocculation retention time
Plate/Lamella settling zone of OEM clarifier (Serving Modules 1 and 2)		
Lamella plates	27m^2	Unit not currently used as settled – but only to provide additional retention time for flocculation
Rectangular Settling Tank (Serving Modules 1 and 2)		
Gravity Settling	T.B.C Dimensions, Up-flow Velocity of ±0.5 – 1.5m/hr	Rectangular concrete tank
Gravity Filtration (Originally serving Module 1, now serving Modules 1, 2 and 3)		
Tank	3 m high and 2.4m Dia	Circular, rapid gravity filter vessel with grade silica sand, false floor and nozzles, capacity of 27.1 m^3/h (±600 m^3/d over 22 hours)
Filtration rate	5 m/hr	
Backwash rate	20 m/h	
Pressure Filtration (Decommissioned Module 2)		
Amount of filters	1 off	
Diameter	1.5 m diameter	
Filtration rate	8 – 10 m/hr	14 m^3/h (308 m^3/d over 22 hours
Pressure Filtration (Decommissioned Module 3)		
Amount of filters	3 off	
Diameter	1.1m diameter	
Filtration rate	8 – 10 m/hr	22.8 m^3/h (500 m^3/d over 22 hours)
Chlorination (common to Modules 1, 2 and 3)		
Dosing range of chlorinator	0.025 – 0.5Kg/h	Flow of chlorine is controlled via a vacuum regulator. Booster pump activated as and when filtered water is drawn from the storage reservoir.

4. WATER QUALITY

The quality of the raw incoming water determines the process train that is required for successful treatment to potable Standards. Therefore, different constituents present in the raw water as well as their concentrations, along with the required product water demand, dictates the required process units as well as their respective design capacities.

The Bitou Municipality makes use of different sources to supply the works, with the future basket of water resources as flows:

- **Existing, quantified raw water resources**
  - Surface water from the Wit River
  - Groundwater from 2 Boreholes located on-site
- **Potential, unquantified raw water resources**
  - Raw from Plettenberg Bay
  - Additional allocation from the Wit River
  - Additional groundwater from boreholes
- **Potential for potable water directly from Plettenberg Bay**

At this stage, it is unsure what raw water sources will be utilized, and to what extent, as feed water to the Kurland WTW for treatment.

5. PRODUCT WATER REQUIREMENTS

The product water shall comply with SANS 241:2015 Standard for Drinking Water Quality. It is understood that SANS 241:2015 is currently under review and some changes/additions are anticipated.

Table 2 below details the current list of determinants and their applicable limits. However, once the revised document is accepted/approved and published, the new determinant requirements shall become applicable.

Table 2: Blue Drop Limits (SANS 241:2015) for Drinking Water Quality

DETERMINANT	UNIT	STANDARD LIMIT	RISK
E. Coli	Count/100mℓ	ND*	Acute Health
Fecal Coliforms	Count/100mℓ	ND*	Acute Health
Cryptosporidium	Count/10mℓ	ND*	Acute Health
Giardia	Count/10mℓ	ND*	Acute Health
Total coliforms	Count/100mℓ	< 10	Operational
Heterotrophic plate count	Count/mℓ	< 1000	Operational
Somatic coliphages	Count/10mℓ	ND*	Operational
Free Chlorine	mg/ℓ	<5	Chronic Health
Monochloramine	mg/ℓ	≤3	Chronic Health
Conductivity at 25°C	mS/m	≤170	Aesthetic
Total Dissolved Solids	mg/l	≤1 200	Aesthetic
Turbidity	NTU	≤5	Aesthetic
Turbidity	NTU	≤1	Operational
pH at 25°C	pH	5 – 9.7	Operational
Ammonia as N	mg/l	≤1.5	Aesthetic
Calcium	mg/l	-	-
Chloride as Cl-	mg/l	≤200**	Aesthetic
Fluoride as F-	mg/l	≤1.5	Chronic Health

DETERMINANT	UNIT	STANDARD LIMIT	RISK
Magnesium as Mg	mg/l	-	-
Nitrate as N	mg/l	≤11	Acute Health
Nitrite as N	mg/l	≤0.9	Acute Health
Sodium as Na	mg/l	≤200	Aesthetic
Sulfate as SO42-	mg/l	≤500	Acute Health
Sulfate as SO42-	mg/l	≤250	Aesthetic
Zinc as Zn	mg/l	≤5	Aesthetic
Aluminium as Al	µg/l	≤300	Operational
Antimony as Sb	µg/l	≤20	Chronic Health
Arsenic as As	µg/l	≤10	Chronic Health
Barium as Ba	µg/l	≤700	Chronic Health
Boron as B	µg/l	≤2 400	Chronic Health
Cadmium as Cd	µg/l	≤3	Chronic Health
Chromium (total) as Cr	µg/l	≤50	Chronic Health
Cobalt as Co	µg/l	-	-
Copper as Cu	µg/l	≤2 000	Chronic Health
Cyanide (recoverable) as CN–	µg/l	≤200	Acute Health
Iron as Fe	µg/l	≤2 000	Chronic Health
Iron as Fe	µg/l	≤300	Aesthetic
Lead as Pb	µg/l	≤10	Chronic Health
Manganese as Mn	µg/l	≤400	Chronic Health
Manganese as Mn	µg/l	≤100	Aesthetic
Mercury as Hg	µg/l	≤6	Chronic Health
Nickel as Ni	µg/l	≤70	Chronic Health
Selenium as Se	µg/l	≤40	Chronic Health
Uranium as U	µg/l	≤30	Chronic Health
Vanadium as V	µg/l	-	-
Dissolved organic carbon as C	mg/l	-	-
Total organic carbon as C	mg/l	≤10	Chronic Health
Trihalomethanes (total)***	mg/l	-	-
Total Microcystin as LR	µg/l	≤1	Chronic Health
Phenols	µg/l	≤10	Aesthetic

*ND – Not Detected

**According to SANS 241, the chlorine concentration of the product water should be <300mg/l. However, based on previous experience it was proposed that a value of <200mg/l should be accepted as values above 200mg/l gives water a saline taste and result in customer complaints. This value is also in line with the WHO guidelines.

***All Trihalomethanes (including Bromate (< 10 µg/l) as well as the sum of the disinfection by-products shall / should be monitored.

6. PROPOSED UPGRADE OPTION

Given that no information is available on the additional new raw water source's quality, the following scope of work is identified as likely to indicatively provide for a budget. This shall however be subject to a proper process design, based on a statistically representative dataset that properly defines the raw water quality in terms of contaminants of concern and variability.

6.1 SHORT TERM

From inspection, it is clear that the existing functional treatment infrastructure consists of the building, chemical dosing equipment, coagulation/flocculation tank, rectangular clarifier, circular rapid gravity filter, waste sump, clearwater tank, chlorine dosing equipment, duty pumps and blower.

Roughly 50% of the filtration capacity have been decommissioned, depending on the actual pressure filtration rate required.

Several changes and recommissioning of existing equipment can be contemplated to provide some redundancy and/or additional capacity, however it is unclear as to whether the decommissioned equipment is still serviceable.

Provided that the pressure filters are still serviceable, the following recommissioning could be considered:

- **Existing Building**
    - Provide a wall separating the chemical make-up area and MCC, with the MCC area being provided with a normally closed door and a positive pressure fan to ensure dust-free conditions;
    - Fix the chemical dosing area to be workmanlike and uncluttered by reconfiguring cable runs and pipework to allow uninterrupted and clear access to each functional area;
    - Provide the blower area with soundproofing and an external air intake to limit chemical dust intrusion;
    - Consider the use of an A-frame to assist with chemical handling directly from vehicles into the chemical storage area.
- **Groundwater Feed**
    - Provide for an aeration cascade to release of noxious odours and effect oxidation of dissolved iron;
    - Split the groundwater feed to enter the lamella settler after the cascade;
    - Consider providing a pre-chlorination for enhanced oxidation of dissolved iron in the lamella settler;
    - Add a new LDPE tank serving as sump for the pressure filtration assembly;
    - Provide new feed pumps to the 4 off pressure filters;
    - Tie into the rapid gravity backwash pump;
    - Provide pipework as required for filter operation and backwashing using either HDPE or uPVC;
    - Tie into existing clearwater and backwash sumps.
- **Surface Water Feed**
    - Bypass the lamella settler to deliver flocculated surface water only to the rectangular clarifier;
    - Retain the existing process stream from the rectangular clarifier to the circular rapid gravity filter as per the current installation.
- **Stabilisation**
    - Retain existing system unchanged.
- **Disinfection**
    - Retain existing system unchanged, after seeking expert intervention to make the single bottle system compliant to “SANS 10298:2009 Indirect small to medium-sized gas chlorination systems for the disinfection of water”;
    - Consider a safety shower/eye-bath to service chemical dosing and chlorine installations respectively.

In theory, this upgrade could provide the facility with a surface water capacity of 27.1 m^3/h and a borehole treatment capacity of 36.8 m^3/h (14 m^3/h from Module 2 filter and 22.8 from Module 3 filters). Assuming a 22hour day for the surface water treatment train (596 m^3/d) and a 14hour day @ 10 litres/second sustainable yield for the borehole treatment train (515 m^3/d), the existing facility could provide a treatment capacity of roughly 1 010 m^3/d.

The above work can be executed in-house by municipal staff, as the expensive unit treatment processes is largely available on site and it is likely to require about R 8 500 000.00 exclusive of VAT.

6.2 LONG TERM

From inspection, it is clear that the existing building, rectangular clarifier, waste sump and clearwater tank will very likely be serviceable for an upgraded works. However, the existing non-functional lamella settler and 4 off pressure filters have proven to be ill-suited to the application given operational experience.

In addition to this, the circular rapid gravity filter is likely reaching its serviceable life and consideration should be given to constructed rapid gravity filters.

Assuming similar water quality to that received currently, the envisaged long-term upgrade would most likely comprise of the following:

- **Common Facilities**
  - Ablution facilities, kitchen, dining area, 2 offices and small on-site laboratory;
  - Conservancy tank;
  - Small pressure sustaining pump for on-site potable water.
- **Groundwater Feed**
  - Aeration cascade (release of noxious odours and oxidation of dissolved iron);
  - Pre-chlorination for oxidation of dissolved iron;
  - Stabilisation (Lime addition and/or soda-ash) to prevent scaling nuisance;
  - Potentially need settling step if new groundwater will require metals precipitation;
  - Then onto filtration, stabilisation and disinfection.
- **Surface Water Feed**
  - Upgraded flocculation/coagulation facility;
  - Increased settling/clarification capacity (possibly an additional settling tank);
  - Acceptable sludge disposal and recovery of supernatant.
- **Filtration**
  - Provision of 2 new rapid gravity sand filters, complete with;
    - proper manual valve control (via extended spindles);
    - local stop/start control panel for the blowers and backwash pumps;
    - Safe and easy access to all structures (stairs, handrailing, site lighting, etc).
  - Depending on the water source, dual media filtration may be required;
  - Acceptable back-wash water disposal;
  - Duty/standby assemblies for backwash pumps and blowers.
- **Stabilisation**
  - Consider using limestone stabilisation, combined with soda-ash – water quality dependant;

- Additional lime dosing may be required for cost-effective stabilization – water quality dependant.

- **Disinfection**
  - Upgrade the chlorine dosing installation to comply with "SANS 10298:2009 Indirect small to medium-sized gas chlorination systems for the disinfection of water";
  - Consider providing for an auto change-over assembly;
  - Ensure that correct safety equipment and procedures are supplied and adhered to;
  - Safety shower and eye-bath.
- **Decommissioning of redundant process units and equipment in the current installation**

The budget for the above scope of work is estimated at around R 19 000 000 exclusive of VAT.

7. CONCLUSION

Given the above context, it is clear that the facility can be upgraded, but that the upgrade approach could be varied, based on the serviceability of decommissioned infrastructure, the redundancy philosophy, and most importantly, the water quality of the yet to be determined additional raw water source water.

Theunis Duminy (Pr Eng)
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iX engineers (Pty) Ltd

ANNEXURE F2

TECHNICAL REPORT FOR KURLAND WATER TREATMENT WORKS BY REFLEKT WATER AUGUST 2022

DESIGN REPORT
FOR

UPGRADING OF THE KURLAND WATER TREATMENT WORKS

August 2022

Rev02

COMPILED FOR:	COMPILED BY:
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REPORT DETAILS :

Contract No.:	TBC
Client:	Bitou Municipality
Client representatives:	Etienne de Waal / Franclyn Samuel
Lyners reference no :	22033CG
Revision record and date	Rev 2 : 11 August 2022
Report prepared by:	M Kritzinger / FJ van Eck

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REV	DESCRIPTION	ORIGINAL	LYNERS APPROVAL	DATE	CLIENT APPROVAL	DATE
2	Design Report	M KRITZINGER	FJ VAN ECK	11 August 2022		

1 Contents

2 Background

Neil Lyners and Associates (RF) (Pty) Ltd (Lyners) has an active appointment in terms of Contract Number "SCM/2020/80/ENG" for professional engineering services for the period ending June 2023 with Bitou Municipality.

Lyners received a project appointment to provide agreed services under the abovementioned contract number for the Kurland Treatment Works, of which the relevant individual project appointment to this report is for the upgrading of the existing Water Treatment Works(WTW), in support of current and future developments.

The purpose of this Design Report aims therefore to provide details on the existing Kurland WTW, define the background, data, assumptions, and design principles informing the upgrade and allow the Bitou Municipality the opportunity to comment and agree on the way forward.

3 Water Sources

A report titled "*TECHNICAL REPORT FOR UPGRADING OF KURLAND WATER SOURCES, WATER TREATMENT WORKS, RESERVOIR AND BULK SUPPLY PIPELINE*" was prepared and submitted for Bitou Municipality in January 2021. In this report the existing water sources and potential options for upgrading the water supply to the Kurland WTW is discussed in detail. There are two water sources that supply the Kurland WTW namely the Wit River and boreholes in the vicinity of the WTW.

3.1 Wit River

The main raw water supply to the Kurland area is from the Wit River abstraction point. Water is pumped from a pump station at the Wit River abstraction point via a 700 m long 150 mm diameter rising main to the water treatment works. The capacity of the scheme is 648 kl/day. The abstraction from the Wit River is not exceptionally reliable since the delivery of 648 kl/day reduces drastically during dry periods. Back-up sources are therefore important to provide sustainable supply.

3.2 Boreholes

There are two fully equipped boreholes on the site of the Kurland water treatment works (WTW) with the equipping of a further two boreholes currently underway. A report by Groundwater Africa Titled "*KURLAND GROUNDWATER INVESTIGATION: YIELD RECOMMENDATIONS FOR THE FOUR BOREHOLES AT THE KURLAND WATER TREATMENT WORKS*" and dated 10 January 2022 gives the sustainable yield of these boreholes when operated continuously as shown in Table 3-1. The recommended combined yield is 8.2 l/s or 708 kl/d. The maximum combined yield is 9.2 l/s or 795 kl/d.

Table 3-1: Recommended borehole yields for continuous (24 hrs/day) operation

Bh Number	Lat. °	Long. °	Depth (m)	1st RWL (m)	RWL date	Rec. PID* (mbgl)	Rec. (L/s)	Max. (L/s)
GWA-Kur1	23.49610	33.92720	265	3.1	15-Jul-2017	68	1.2	2.2
GWA-Kur2	23.49633	33.92706	259	1.6	11-Nov-2017	58	2.7	2.7
GWA-Kur3	23.49590	33.92732	301	12.6*	14-Nov-2021	71	2.3	2.3
GWA-Kur4	23.49598	33.92690	277	12.7*	17-Nov-2021	63	2.0	2.0
Total yield (L/s)							**8.2**	**9.2**
Total Yield (Ml/day)							**0.71**	**0.79**
Total Yield (Mm^3/a)							**0.26**	**0.29**

4 Design Capacity

The required design capacity of the upgraded Kurland WTW was identified as 1100 kl/d with nominally 550 kl/d supplied from the Wit River and 550 kl/d supplied from the boreholes. Operators will however have flexibility to choose between these two sources based on the availability and quality of the water from each. To reduce the amount of iron abstracted from the boreholes the boreholes pumps will be equipped with VSD's and should ideally never be stopped.

It is proposed that the Kurland WTW be designed based on a 16 hour per day operation. This reduces the operational burden from staff to work night shift and creates time for maintenance activities. The hydraulic design capacity of the plant would then be 1100/16 = **69 m^3/hr** (or 19.1 l/s).

The boreholes and the Wit River will have separate pre-treatment trains due to the difference in water quality. The sizing of the pre-treatment trains will be according to the maximum supply from each source to enable the operators to maximise supply from each source at will as shown in

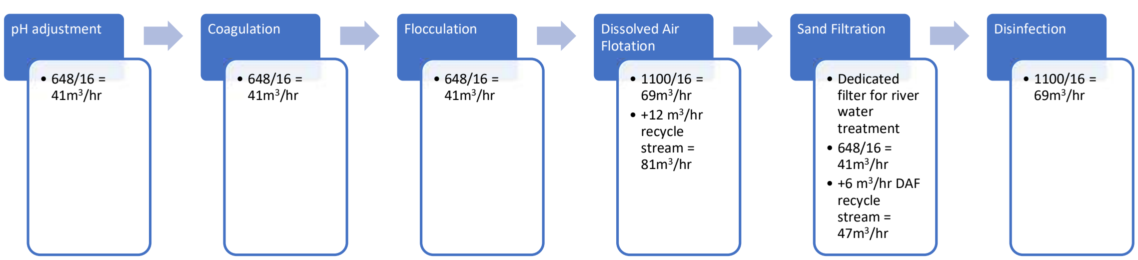


Figure 4-1: Unit Process Design Capacities for Wit River Water Treatment

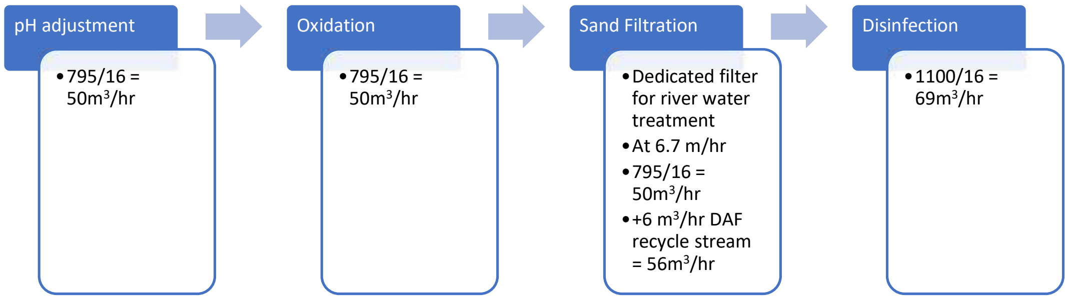


Figure 4-2: Unit Process Design Capacities for Borehole Water Treatment

5 Water Quality

5.1 Wit River

A data set of monthly samples taken over the period from January 2019 to February 2022 was received from Bitou Municipality and is summarized in Table 5-1. The data set dd not include the full SANS 241 list of parameters, but all parameters of concern for the Wit River source were included.

Table 5-1: Wit River monthly sampling results (Bitou Municipality)

Wit Rivier	**Unit**	**10th percentile**	**Average**	**90th percentile**
Temp				
pH		4.3	**4.9**	5.9
Conductivity	*mS/m*	8.0	**42.9**	86.4
TDS	*mg/l*	52.6	**76.8**	167.0
Turbidity	*N.T.U*	0.2	**1.5**	1.8
Colour		64.8	**175.3**	321.2
Alkalinity		0.0	**3.7**	7.0
Total Hardness as CaCO3	*mg/l*	6.7	**35.9**	33.8
Ca as CaCO3	*mg/l*	3.7	**16.1**	11.2
Mg as CaCO3	*mg/l*	3.0	**19.8**	19.6
E.coli	*/100ml*	0.0	**65.5**	312.0

The water has a low pH and low alkalinity. It is undersaturated (has a negative calcium carbonate precipitation potential) and therefore is considered corrosive. The colour is very high due to tannins or humic acids derived from the natural vegetation in the catchment. The turbidity is relatively low.

5.2 Boreholes

The Groundwater Africa Report included water quality testing of all four boreholes. It also referenced the water quality results from 2017 when boreholes GWA-Kur1 and GWA-Kur2 were yield tested. A comparison of the water quality from the boreholes in 2017 and 2021 reveals that the iron concentrations from these two boreholes have increased significantly while manganese concentrations also increased marginally.

	2017	2021
GWA-Kur1 Iron (mg/L):	0.36	0.63
GWA-Kur2 Iron (mg/L):	0.12	0.22
GWA-Kur1 Turbidity (NTU):	20.1	6.5
GWA-Kur2 Turbidity (NTU):	3.2	1.0
GWA-Kur1 Manganese (mg/L):	0.06	0.08
GWA-Kur2 Manganese (mg/L):	0.07	0.09

The sampling and testing done in 2021 included the newly drilled boreholes GWA-Kur3 and GWA-Kur4. The weighted average results based on the recommended abstraction rate for each borehole are provided in Table 5-2.

Table 5-2: Weighted average water quality from 4 boreholes (2021)

Determinand	Units	SANS 241-1:2015 RECOMMENDED LIMITS	Average	Weighted Average based on recommended abstraction rates
Electrical conductivity at 25°C	mS/m	< 170	11.5	11.6
Iron	µg Fe/l	Chronic: < 2000 Aesthetic: < 300	348	304
Manganese	µg Mn/l	Chronic: < 400 Aesthetic: <100	102	105
pH at 25°C	pH units	5.0 - 9.7	4.9	4.7
Total dissolved solids at 180°C	mg/l	< 1200	75	75
Turbidity	NTU	Operational <1 Aesthetic <5	3.5	2.9

The borehole water also has a low pH and corrosive properties, similar to the Wit River. The iron and manganese levels from the boreholes are slightly above the SANS 241 aesthetic limits and there is a concern that these levels might increase more with time.

5.3 Water Quality Standard

The water will need to be treated to the SANS 241-2015 (potable) standard.

6 Proposed Process

The process design was done with consideration of the existing infrastructure available on site as well as the available footprint. The two water sources have very different water qualities. A process was sought whereby the same basic process can treat both streams, but with separate preconditioning steps.

For the borehole water the preconditioning steps are pH adjustment and aeration to create conditions that are conducive for the oxidation and precipitation of iron. In addition, chlorine dosing is proposed to oxidise manganese on the sand filters. Chlorine dioxide is being investigated as an alternative to chlorine gas.

For the river water the preconditioning steps are pH adjustment, coagulation and flocculation to remove the colour originating from tannins or humic acids in the water.

When iron and manganese (from borehole water) mix with the humic substances in the coloured river water it becomes more difficult to oxidise these metals as explained by Reali et al.:

> *"As widely related in several works, the humic substances responsible for the colour of natural water easily associate with metals and oxides forming usually coloured complexes. Due to its high stability when associated with NOM, the iron and manganese removal becomes more difficult than*

the removal of the free forms of these metals. As observed by Knoche et al. (1991), the organic complexes are very hard to be removed by oxidation and subsequent precipitation of Fe(OH)$_3$."

Therefore, the oxidation of the iron and manganese in the borehole water is done separately from the river water. The optimal pH ranges for oxidation of the metals and coagulation of organic material in the coloured water differ (8.5 and 5.8 respectively) and it makes sense to precondition these streams separately. It should be noted that oxidation and precipitation of the manganese will not be complete after the preconditioning step as time is required for this process. While the preconditioning steps' retention time will be oversized slightly with this in mind, the oxidation and precipitation of the metals will continue on the media filters.

The existing settling tank will be converted to a dissolved air flotation (DAF) plant. The DAF process is more effective at removing colour than settling due to the nature of the low weight flocs typical of high coloured water. The DAF plant requires a much lower upflow velocity (8 m/hr) than settling (0.5 m/hr) and therefore the existing settling tank, when converted to a DAF tank, will have sufficient capacity to treat both the river and the borehole water. This means the DAF plant can be divided in two sections, one for treating river water and one for treating borehole water. DAF is not typically used for iron and manganese removal, but it could present some benefits such as increased retention time and oxygen to facilitate oxidation and precipitation of the metals. Some of the floc may precipitate in the bottom of the DAF tank where it can be removed periodically by opening the DAF desludging valves. Operational flexibility will be provided for the borehole water to bypass the DAF plant for direct filtration of the borehole water.

The water from both sources will then pass through media filtration. Operators will have the option to blend both streams upstream of the media filters or to keep them independent. Chlorine disinfection is done before the water is discharged to the distribution reservoirs. Basic process flow diagrams are shown in Figure 6-1 and Figure 6-2. A brief overview of each process step is given in the following section.

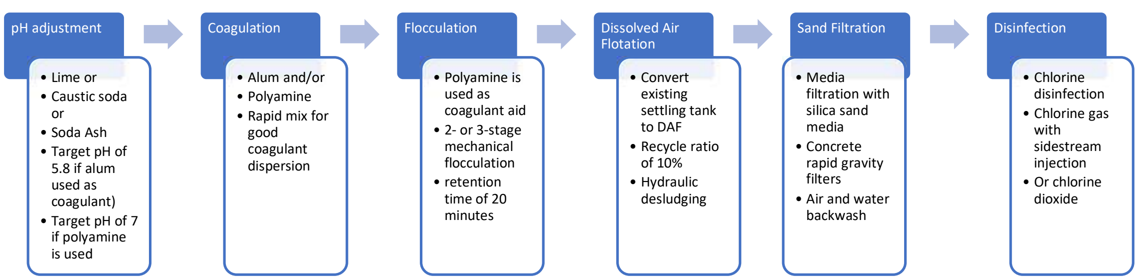


Figure 6-1: Simplified Process Flow Diagram for Wit River Water Treatment

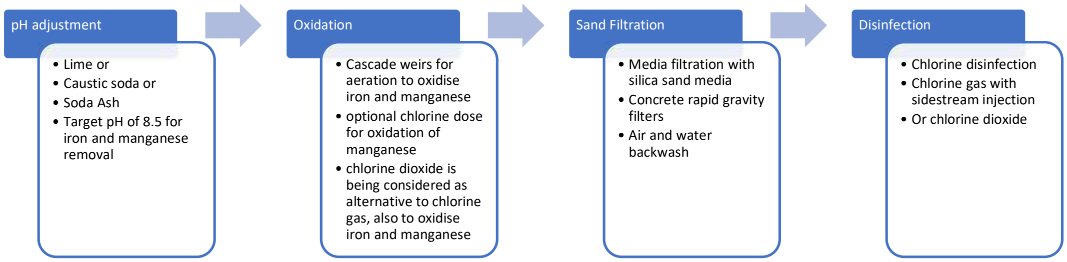


Figure 6-2: Simplified Process Flow Diagram for Borehole Water Treatment

6.1 pH adjustment – Borehole Water

Both iron and manganese in the raw borehole water is marginally above the SANS 241 drinking water aesthetic limits, but it is expected that these levels may increase over the years as continuous abstraction is done. The weighted average pH of the water from the boreholes is 4.7. To oxidise iron a pH of above 7.5 is optimal, while a pH of 8.5 is required to oxidise manganese. A pH of 8.5 will therefore be targeted for the borehole treatment.

6.2 Oxidation of Metals - Borehole Water

Iron and manganese ions that are present in the soluble divalent (Fe^{2+} and Mn^{2+}) state need to be oxidised to higher valence insoluble states before it can be precipitated and filtered out. Aeration or chlorination is typically used for the oxidation step. Where borehole water is not complexed with natural organic matter (NOM) and at the correct pH range iron is typically oxidised rapidly through aeration. Manganese on the other hand oxidises at a much slower rate through aeration. Chlorine, chlorine dioxide or permanganate is typically used to oxidise manganese. Ozone could be used, but accurate dosing would be required since overdosing will convert manganese to permanganate which requires additional contact time to be reduced to insoluble manganese oxides.

For this application manganese was marginally above the aesthetic limit and it should be possible to remain below the limit of 100µg/l without the addition of a strong oxidant. This simplifies operation and reduces the risk of producing disinfection byproducts (in the case of chlorine). When the borehole treatment train is run independently from the river water train, chlorine can be dosed without concerns over DBP's since the NOM (or TOC) levels in the borehole source is very low at TOC <1.2 mg/l.

The operational flexibility will be provided for a media filter to receive only borehole water, without prior blending with river water. This will enable operators to operate this filter with a free chorine residual across the filter. This will create a manganese oxide coating on the media that will effectively adsorb manganese. For this filter alternatives to sand can be considered for improved iron and manganese removal. Engineered manganese oxide coated media like Katalox Light could be used in future to improve iron and manganese removal.

Chlorine dioxide is still being investigated as an alternative to chlorine for this application. It has some advantages over chlorine gas such as safety and being a stronger oxidant than chlorine. It also does not create as many disinfection by-product concerns as chlorine, although chlorite and chlorate formation needs to be controlled.

6.3 pH adjustment – River Water

Two options of coagulants are included for the river water treatment. The first is aluminium sulphate (or alum) and the second is polyamine. The two can also be used in conjunction with aluminium sulphate first as coagulant and polyamine second as coagulant-aid.

When alum is dosed the optimal pH for coagulation is 5.8. Polyamine is less sensitive to pH and performs equally well over a wide pH range. When polyamine is dosed a pH of 7.5 can be targeted to protect equipment and concrete from corrosion.

Operators can either dose lime or soda ash and set dosing rates to target a pH of 5.8 or 7.5.

6.4 Coagulation – River Water

When alum or polyamine is dosed as coagulant it is important to get rapid dispersion of the chemical throughout the whole stream. A hydraulic rapid mix will be provided where the water simply falls over a weir and the coagulants are dosed directly above the weir.

Some of the key design parameters are listed here:

i. G – values of 600 – 1000 s^{-1}
ii. mix time of 1 to 5 seconds
iii. Gt values of 300 - 1600

6.5 Flocculation – River Water

It has been shown (AWWA 9.75-9.76) that for DAF system the optimal flocculation conditions are found at:

i. G = 70s-1
ii. Gt of 40000-60000
iii. Retention time of 5 - 20 minutes

Mechanical flocculation will be provided by means of paddle mixers with a tip speed below 0.5 m/s. Two stages of flocculation will be provided with the mixing intensity of the first stage higher than that of the second.

6.6 Dissolved Air Flotation

The existing settling tank will be converted into a DAF tank. For the settling tank to perform well for the removal of the light flocs typical of the coloured waters a settling upflow velocity of less than 0.5 m/hr would be required. This would mean that the settling tank capacity had to be doubled to deal with the water from the river only.

DAF is particularly effective at removing colour flocs from water as indicated widely in literature and as experienced by Bitou Municipality at the Plettenberg Bay WTW. Moreover, a DAF plant can operate at an upflow velocity of 8 m/hr or more. Since the settling tank will be converted this DAF will operate at a very low upflow velocity (about 2 m/hr) which will ensure that it performs even better.

Microbubble pumps are a relatively new technology that simplifies the microbubble generation process dramatically. A recycle stream of 10% of the flow will pass through the microbubble pump where the water will be saturated with air at approximately 4 bar pressure. The pressure is released directly upstream of the DAF tank contact zone and microbubbles are generated. In the contact zone the microbubbles attach to the flocs. In the separation zone the bubble-floc aggregates float to the surface and create a scum layer.

There are two different scum removal systems that could be employed. The first is by means of a mechanical scum scraper (travelling scraper or rotational beach scraper). The second is a hydraulic scum removal system where the DAF outlet valve is closed momentarily allowing the level in the DAF tank to rise and causing the scum blanket to overflow into the scum collection channels. Mechanical scum removal systems have the benefit that it can achieve a greater scum thickness (2-3%) and thereby reduce scum volumes. The hydraulic scum removal system has the benefit of operational simplicity. Since it is foreseen that sludge and scum dewatering and backwash recovery will be done it is less important to achieve high scum concentrations. Therefore, a hydraulic scum removal system is chosen in this case.

The DAF tank will be divided in two trains. Both trains could be used for treating the river water, or one train could be used for additional contact time for the borehole water.

6.7 Media Filtration

Media filtration forms the heart of the water treatment process and is responsible for pathogen removal, turbidity removal, colour flocs removal and the removal of iron and manganese precipitates. Silica sand will be used as the filtration media. It is foreseen that an 900mm deep bed of 0.7mm effective size media will be used. This is a slightly coarser media and a slightly deeper bed than what is used typically. The reason for this is that the metal precipitates can easily cause surface blinding of the filters, requiring frequent backwashing. By providing a coarser media, deep bed filtration is achieved, and filter runs are prolonged.

A design filtration rate of 3.0 m/hr will be employed. This is at the low end of filtration rates which will help to achieve better filtrate quality. Four filters will be provided in this phase, two for the borehole water and two for the river water. This is done to ensure that the plant can still cope when one filter is out of operation for maintenance and to allow continuous operation during backwashing. While one filter is in backwash mode the other will operate at a filtration rate of 6.0 m/hr. Space provision is made on the site for a further two identical filters to be installed in future.

Means to backwash the filters with air and water sequentially will be provided. Duty and standby backwash pumps will draw water from the reservoirs for this purpose. Duty and standby rotary lobe blowers will be provided for the air scour. It is proposed that the backwash cycle be initiated manually by operators or based on a timer. The backwash sequence will however be automated to save operators time and effort and to minimize human error.

Dual parallel lateral underdrains will be specified since it provides superior flow distribution characteristics for filtration and backwashing, ensuring utilization of the entire filter area. The units are grouted onto the concrete floor and significantly simplifies the construction of a false floor system. Media retainer caps can be used in place of a gravel layer, however iron and manganese can cause the pores in the caps to get blocked and therefore a gravel support layer will be used instead.

Figure 6-3: Dual Parallel lateral underdrain system

The filters will be operated as influent flow splitting, variable level filters. This means the flow is distributed equally to all filters. As the filter gets clogged the headloss across the media increases and the water level above the media rises. This makes it simple for operators to see when a backwash is required. This setup also does not require any additional control equipment or instrumentation.

Provision is made to blend the river water that has passed through the DAF process with the borehole water that has bypassed the DAF and thereby treat both streams collectively on the media filters. Provision is also made to keep these two streams separate and thereby operate the media filters distinctly as receiving only river water or only borehole water. The benefits of this separation will now be discussed.

6.7.1 Dedicated River Water Filtration

Since the river water contains high concentrations of humic acids this stream should not be mixed with the borehole stream where chlorine is dosed until the TOC levels are low enough (post filtration) to avoid formation of disinfection byproducts. Although it is not explicitly recommended for this phase it is an option to include a layer of GAC media in the filter to further enhance the removal of colour from the water.

6.7.2 Dedicated Borehole Filtration

To avoid iron and manganese complexing with the natural organic material (NOM) from the river water the borehole water stream can be kept separate from the river water – even through separate filters. This makes it easier to oxidise the iron and manganese. Since the NOM (or TOC) concentrations in this stream is low, chlorine can be added to maintain a free residual chlorine level across the filters without a concern for DBP formation. This will cause manganese oxide coatings to form on the sand which catalyses the oxidation of Mn(II) to Mn(IV) which will precipitate on the filter. Although not explicitly recommended for this phase it is an option to replace the dedicated borehole filter's sand with specialized manganese oxide coated filter media such as Katalox Light in future for enhanced iron and manganese removal.

6.8 Chlorine Disinfection

Chlorine is a tried and tested means of disinfection. Although many alternatives exist, chlorine is still favoured for the residual chlorine disinfection it provides throughout the distribution network. The existing Kurland WTW operates with chlorine gas as disinfectant and is therefore familiar to operators. The chlorination equipment will be moved to the new service building. The new chlorine gas facility will include:

i. 3 x digital scales
ii. 3 x 100 litre chlorine gas bottles
iii. Vacuum regulators
iv. Automatic change over
v. Chlorine ejector and proportional dosing control
vi. Chlorine gas leak detection with audio-visual alarm.

Chlorine dioxide is being investigated as a potential alternative to chlorine gas. It is a stronger oxidant, produces less disinfection by-products and also provides residual disinfection for the distribution network.

6.9 Stabilization

The borehole water pH will be adjusted to 8.5 at the head of the works for manganese removal. The river water pH will be adjusted to either 5.8 or 7.5 depending on whether alum or polyamine is used as coagulant. The blend of borehole water to river water will also vary seasonally and therefore the final treated water pH will also vary. The alkalinity and calcium carbonate precipitation potential (CCPP) will also vary depending on the seasonal blend of river and borehole water. The Langelier Saturation Index (LSI) aims to predict whether water will be corrosive (LSI < -0.5) or scale forming (LSI > 0.5). The easiest way operationally to remain withing the acceptable range of -0.5 to 0.5 is by providing a limestone contact tank. A limestone contact tank is in some ways self-correcting since the dissolution rate of calcium carbonate is affected by the LSI of the incoming water. If the water has a high pH and positive CCPP, the limestone won't dissolve, while when the water has a negative CCPP the lime will dissolve more readily.

The design guidelines for a limestone contact tank are as follows:

- Retention time > 20 mins
- Upflow velocity < 10 m/hr
- Limestone bed height > 2.0 m
- Circular shape, closed structure with access lid.

Note that due to capital budget and space constraints the limestone contact tank may have to be omitted from the scope of works. This means that the pH adjustment at the head of the works should be done so that the final water pH and alkalinity is in a suitable range. For this reason polyamine may be a more desirable coagulant than alum since it can is more efficient at a pH of 6.5 – 7.5 than alum and produces less sludge.

6.10 Storage

Two existing reservoirs with capacities of 0.5 ML and 1.5 ML will be used for storage. The reservoirs will provide contact time for the chlorine and will serve as storage of water for backwashing the media filters. Future planning includes the addition of a third 1.5 ML reservoir. From these reservoirs the water gravitates to the distribution network. The existing storage volume provides the operators with up to two days' time for critical maintenance activities.

7 Operational Considerations

7.1 Blending of Streams

It is proposed that the Operators aims to always use a blend of river and borehole water in the feed to the Kurland WTW. This will reduce the risks of not complying to with the standard for specific parameters. By blending the two streams the combined concentration of colour will be lower than for the river water alone. Similarly, the combined concentration of iron and manganese will be lower than in the borehole water alone.

8 Regulatory and Statutory Requirements

8.1 SANS 241-1:2015 Edition 2

This design was done with the objective of meeting the requirements of the SANS 241-1:2015 Edition 2 regulations. It should however be noted that the SANS 241 standard is currently being reviewed and may impact the design and operation of the plant one promulgated.

9 Electrical

9.1 Site Supplies

The Kurland WTW is currently fed by a 50kVA, 22kV/400V pole-mounted transformer, with a 80A main CB in the existing Main DB. The site is also equipped with a 105kVA standby generator, that automatically starts in the event of a power failure.

For the intended plant expansion, with proposed motor and equipment loading, an Eskom supply upgrade application will need to be lodged, as the existing supply capacity is inadequate. The final NMD value will need to be assessed once the design principles from this report have been established. This application will need to be lodged as soon as possible, as the process of submission, through to quotation and implementation can be in excess of 9 months.

The generator size is adequate for the planned expansion, but careful consideration will need to be made with equipment sequence starting and specific equipment starter types.

9.2 Site Distribution

A new Main MCC will need to be provided for the complete site, integrated with the generator changeover. The new Main MCC will feed the various plant sub-distribution MCCs, as well as the four boreholes on-site. The new MCC's fault rating will be suited for the intended increases bulk supply, and will be of the indoor type.

Where possible, existing site cables will be re-used, but given the final new location of the main MCC, as well as the planned supply upgrade, most of the cables under the contract will be new.

9.3 Control Methodology

It is recommended that the plant be controlled by a central PLC, with all system, and specific plant sections, be controlled from this central PLC. This allows one entity to be responsible for the coding and management of the entire plant, and further allows for ease of integration with a control room and telemetry equipment (via network).

The general intent of the plant is for dosing to adjust according to the flows, but with pre-set dosing rates. Pumping equipment will function on level and flow (and PID where required for optimal system and energy efficiency). Filter backwash process will need to be a function of manual initiation, followed by a set, automated sequence of pumps, blower and valve integration. Given the proximity of the proposed control room to the filters, a central HMI/Industrial PC (IPC) solution is proposed here, instead of a dedicated filter desk.

The control HMI/IPC will be either wall or desk-mounted, to provide complete plant feedback, as well as the interface point for process adjustments. A complete and separate SCADA system is not recommended for this site, as the signals will be communicated through to the Plettenberg Bay WTW, where trending and data storage will occur. The plant will be able to be trended, controlled and adjusted only from this main control room interface point.

9.4 Telemetry / SCADA

All signals will be networked from the new PLC to the upgraded telemetry outstation (currently of the Elpro digital radio type). The outstation will need to be upgraded, with additional I/O and network cards added. It is further recommended that the outstation be relocated from the existing Inlet Works MCC, to the new MCC room.

The Plettenberg Bay SCADA is of the Citect type, but is running out of tags (allocated software usage). If not addressed under another contract, the SCADA package will need to be increased to accommodate this plant upgrade, with associated costs.

The plant graphics will need to be amended and expanded, to accommodate the new process trains, with trending and storage to suit. No remote control will be provided from the SCADA system.

10Implementation Programme

The following programme is proposed to align with the available financial year budgets.

CIVIL CONTRACT	
Timeframe	**Deliverables**
July-August 2022	Tender Documentation, Advertise Tender
September 2022	Tender Evaluation
October 2022	Appoint Contractor
October 2022 – August 2023	Construction

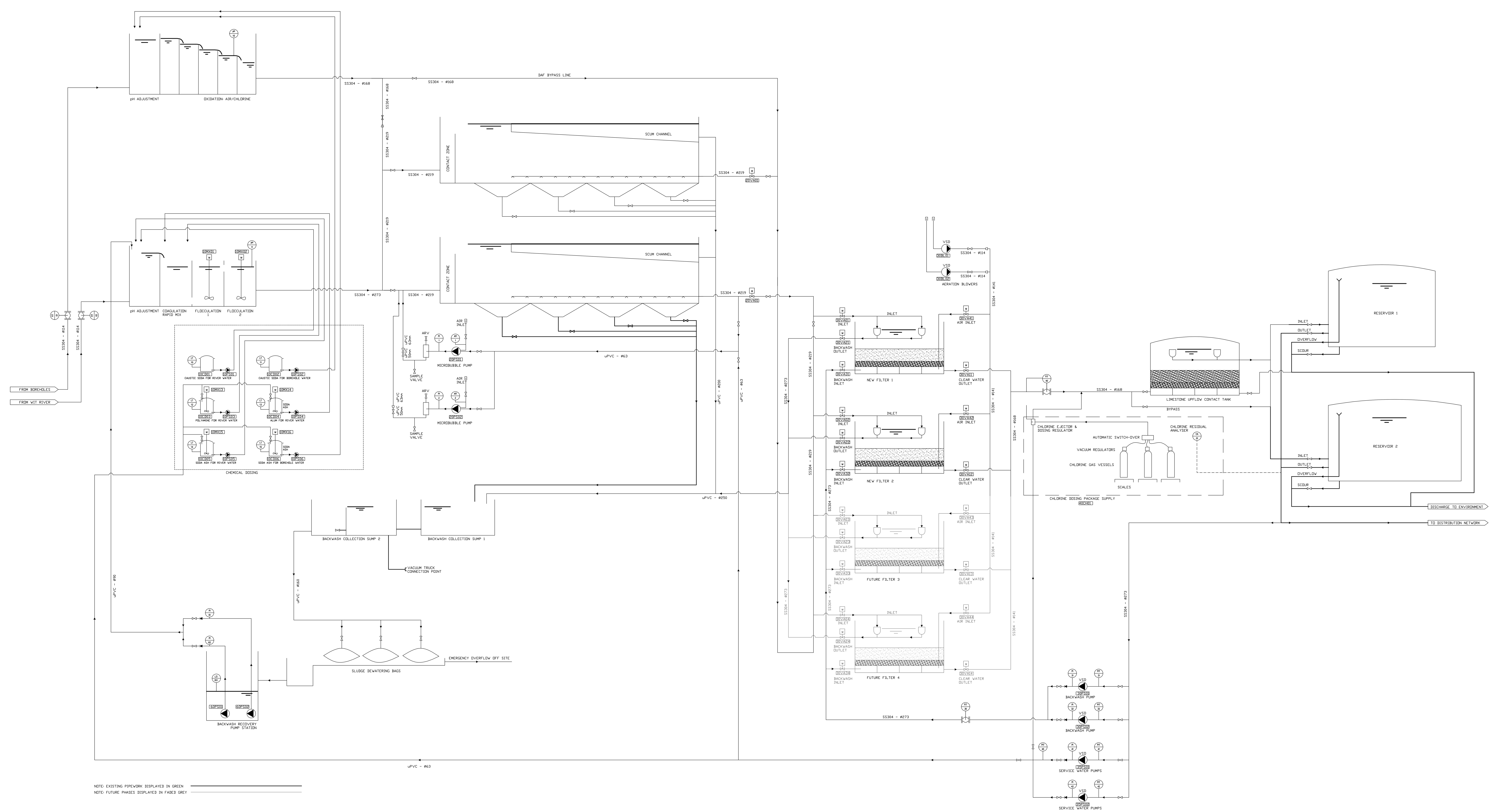
MECHANICAL & ELECTRICAL CONTRACT	
Timeframe	**Deliverables**
September 2022	Tender Documentation, Advertise Tender
October-November 2022	Tender Evaluation
December2022	Appoint Contractor
January 2023 – September 2023	Implementation

11 Cost Estimates

The estimated construction cost shown in the table below excludes professional fees, additional services, site supervision and OHS work. These are cost estimates only that will change according to the final scope of work and actual tendered rates. Should the tendered rates not align with the available budget, the scope of works can be adjusted accordingly.

Nr	Section	Phase 1: Civil	Phase 2: M&E
1	Preliminary & General	R 1 395 460.00	
2	Site Works	R 501 215.00	
3	Preconditioning Chambers	R 605 099.00	
4	Dissolved Air Flotation Tank	R 349 112.50	
5	Media Filtration	R 2 284 067.50	
6	Service Building	R 1 166 005.50	
7	Dewatering & Backwash Recovery	R 463 210.00	
8	Interconnecting Pipework	R 413 600.00	
9	Mechanical		R 5 697 600.00
10	Electrical		R 2 757 600.00
	Subtotal	**R 7 177 769.50**	**R 8 455 200.00**
	Allowance for Escalation (10%)		R 845 520.00
	Subtotal Excluding VAT	**R 7 177 769.50**	**R 9 300 720.00**

ANNEXURE A: Process & Instrumentation Diagram (P&ID)



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Water Treament Specialists

REFLEKT WATER

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Email: marco@reflektwater.co.za
Website: www.reflektwater.com

Main Contractor:

Nell LYNERS and Associates (NI) (Pty) Ltd
Consulting Engineers & Project Managers

Client:

Bitou municipality — to be the best together

Project:

UPGRADING OF THE KURLAND WATER TREATMENT WORKS

Drawing Stage:

- [ ] Preliminary Design
- [x] Tender
- [ ] Construction
- [ ] As Build

PrEng: ECSA Pr № 20140238
M KRITZINGER

DRAWN	PAPER SIZE	DESIGNED	CHECKED
M KRITZINGER	A1	M KRITZINGER	M KRITZINGER

SCALE: NTS

DATE: 2022-05-23

TITLE: P&ID

PROJECT NO: 22033

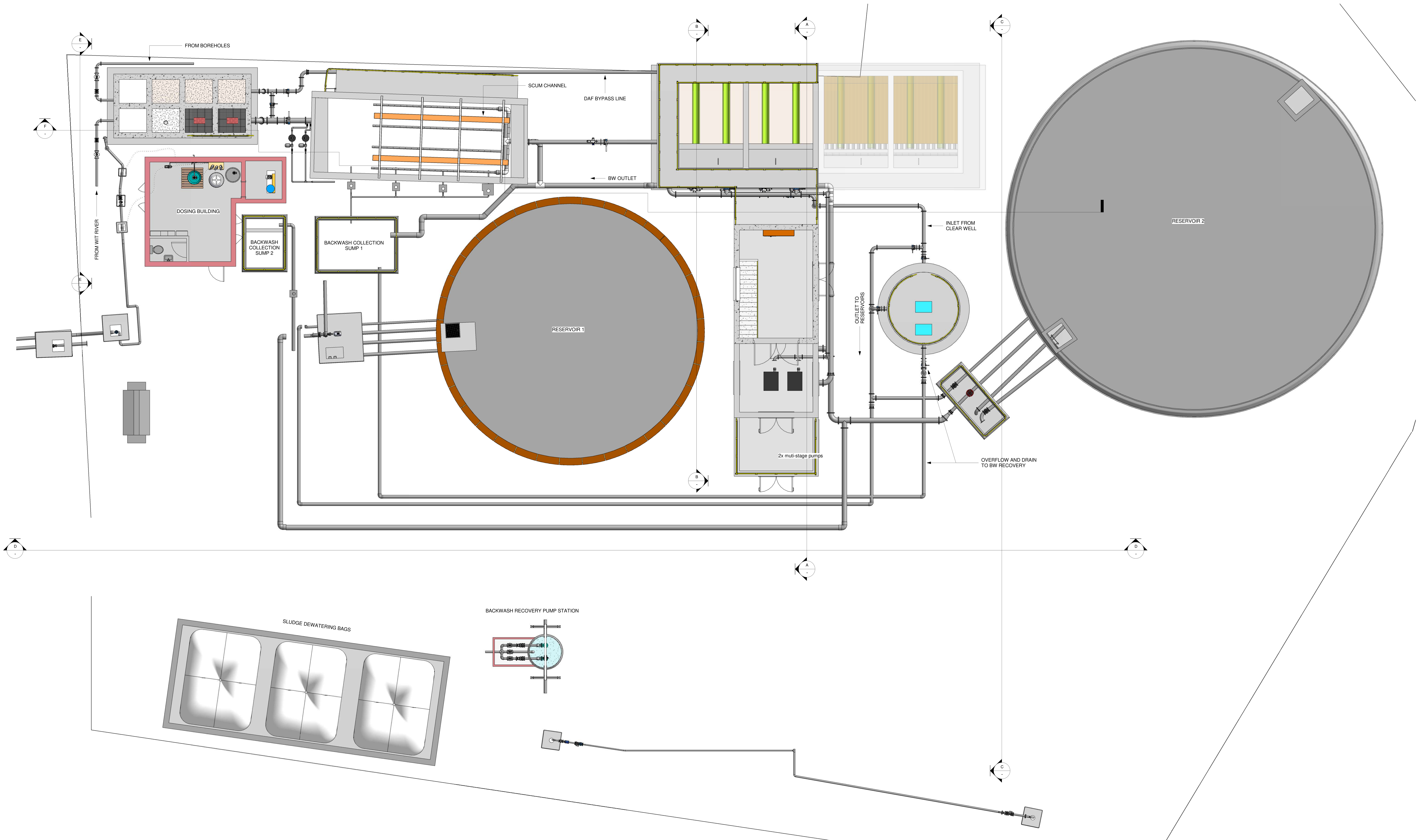
DRWG NO: 22033-01-100

REVISION SCHEDULE

No.	Description	Date
0	FOR INFORMATION	2022-05-23

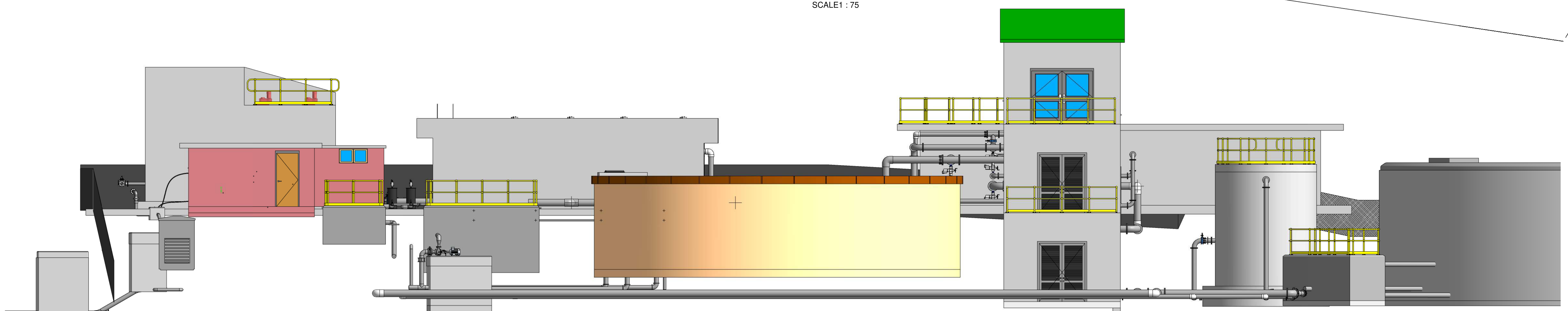
REVISION: 0

ANNEXURE B: Site Layout



SITE COORDINATION PLAN

SCALE1 : 75



SITE ELEVATION D-D

SCALE1 : 75

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REVISION SCHEDULE

No.	Description	Date
0	AS-BUILT	2022-03-23
1	TENDER	2022-06-02

Legend:

Client:

Main Contractor:

Project:

KURLAND WATER TREATMENT WORKS

Drawing Stage:

Preliminary Design ■ Tender Construction
As Built

Water Treament Specialists

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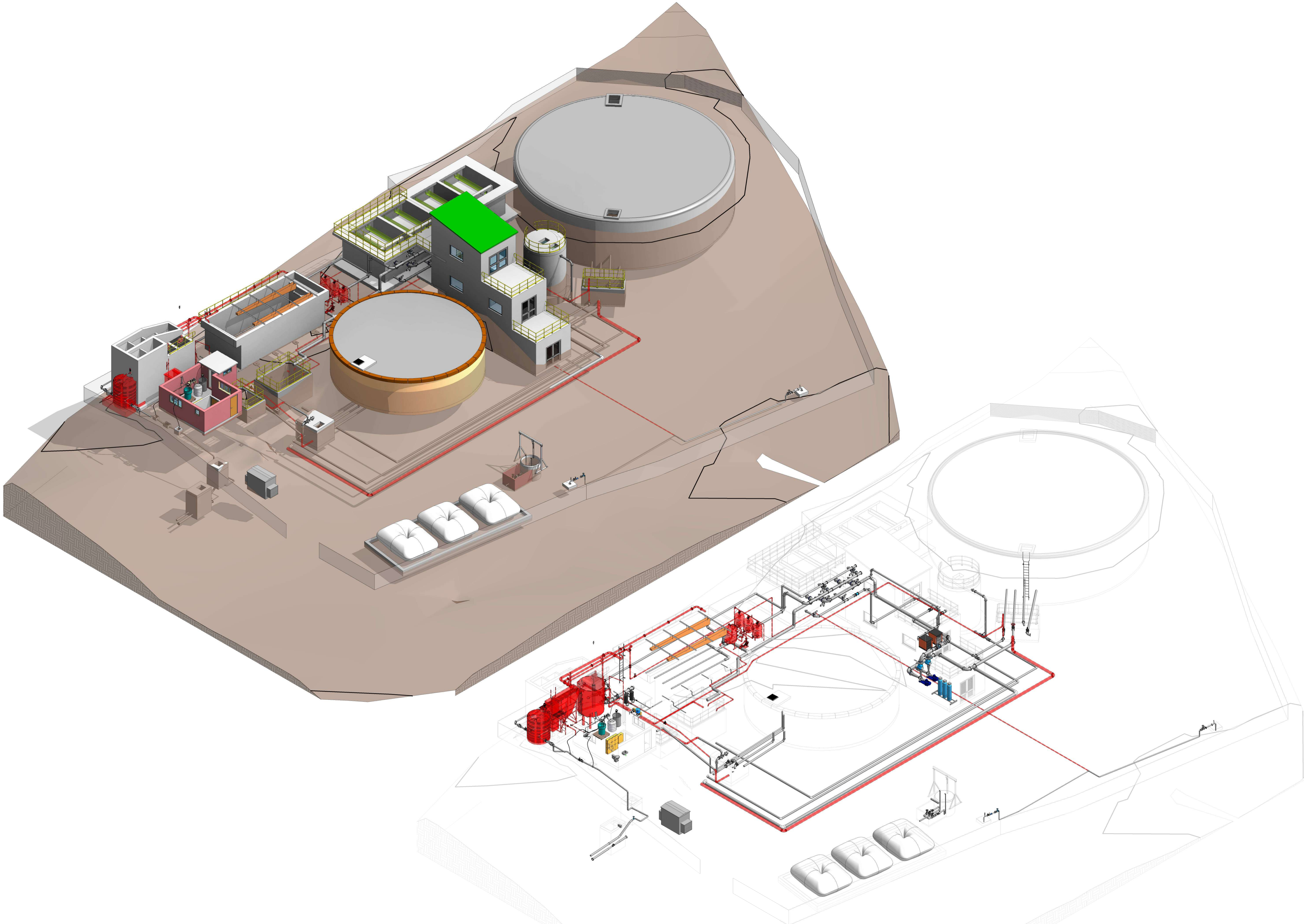
PrEng: Reg Nr 20140238	DRAWN E VLOTMAN	PAPER SIZE A0
	DESIGNED M KRITZINGER	CHECKED M KRITZINGER
SCALE AS SHOWN	DATE 2022-06-02	
TITLE KURLAND WATER TREATMENT WORKS SITE PLAN COORDINATION GENERAL ARRANGEMENT SHEET 1 OF 2	PROJECT NO: KWTW DRWG NO:	REVISION: 1



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REVISION SCHEDULE

No.	Description	Date
0	AS-BUILT	2022-03-23
1	TENDER	2022-06-02

Legend:

Client:

Main Contractor:

Project:

KURLAND WATER TREATMENT WORKS

Drawing Stage:

☐ Preliminary Design ■ Tender ☐ Construction ☐ As Built

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PrEng: Reg Nr 20140238	DRAWN E VLOTMAN	PAPER SIZE A0
	DESIGNED M KRITZINGER	CHECKED M KRITZINGER
SCALE AS SHOWN	DATE 2022-06-02	
TITLE KURLAND WATER TREATMENT WORKS SITE PLAN 3D GENERAL ARRANGEMENT SHEET 2 OF 3	PROJECT NO: KWTW DRWG NO:	REVISION: 1

C:\Users\VLOTECH (Pty) Ltd\Documents\##Vlotech (Pty) Ltd\#Projects\Engineering\Mechanical\Reflekt Water\##Projects\Kurland\Kurland WTW\New Construction\Drawings\Kurland WTW As-built_Phasing New Construction.rvt

ANNEXURE F3

MOTIVATION OF ADJUSTMENT BUDGET FOR KURLAND WATER TREATMENT WORKS BY REFLEKT WATER AUGUST 2022

ANNEXURE F3

MOTIVATION OF ADJUSTMENT BUDGET FOR KURLAND WATER TREATMENT WORKS BY REFLEKT WATER AUGUST 2022

11 AUGUST 2022

UPGRADING OF KURLAND WTW – MOTIVATION FOR ADJUSTMENT OF BUDGET

In February 2021 a Technical Memorandum was compiled by iX Engineers, subconsultants to Neil Lyners and Associates. The Technical Memorandum was not a detailed design report but a high-level investigation to determine the potential scope of works and cost estimates. The Technical Memorandum recommended both **short-term** and **long-term** solutions through a phased approach.

The short-term solution included refurbishments of existing equipment and recommissioning of previously decommissioned infrastructure. The scope of work proposed is shown below:

- **Existing Building**
  - Provide a wall separating the chemical make-up area and MCC, with the MCC area being provided with a normally closed door and a positive pressure fan to ensure dust-free conditions;
  - Fix the chemical dosing area to be workmanlike and uncluttered by reconfiguring cable runs and pipework to allow uninterrupted and clear access to each functional area;
  - Provide the blower area with soundproofing and an external air intake to limit chemical dust intrusion;
  - Consider the use of an A-frame to assist with chemical handling directly from vehicles into the chemical storage area.
- **Groundwater Feed**
  - Provide for an aeration cascade to release of noxious odours and effect oxidation of dissolved iron;
  - Split the groundwater feed to enter the lamella settler after the cascade;
  - Consider providing a pre-chlorination for enhanced oxidation of dissolved iron in the lamella settler;
  - Add a new LDPE tank serving as sump for the pressure filtration assembly;
  - Provide new feed pumps to the 4 off pressure filters;
  - Tie into the rapid gravity backwash pump;
  - Provide pipework as required for filter operation and backwashing using either HDPE or uPVC;
  - Tie into existing clearwater and backwash sumps.
- **Surface Water Feed**
  - Bypass the lamella settler to deliver flocculated surface water only to the rectangular clarifier;
  - Retain the existing process stream from the rectangular clarifier to the circular rapid gravity filter as per the current installation.
- **Stabilisation**
  - Retain existing system unchanged.
- **Disinfection**
  - Retain existing system unchanged, after seeking expert intervention to make the single bottle system compliant to "SANS 10298:2009 Indirect small to medium-sized gas chlorination systems for the disinfection of water";
  - Consider a safety shower/eye-bath to service chemical dosing and chlorine installations respectively.

iX Engineers estimated that the short-term scope of works would cost about **R8 500 000.00** excl. VAT.

The proposed scope of work for the long-term solution proposed by iX Engineers is indicated below:

- **Common Facilities**
  - Ablution facilities, kitchen, dining area, 2 offices and small on-site laboratory;
  - Conservancy tank;
  - Small pressure sustaining pump for on-site potable water.
- **Groundwater Feed**
  - Aeration cascade (release of noxious odours and oxidation of dissolved iron);
  - Pre-chlorination for oxidation of dissolved iron;
  - Stabilisation (Lime addition and/or soda-ash) to prevent scaling nuisance;
  - Potentially need settling step if new groundwater will require metals precipitation;
  - Then onto filtration, stabilisation and disinfection.
- **Surface Water Feed**
  - Upgraded flocculation/coagulation facility;
  - Increased settling/clarification capacity (possibly an additional settling tank);
  - Acceptable sludge disposal and recovery of supernatant.
- **Filtration**
  - Provision of 2 new rapid gravity sand filters, complete with;
    - proper manual valve control (via extended spindles);
    - local stop/start control panel for the blowers and backwash pumps;
    - Safe and easy access to all structures (stairs, handrailing, site lighting, etc).
  - Depending on the water source, dual media filtration may be required;
  - Acceptable back-wash water disposal;
  - Duty/standby assemblies for backwash pumps and blowers.
- **Stabilisation**
  - Consider using limestone stabilisation, combined with soda-ash – water quality dependant;
  - Additional lime dosing may be required for cost-effective stabilization – water quality dependant.
- **Disinfection**
  - Upgrade the chlorine dosing installation to comply with "SANS 10298:2009 Indirect small to medium-sized gas chlorination systems for the disinfection of water";
  - Consider providing for an auto change-over assembly;
  - Ensure that correct safety equipment and procedures are supplied and adhered to;
  - Safety shower and eye-bath.
- **Decommissioning of redundant process units and equipment in the current installation**

The cost estimate for the long-term solutions came to **R 19 000 000** excl. VAT. In the Technical Memorandum the authors explicitly indicated that the approach and scope may vary according to the water quality of the new boreholes that was yet to be determined at the time of writing the Technical memorandum.

In January 2022 Groundwater Africa completed a Report titled "*Kurland groundwater investigation: Yield recommendations for the four boreholes at the Kurland Water Treatment Works"* that included the yield recommendations and the water quality for the boreholes. Some of the key findings were that iron and manganese concentrations in the borehole water was rising gradually over time.

When Reflekt Water were appointed as subconsultants to Lyners in March 2022, the detail design of the upgrades ensued. Some of the discoveries made during the detail design included:

- The borehole water contains high iron and manganese concentrations while the river water contains high colour from humic organic substances. It is therefore not recommended to blend the two source waters to prevent complexing of the iron and manganese with organic substances which would make it difficult to oxidise and precipitate these metals. The design now includes for separate treatment of the two streams.
- The Technical Memorandum considered construction of a second settling tank. Upon closer investigation the opportunity to convert the existing settling tank to a DAF tank with low-cost interventions arose. DAF is a more suitable process than gravity settling for the low-density flocs typically formed during the coagulation of this coloured water.
- It became apparent that the short-term solution proposed would cause expenditure on equipment and infrastructure that will be decommissioned, demolished, or removed when the long-term solution is implemented. Also, the short-term solution would battle to keep the plant consistently compliant with SANS 241 requirements. Therefore, it made more sense to go for the long-term solution as soon as possible and not to implement a short-term solution.
- The new proposal as detailed in the *Design Report for the Upgrading of Kurland Water Treatment Works Rev01* submitted in July 2022 explains the updated scope of works. The scope of works does not vary significantly from what was discussed in the Technical Memorandum compiled earlier by iX Engineers. It does show that the new proposal (a long-term solution) comes to a total cost of **R16.5 million** which is **considerably less** than the R8.5 million plus the R19 million previously estimated to achieve a long-term solution.

The funding supplied by WSIG to Bitou Municipality in the 2022/23 FY is sufficient to complete the civil construction works (first phase) for the upgrading of Kurland WTW. Bitou Municipality is seeking additional funding for the mechanical and electrical engineering works (second phase) so that it can be completed in the 2023/24 FY.

We trust this clarifies how the changes in the required budget came about and that the proposed solution will leave Bitou Municipality with a properly compliant plant at a lower cost than what was anticipated during the high-level investigations at the onset of the project.

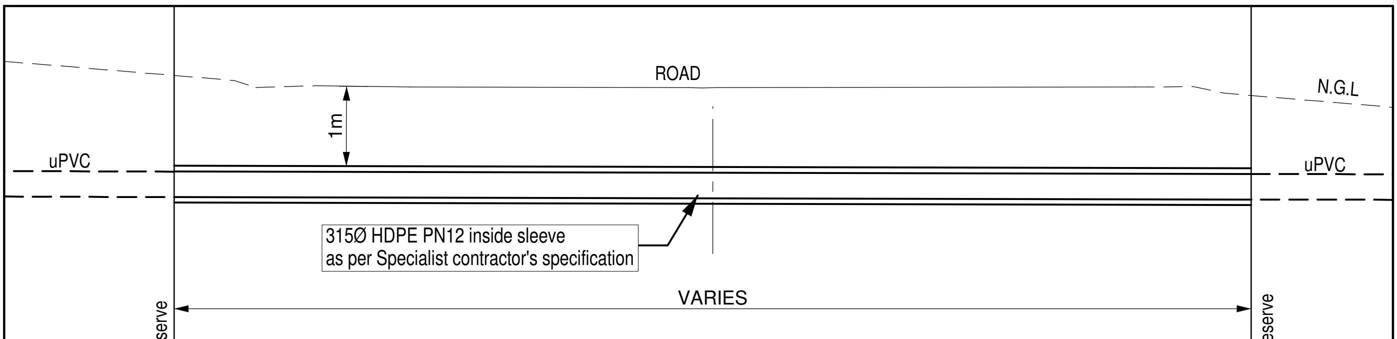
Yours Faithfully

Marco Kritzinger PrEng

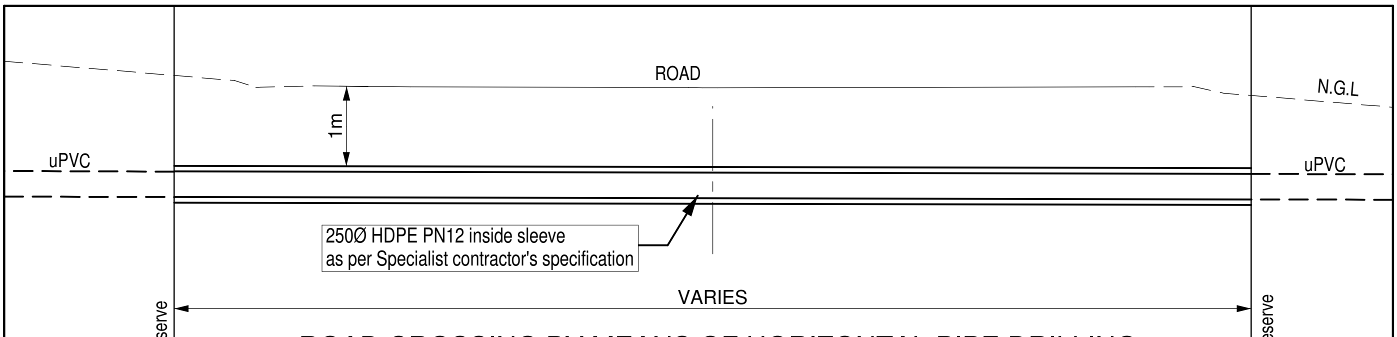
Reflekt Water (Pty) Ltd

ANNEXURE G

TYPICAL DETAILS: PUMPSTATION, RESERVOIR, STREAM CROSSING, ROAD CROSSING



ROAD CROSSING BY MEANS OF HORIZONTAL PIPE DRILLING-
DETAIL 1 (N.T.S.)



ROAD CROSSING BY MEANS OF HORIZONTAL PIPE DRILLING-
DETAIL 2 (N.T.S.)

CONSULTING ENGINEERS

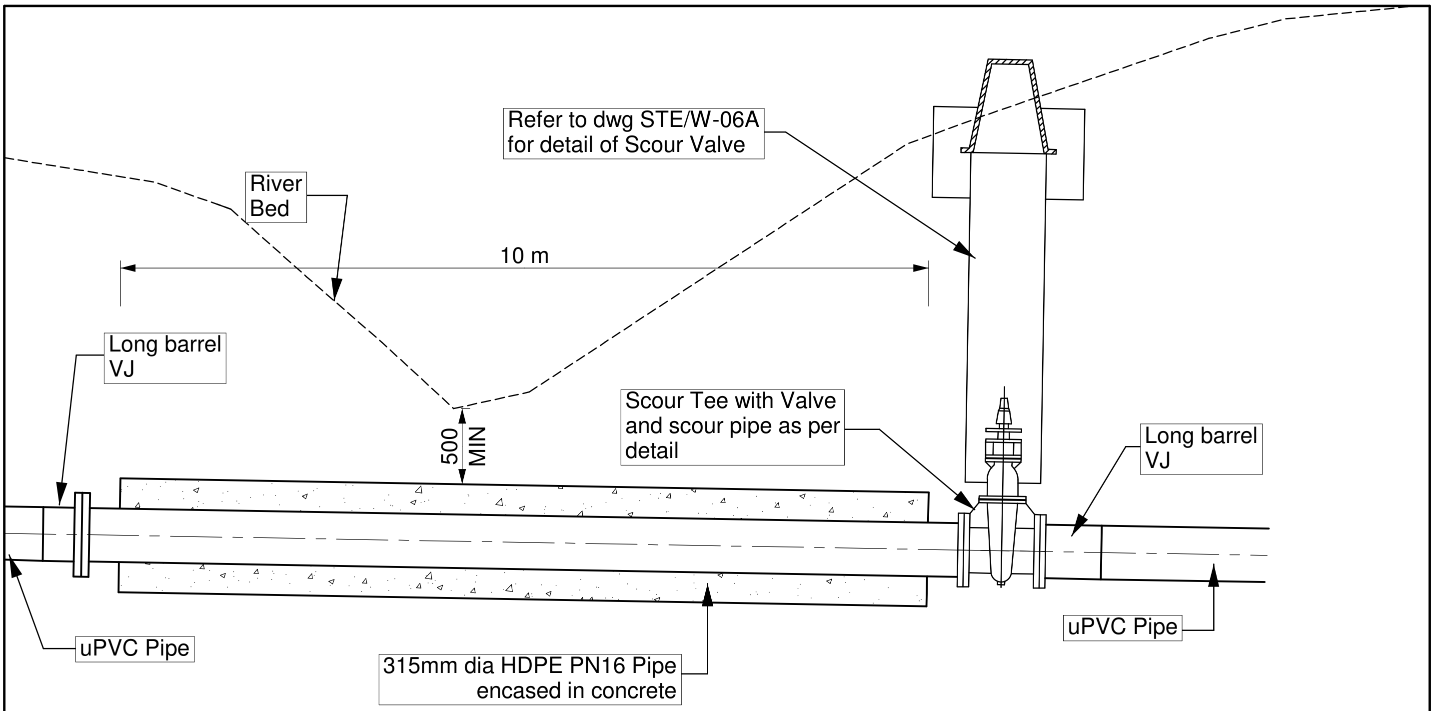
PO Box 757
GEORGE
6530

el: 044 887 0223/Fax: 044 887 0741
email: george@lyners.co.za

TITLE

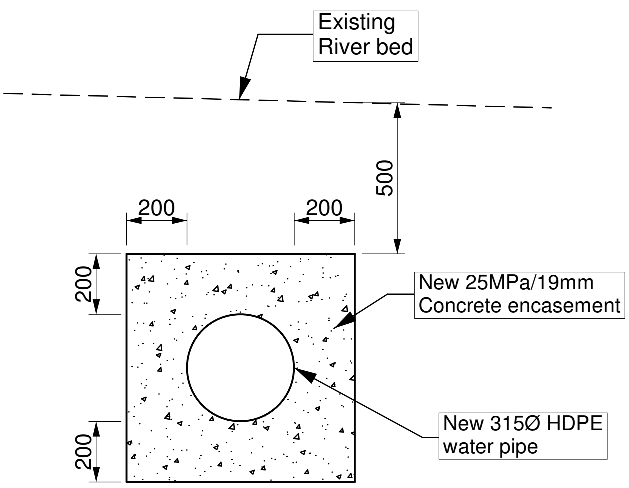
TYPICAL DETAIL OF
ROAD CROSSING

SCALE
N.T.S
DRAWING No.
C20028G-D-01



TYPICAL DETAIL OF RIVER CROSSING
SCALE 1:50
DETAIL 1

NOTE: Contractor to make provision for temporary. Dealing with water during construction in his rates.



RIVER CROSSING CONCRETE ENCASEMENT DETAIL 1
SCALE 1:25

CONSULTING ENGINEERS
PO Box 757
GEORGE
6530
el: 044 887 0223/Fax: 044 887 0741
email: george@lyners.co.za

TITLE	SCALE	DRAWING No.
TYPICAL DETAIL OF RIVER CROSSING	N.T.S	C20028G-D05

CONSTRUCTION NOTES

1. GENERAL

DRAWINGS TO BE READ IN CONJUCTION WITH ALL RELEVANT ARCHITECTURAL DRAWINGS & SPECIFICATIONS. ANY DESCREPANCIES TO BE REPORTED TO THE ENGINEER IMMEDIATELY.

2. SPECIFICATIONS

ALL LATEST EDITIONS:

-SANS 2001 (ALL PARTS)
-SANS 10400 (ALL PARTS)

3. EARTHWORKS

a. ALL EXCAVATIONS & FOUNDATIONS MUST BE INSPECTED & APPROVED BY THE ENGINEER.
b. A 50mm THICK 15MPa MASS CONCRETE BLINDING SHALL BE CAST BELOW ALL REINFORCED FOUNDATIONS. NO BLINDING IS NECESSARY UNDER MASS CONCRETE STRIPFOOTINGS.
c. COMPACTION OF FILL MATERIAL AS SPECIFIED ON DRAWINGS.

4. FOUNDATIONS

a. EXCAVATE TO SPECIFIED FOUNDING LEVELS. IF UNSUITABLE BEARING MATERIAL IS FOUND AT THESE LEVELS, EXCAVATE DEEPER & BACKFILL WITH MASS CONCRETE.
b. MAX. ALLOWABLE BEARING PRESSURE = 150kPa AT APPROX. 1.2m DEPTH FROM N.G.L.

5. CONCRETE

a. CONCRETE CUBE CRUSHING STRENGTH AT 28 DAYS AS FOLLOW:

STRIP FOOTINGS	- 20MPa / 19mm
CONCRETE CAVITY FILL	- 25MPa / 9mm
SURFACE BED	- 30MPa / 19mm
COLUMNS	- 30MPa / 19mm
BEAMS & SLABS	- 30MPa / 19mm

b. ALL REINFORCED CONCRETE TO BE MECHANICALLY COMPACTED / VIBRATED.

6. REINFORCEMENT

a. ALL REINFORCEMENT TO BE INSPECTED & APPROVED BY THE ENGINEER BEFORE CASTING OF ANY CONCRETE. THE ENGINEER SHALL BE NOTIFIED NOT LESS THAN 24h PRIOR TO CONCRETE BEING POURED.
b. MINIMUM COVER TO REINFORCEMENT TO BE MAINTAINED BY CONCRETE BLOCK WITH WIRE TIES OR PVC SPACERS AS FOLLOW:

BASES	(ALL SIDES)	- 50mm
COLUMNS	(TO STIRRUPS)	- 40mm
BEAMS	(TO STIRRUPS)	- 40mm
SLABS	(TOP & BOTTOM)	- 40mm

c. CORRECT COVER TO ALL FIXED REINFORCEMENT WILL STRICTLY BE MONITORED BY THE ENGINEER & WILL BE IMMEDIATELY BE CONDEMNED IF NOT AS SPECIFIED.

7. LOADBEARING BRICKWORK

a. PROVIDE 2 LAYERS OF DPC ON TOP OF ALL LOADBEARING BRICKWORK ON CONTACT SURFACE BETWEEN BRICKS & WET CONCRETE. ANY CAVITIES TO BE CLOSED OFF WITH GALV. STEEL PLATE CAVITY CLOSURES.
b. MINIMUM STRUCTURAL REQUIREMENTS ACCORDING TO SANS 10164:
MORTAR - CLASS II
MASONRY UNITS - 14 MPa
CONCRETE BLOCKS - 3.5 MPa
c. APPROVED BUTTERFLY WALL TIES TO BE USED AT THE FOLLOWING MAXIMUM SPACING IN CAVITY WALLS:
HORIZONTAL -750mm
VERTICAL -340mm

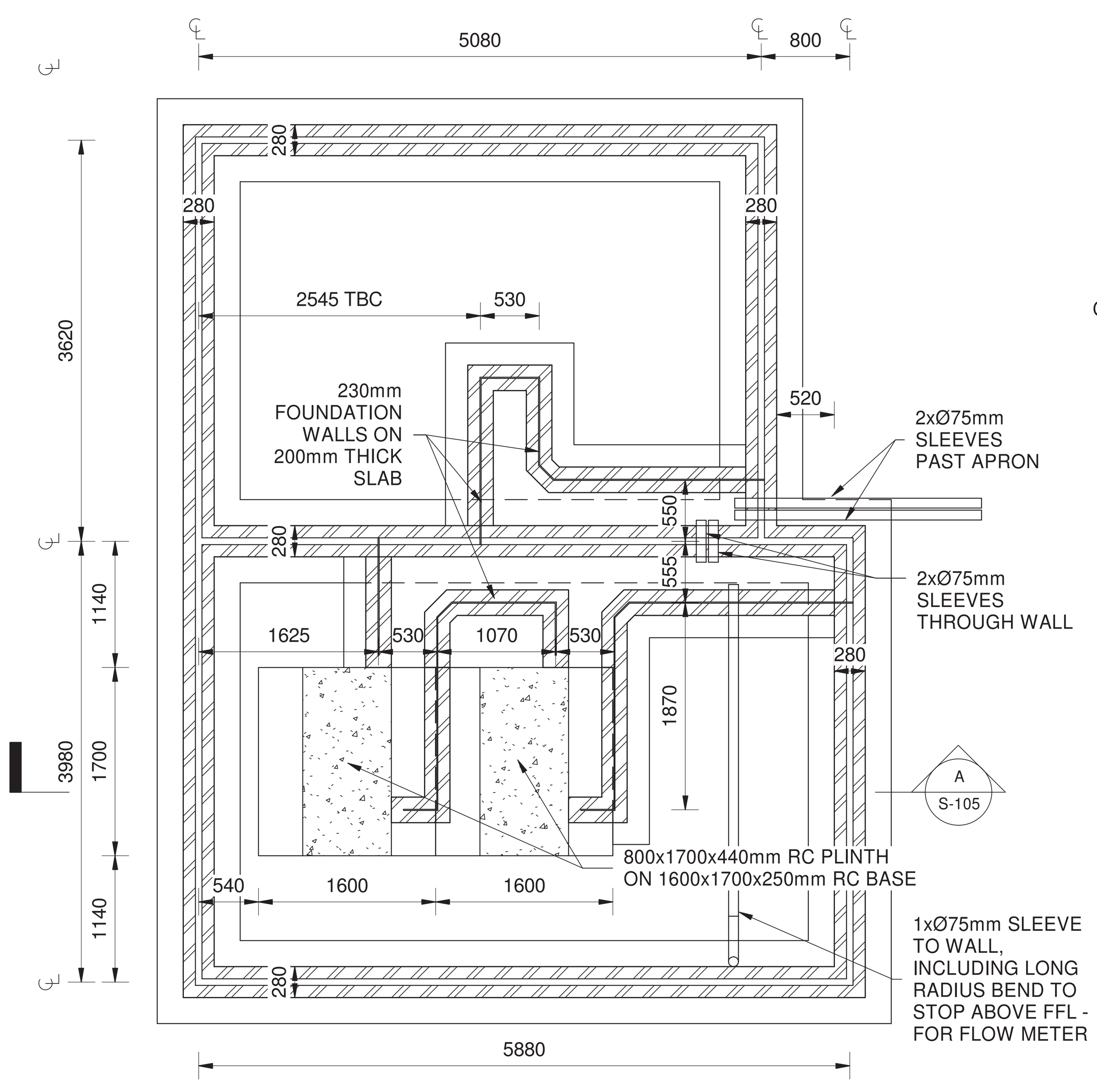
8. STRUCTURAL STEELWORK

a. ALL STRUCTURAL STEEL TO BE GRADE S355JR, INCLUDING PLATES.
b. ALL STEELWORK TO BE HOT DIP GALVANIZED TO SANS 121 AND COATED WITH:
- 1 X COAT ETCHING PRIMER;
- 1 X COAT EPOXY TOP PAINT TO CLIENT COLOUR PREFERENCE.

c. THE CONTRACTOR MUST CONFIRM ALL DIMENSIONS ON SITE, ANY DISCREPANCIES MUST BE REPORTED TO THE ENGINEER IMMEDIATELY.
d. THE CONTRACTOR IS RESPONSIBLE FOR THE STABILITY OF THE STRUCTURE DURING CONSTRUCTION.
e. WORKSHOP DRAWINGS MUST BE APPROVED BY LYNERS BEFORE MANUFACTURING ANY OF THE STRUCTURAL STEEL ELEMENTS. ANY CHANGES TO THE ENGINEER'S DRAWINGS MUST BE INDICATED TO & APPROVED BY THE ENGINEER.
f. ALL WELDED CONNECTIONS MUST BE WELDED ALL AROUND WITH A 6mm FILLET WELD EXCEPT WHERE SHOWN OTHERWISE.
g. WELDING MUST BE IN ACCORDANCE WITH SANS 10044 STANDARDS.
h. ALL BOLTS TO BE GRADE 8.8 EXCEPT WHERE SHOWN OTHERWISE. HOLDING-DOWN BOLTS TO BE COMMERCIAL GRADE THREADED BAR. ALL FASTENERS SHALL BE HOT DIP GALVANIZED.

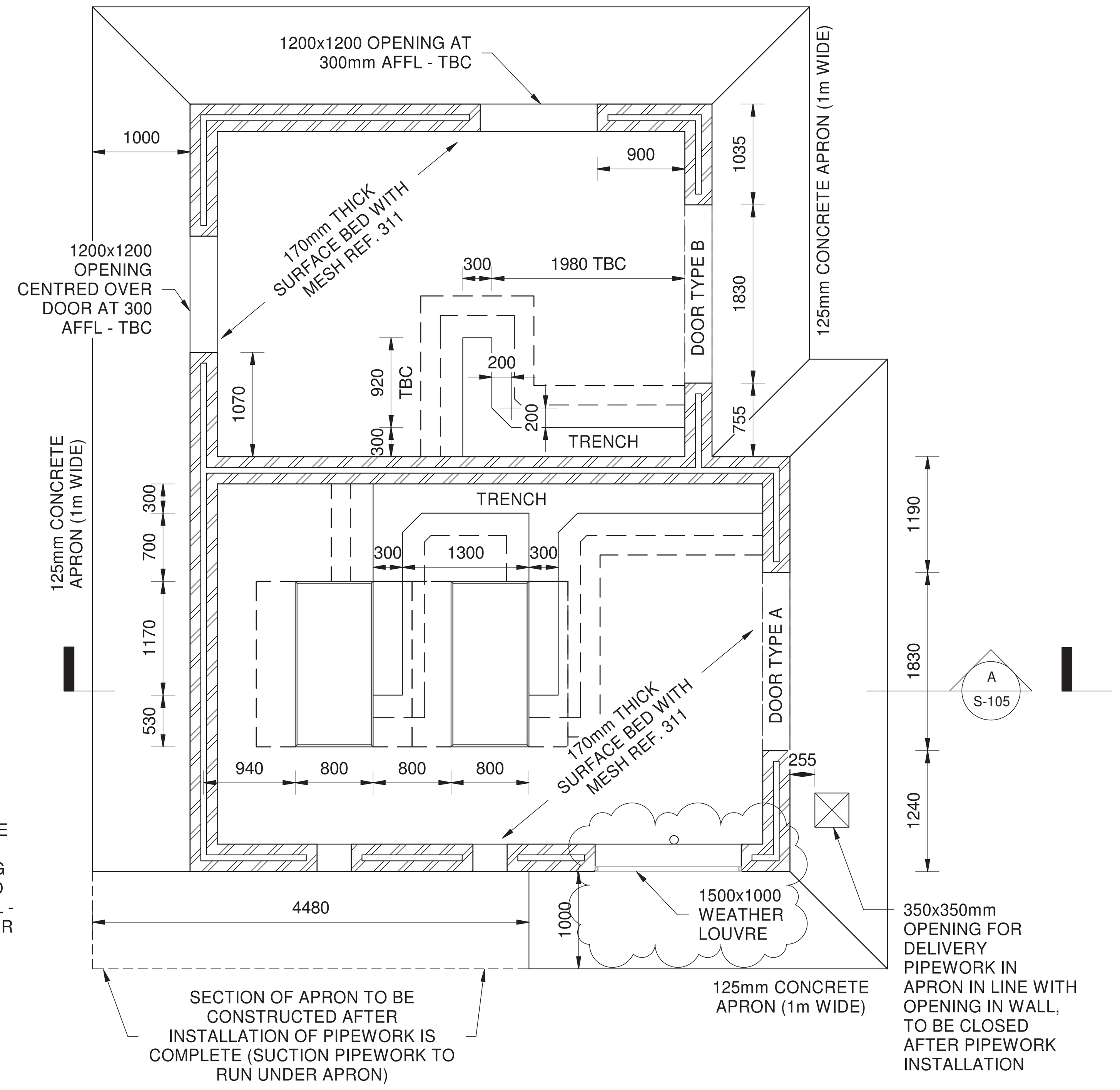
9. MISCELLANEOUS ITEMS

a. WHERE APPLICABLE, ALL CHEMICAL ANCHORS TO BE INSTALLED STRICTLY IN ACCORDANCE WITH SUPPLIER'S INSTRUCTIONS & GOOD PRACTICE GUIDELINES.
b. SUPPLIERS OF PRECAST SLABS SHALL PROVIDE THE ENGINEER WITH A SANS 10400 FORM 3.



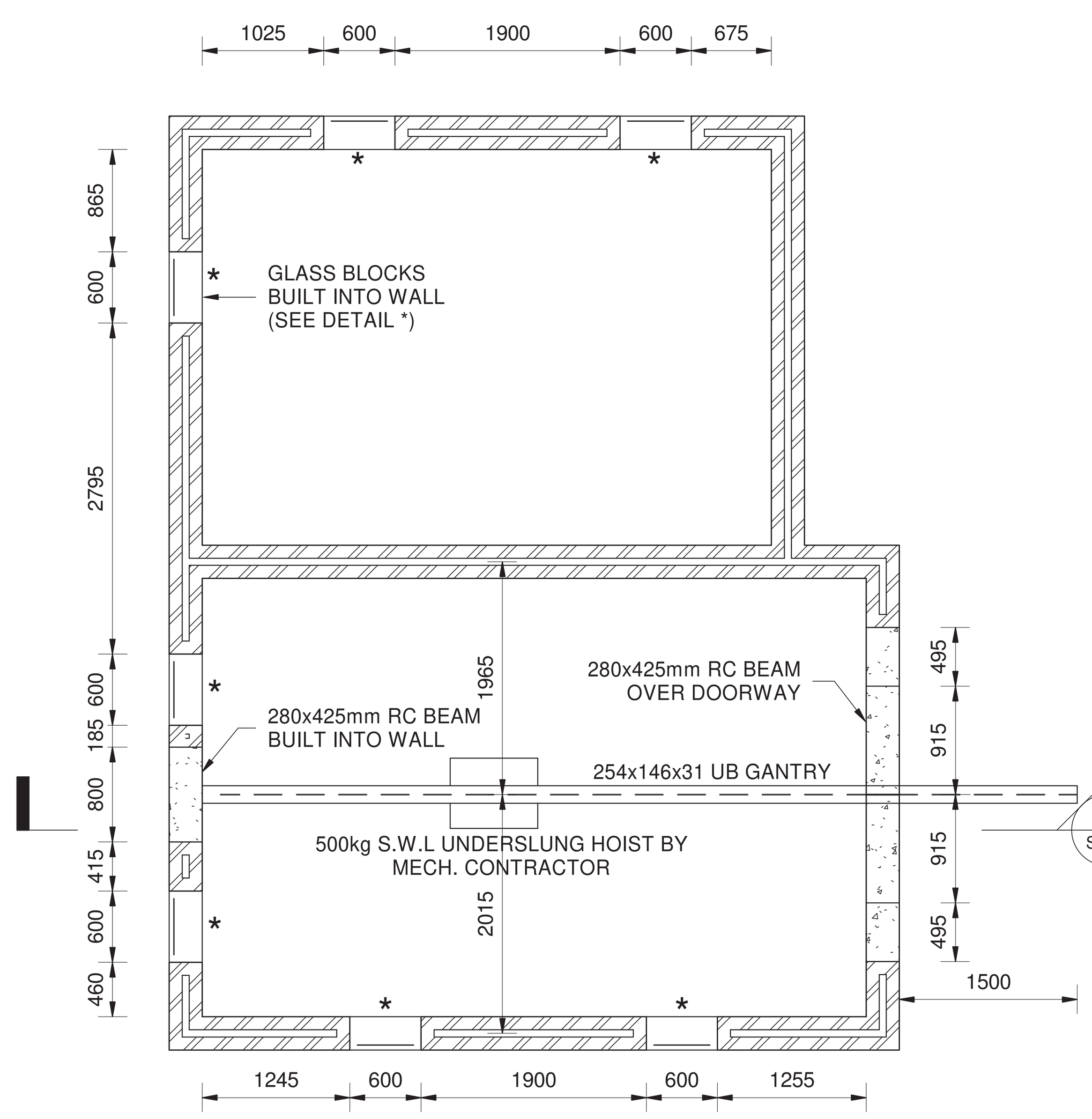
FOUNDATION LAYOUT

SCALE 1 : 50



SURFACE BED LAYOUT

SCALE 1 : 50

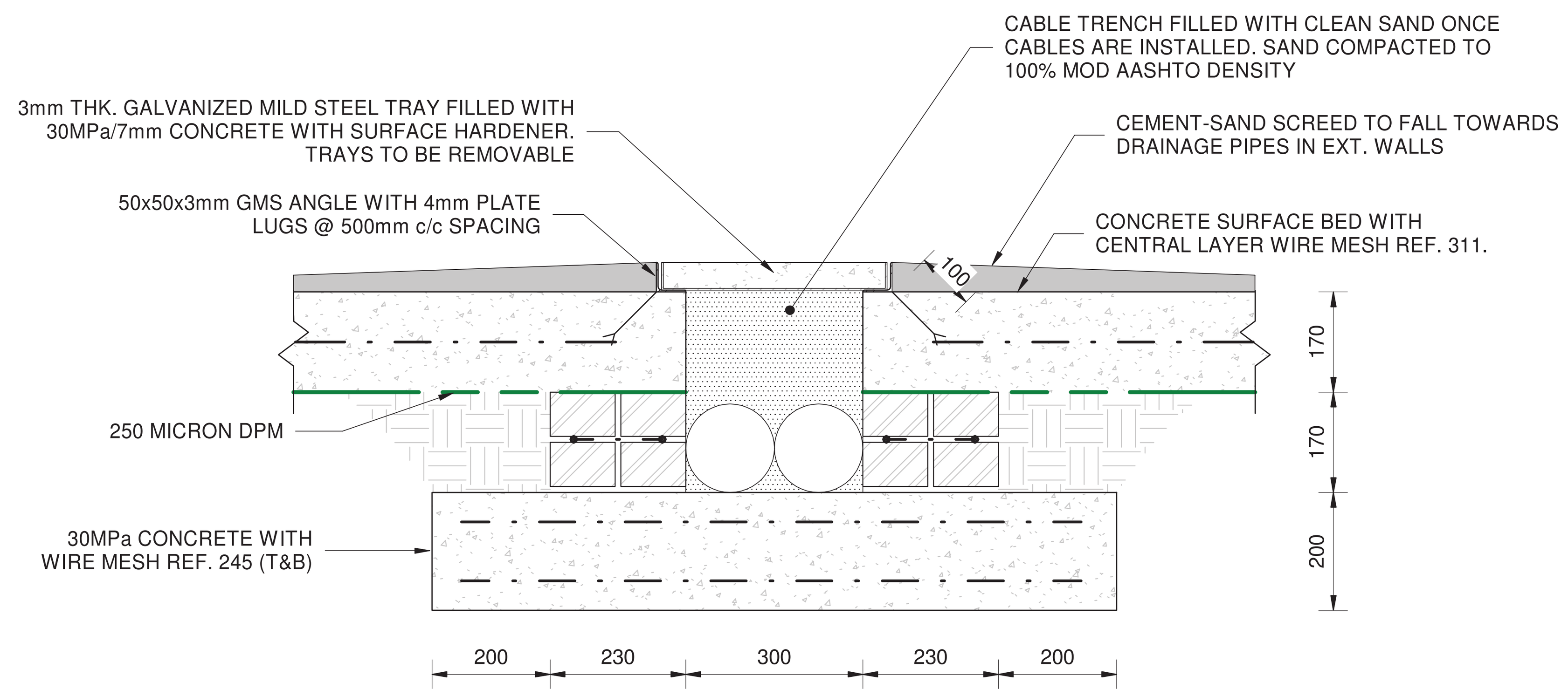


PLAN ON GANTRY

SCALE 1 : 50

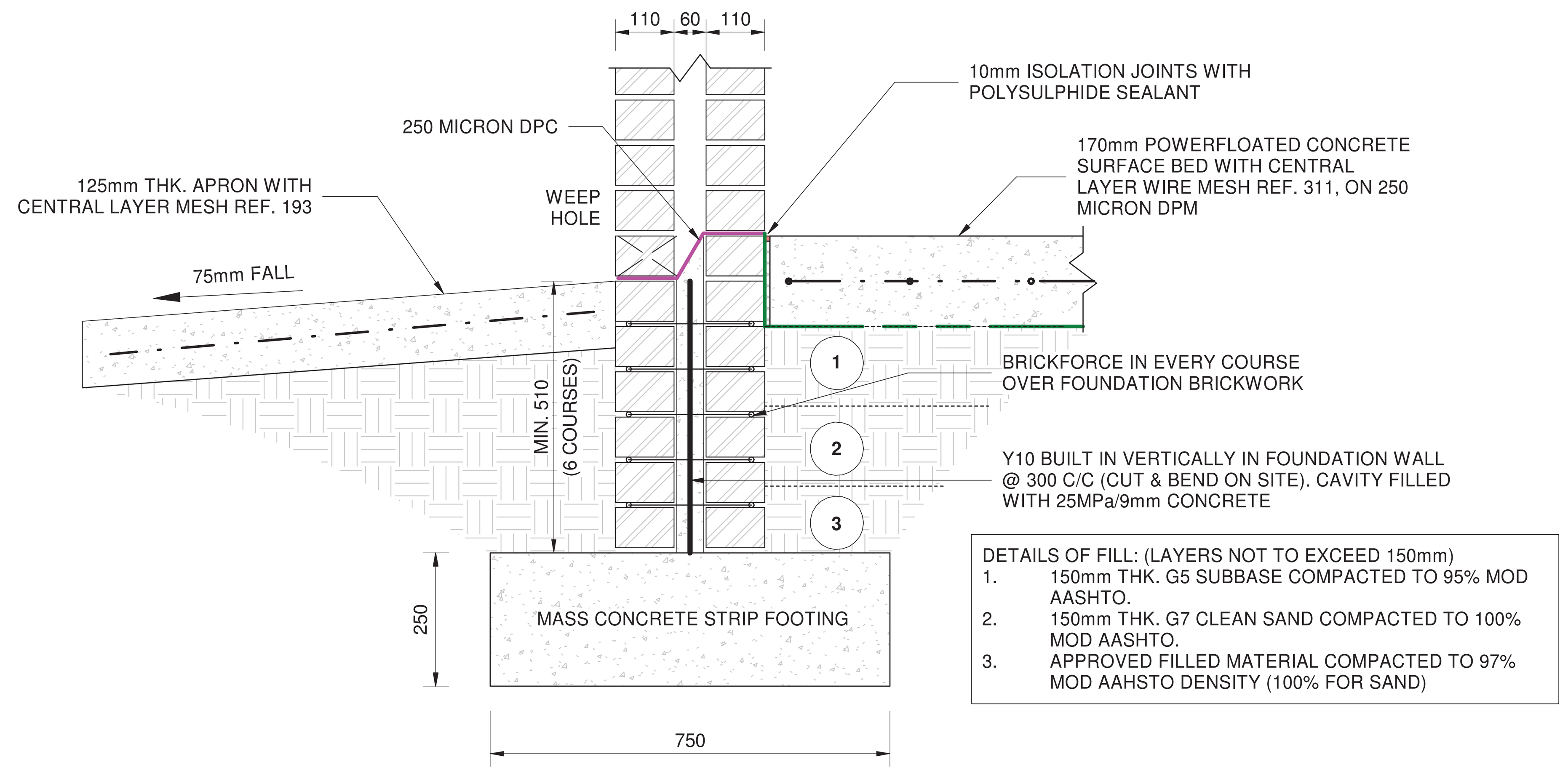
NOTE:

FINAL DIMENSIONS & LOCATIONS OF OPENINGS CAN ONLY BE CONFIRMED ONCE WORKSHOP DRAWINGS ARE RECEIVED FROM THE MECHANICAL / ELECTRICAL CONTRACTOR.



TYP. SECTION: CABLE TRENCH

SCALE 1 : 10



TYP. SECTION: 280mm EXTERNAL WALLS

SCALE 1 : 10

The reference made to Engineer will also refer to Employer's Agent for GCC 2015 Contracts

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REV	DESCRIPTION	DATE	REV BY	CHKD
0	Preliminary Design	'21-04-12	JDB	LB

REVISIONS

DESIGNED	JDB
DRAWN	JDB
CHECKED	LB

CONSULTING ENGINEERS
LYNERS
PO BOX 4901
TYGERVALLEY
7530
Tel: 021 914 0300
Fax: 021 914 0437
email: bellville@lyners.co.za

APPROVED:
ENGINEERS:
DATE:

APPROVED:
CLIENT:
DATE:

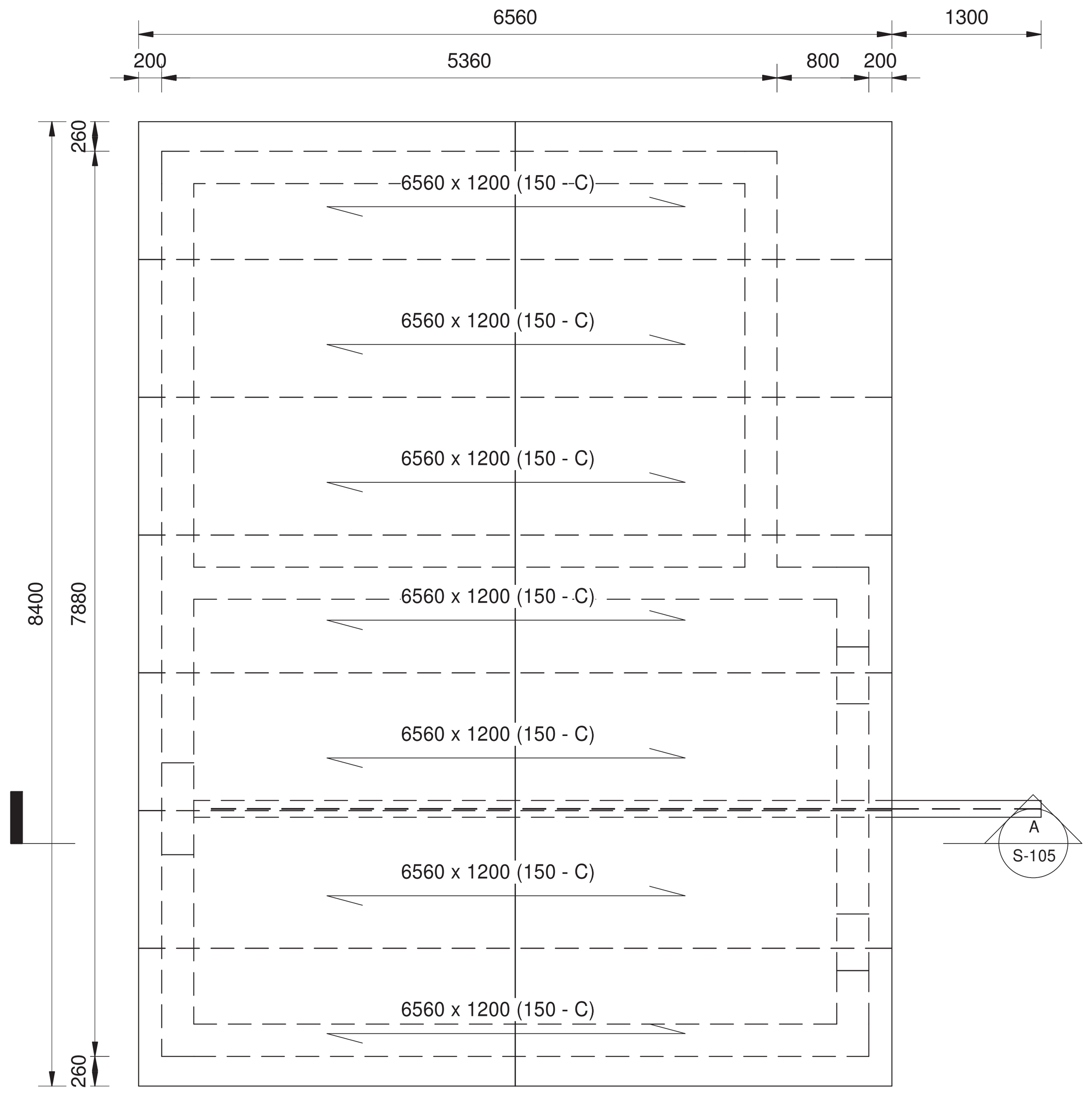
CLIENT:
Bitou municipality — to be the best together

PROJECT NAME
KURLAND BULK WATER SUPPLY

TITLE
KURLAND PUMPSTATION
LAYOUTS AND DETAILS 1

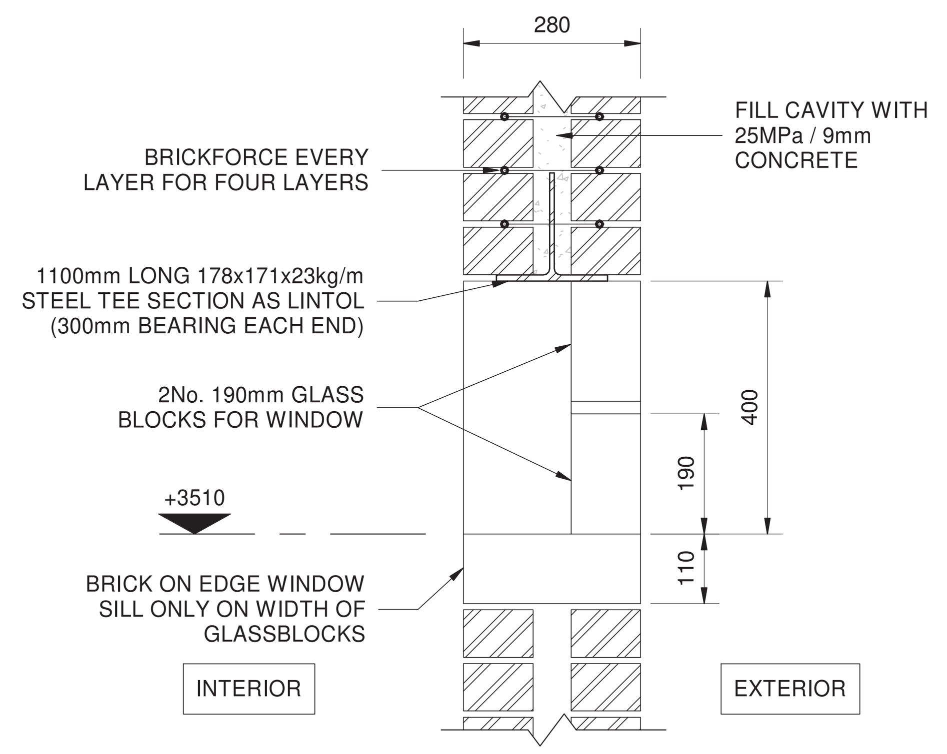
SCALE ON A1: As indicated
SHEET
CONTRACT NO
PROJECT NO: 20028
DRAWING NO: 20028-S-104
REV NO: 2
COORDINATE SYSTEM:

U:\Werke\1700\17094 CG - Kranshoek Pump Station Upgrade\Drawings\1.2 Active\Kranshoek Pumpstation.rvt



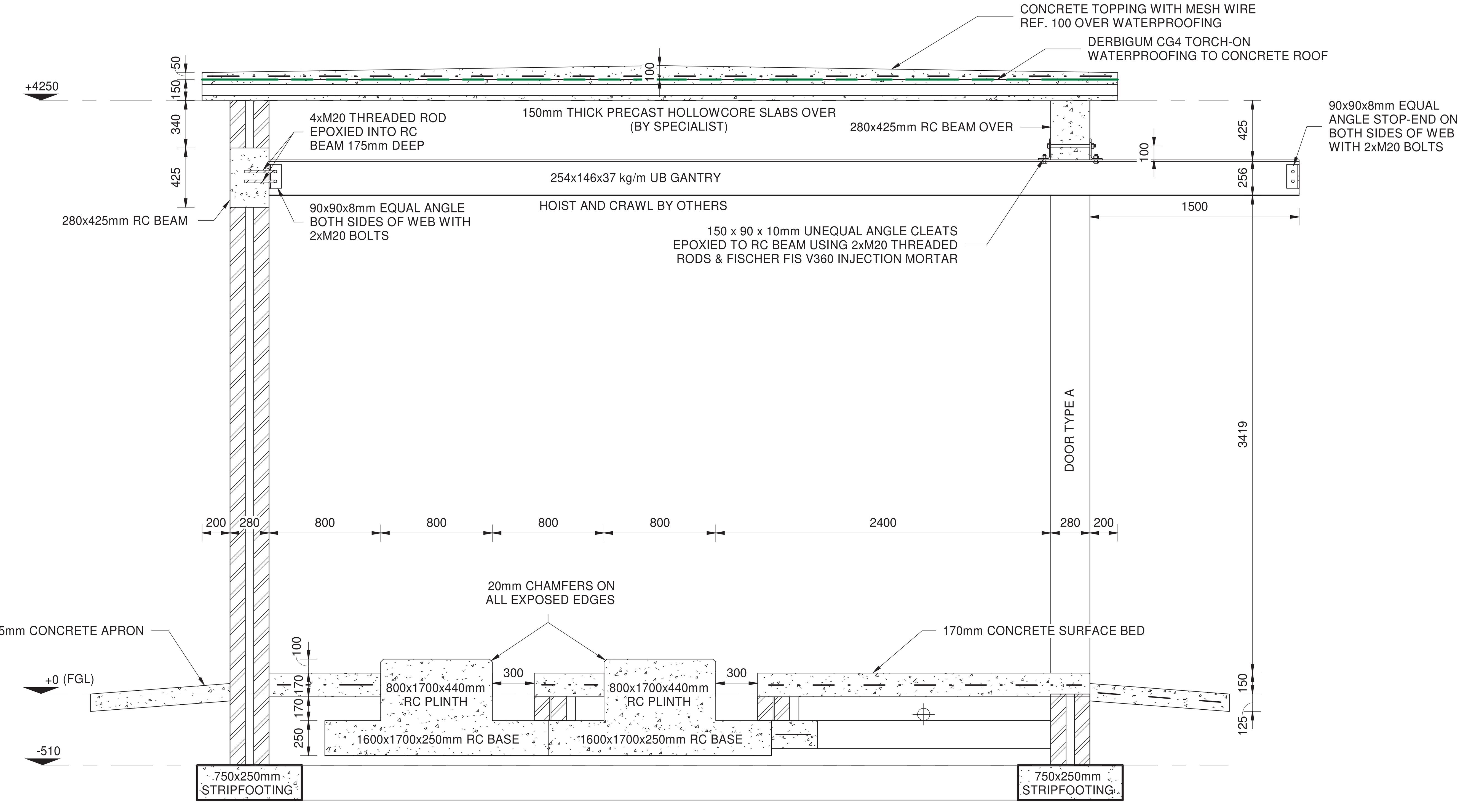
ROOF LAYOUT

SCALE 1 : 50



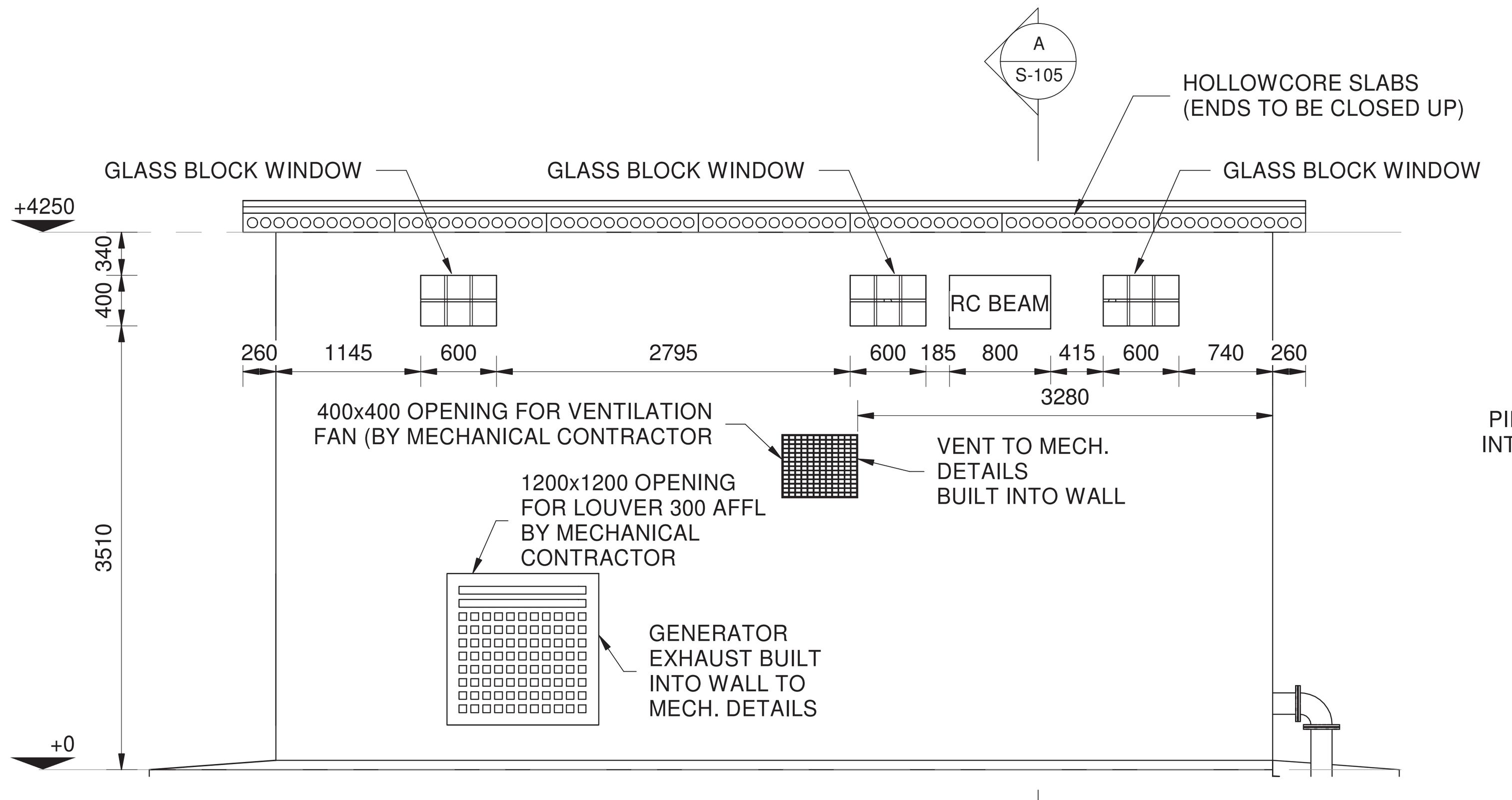
TYP. SECTION THROUGH GLASS BLOCK WINDOW

SCALE 1 : 10



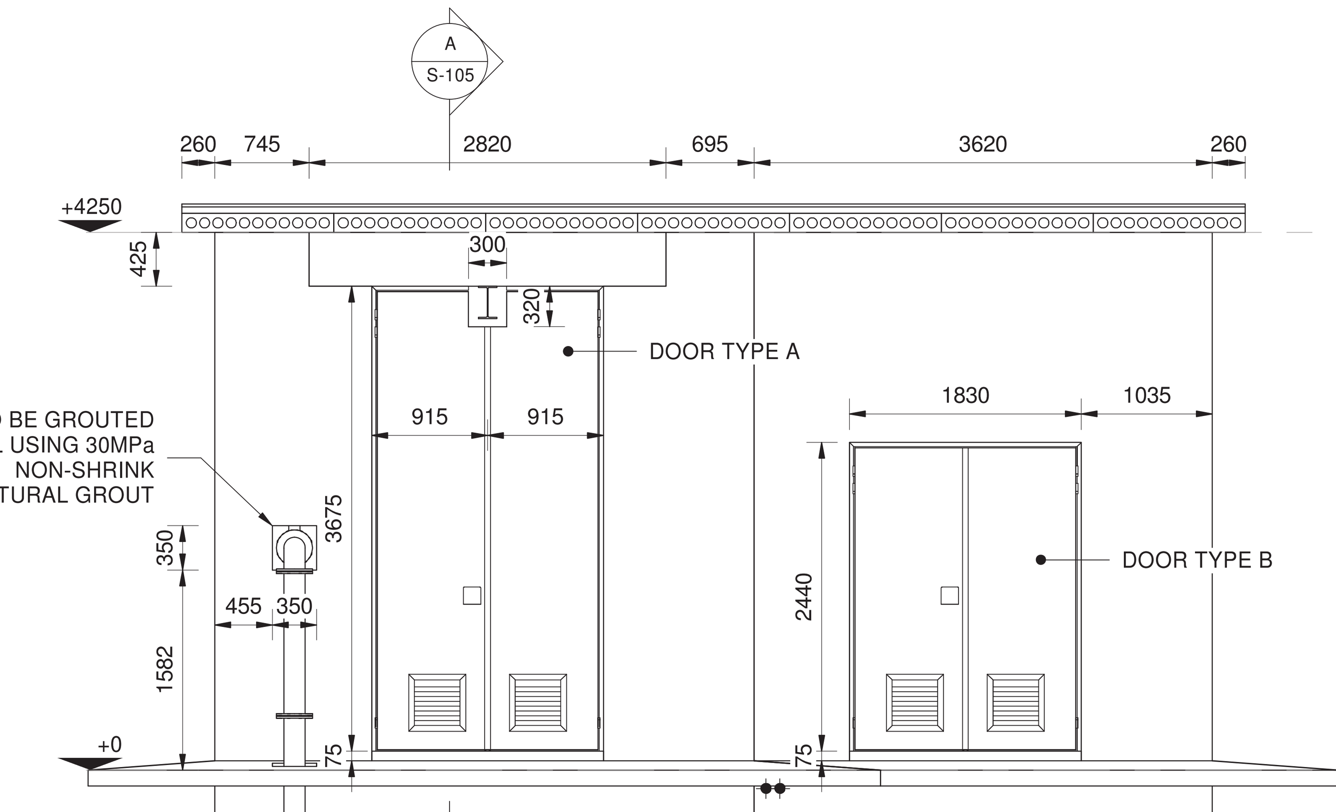
SECTION A-A

SCALE 1 : 25



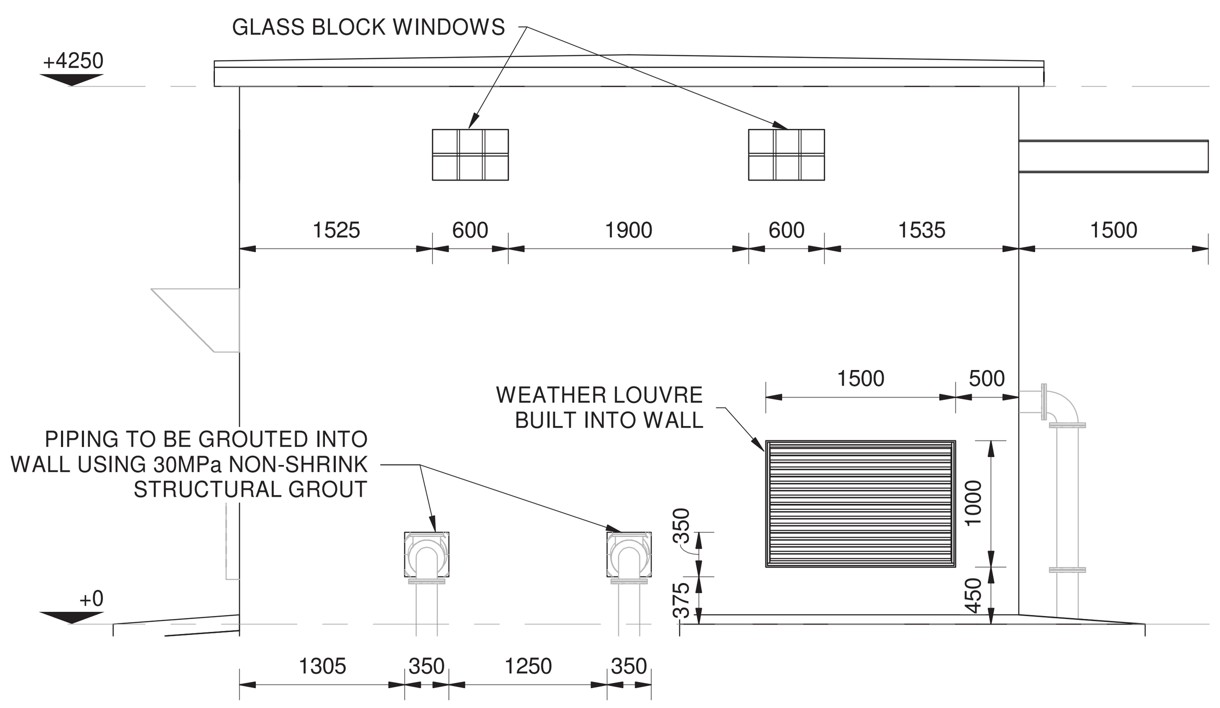
BACK ELEVATION

SCALE 1 : 50



FRONT ELEVATION

SCALE 1 : 50



LEFT ELEVATION

SCALE 1 : 50

NOTE:

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DOOR SPECS:

TYPE A: 1830x3675mm PURPOSE MADE GALVANIZED MILD STEEL DOUBLE DOOR WITH OPENING FOR GANTRY BEAM
TYPE B: 1830x2440mm GALVANIZED MILD STEEL DOUBLE DOOR

GENERAL REQUIREMENTS:
- MIN. 32x32x2mm SQUARE STEEL TUBE FRAME AND INTERIOR SUPPORTS
- MIN. 2mm THICK STEEL PLATE SHEETING
- 2 x BOTTOM WEATHER LOUVRES (±360x360mm EACH)
- BOTTOM LOCKPAD/DROPLOCK TO LOCK INTO CONCRETE
- LOCKBOX WITH HANDLE ON INTERIOR SIDE WITH LATCH LOCK
- MIN. 20mm HINGES
- HOT DIP GALVANIZED AND PAINTED WITH:
  - 75 MICRON EPOXY PRIMER, PLUS
  - 75 MICRON POLYURETHANE TOPCOAT (GREY)

The reference made to Engineer will also refer to Employer's Agent for GCC 2015 Contracts

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0	Preliminary Design	'21-04-12	JDB	LB

REVISIONS

DESIGNED	JDB
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CHECKED	LB

CONSULTING ENGINEERS

LYNERS

PO BOX 4901
TYGERVALLEY
7530

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Fax: 021 914 0437
email: bellville@lyners.co.za

APPROVED:
ENGINEERS:
DATE:

APPROVED:
CLIENT:
DATE:

CLIENT: Bitou municipality — to be the best together

PROJECT NAME
KURLAND BULK WATER SUPPLY

TITLE
KURLAND PUMPSTATION
LAYOUTS AND DETAILS 2

SCALE ON A1: As indicated
SHEET
CONTRACT NO
PROJECT NO: 20028
DRAWING NO: 20028-S-105
REV NO: 1
COORDINATE SYSTEM:

U:\Werke\1700\17094 CG - Kranshoek Pump Station Upgrade\Drawings\1.2 Active\Kranshoek Pumpstation.rvt

SCALE FOR REDUCED PLAN

0 10 20 30 40 50 60 70 80 90 100

100mm ON ORIGINAL PLAN

Notes

THIS DRAWING TO BE READ WITH ALL OTHER APPLICABLE DRAWINGS AND SPECIFICATIONS

SPECIFICATIONS:

a) ALL CONCRETE WORK TO COMPLY WITH SABS 1200 G
b) ALL STRUCTURAL STEEL WORK TO COMPLY WITH SABS 1200 H
c) ALL EARTH WORKS TO COMPLY WITH SABS 1200 D

EARTH WORKS (SPEC. SABS 1200 D)

a) ALL EXCAVATIONS AND FOUNDATIONS TO BE APPROVED BY THE ENGINEER.
b) NO FOUNDING ALLOWED ON FILL MATERIAL. EXCAVATE TO FOUNDING DEPTHS SHOWN. IF NO SUITABLE BEARING MATERIAL IS FOUND AT THIS DEPTH EXCVATE DEEPER AND FILL WITH 20 MPa/19mm MASS CONCRETE AS AGREED AND INSTRUCTED BY THE ENGINEER.
c) COMPACTION OF FILL MATERIAL AS SPECIFIED.

CONCRETE (SPEC. SABS 1200 G)

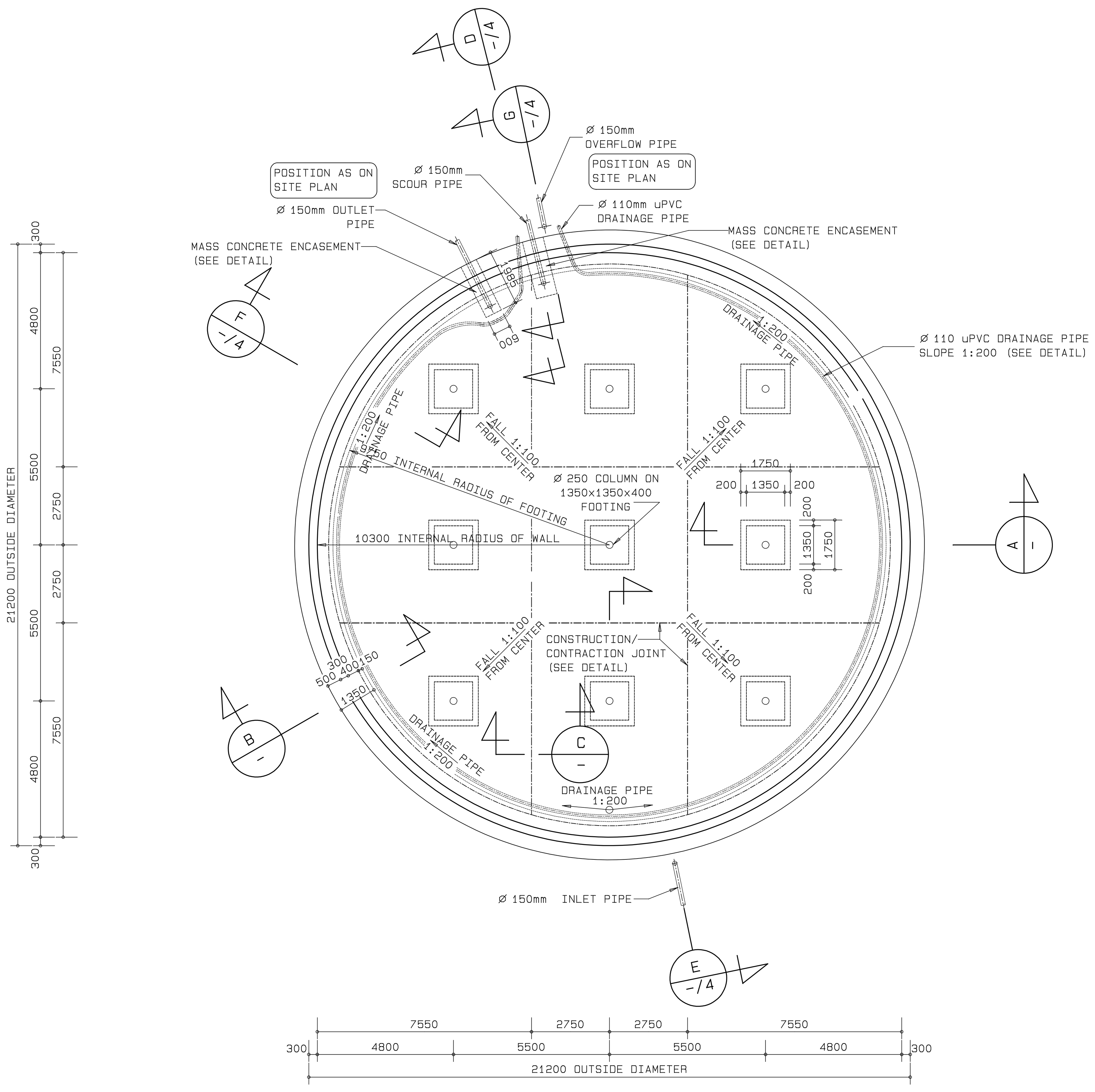
a) A MIXTURE (ACCORDING MASS) OF 50% CEMENT, ACCORDING CLAUSE PSG 3.2.1 OF SPECIFICATION AND 50% GROUNDED SLAGMENT TO BE USED IN ALL REINFORCED CONCRETE
b) GRADE OF CONCRETE STRENGTH AND THE MAXIMUM NOMINAL SIZE OF THE STONE AGGREGATE FOR EACH PART OF THE WORKS TO BE AS FOLLOWS:

MASS CONCRETE AND SCREED	-CLASS 20/19
COLUMNS AND FOOTING	-CLASS 30/19
WALL AND FOOTING	-CLASS 30/19
FLOOR SLAB	-CLASS 30/19
ROOF SLAB	-CLASS 30/19

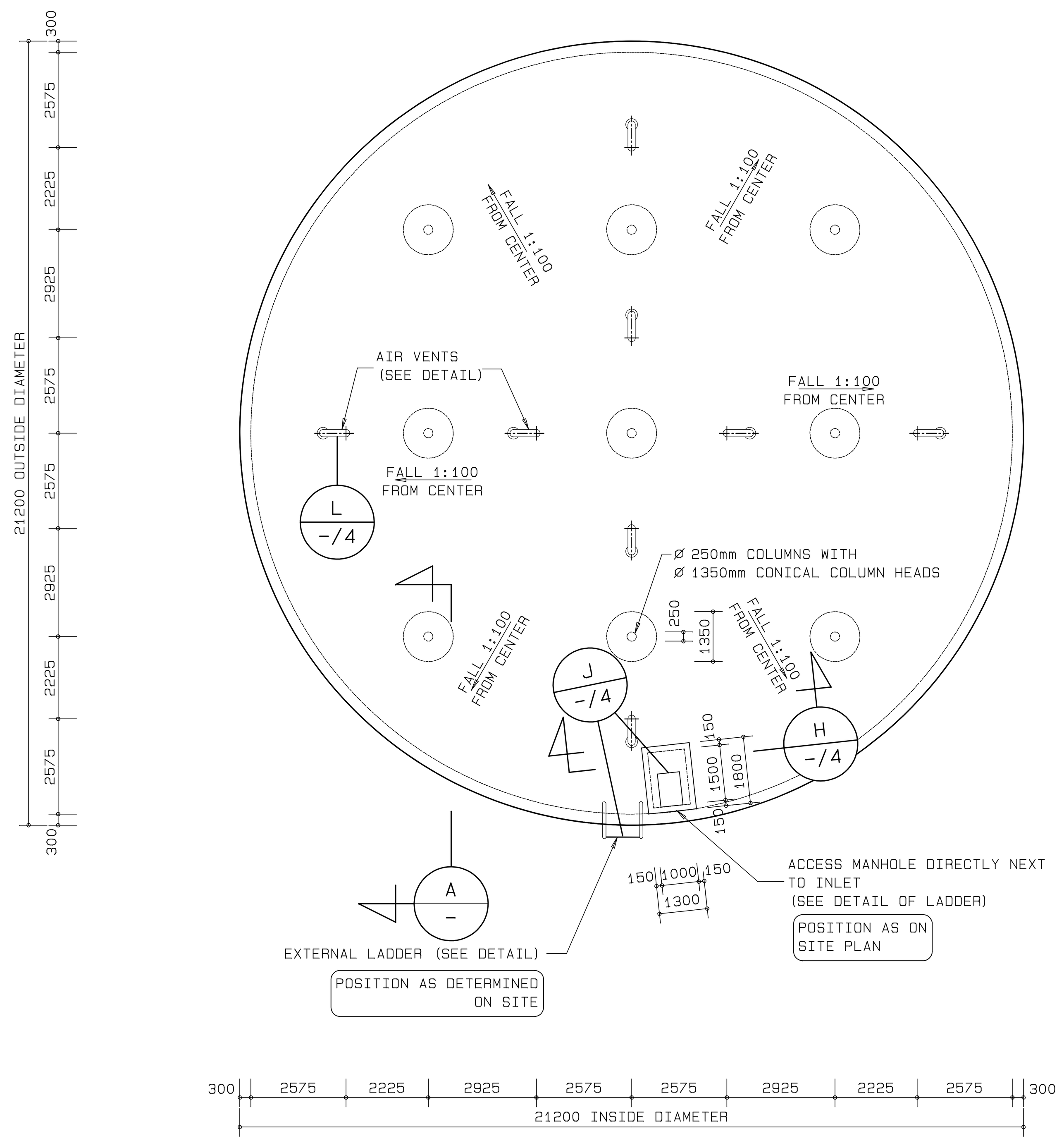
REINFORCEMENT

a) ALL REINFORCEMENT TO BE APPROVED BY THE ENGINEER BEFORE CONCRETE IS CAST. THE ENGINEER MUST BE GIVEN AT LEAST 48 HOURS NOTICE.
b) MINIMUM COVER TO REINFORCEMENT MUST BE PROVIDED BY MEANS OF PVC SPACERS AS FOLLOW:

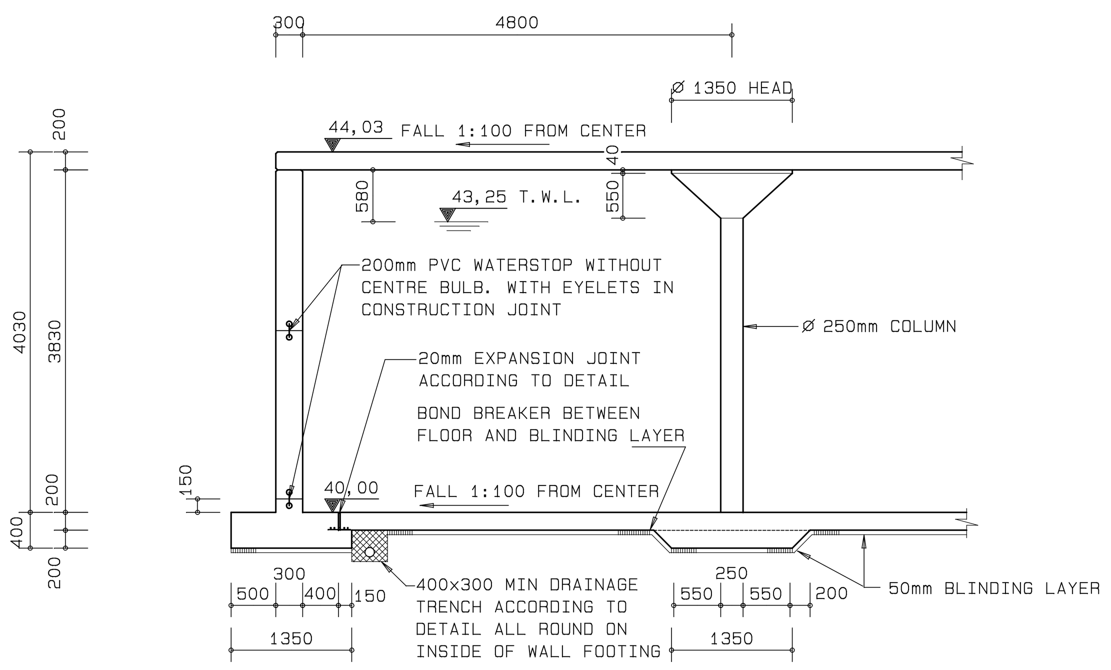
FOOTINGS	-BOTTOM	-75mm
	-SIDES	-50mm
COLUMNS	-STIRRUPS	-40mm
	-MAIN REINFORCEMENT	-50mm
ROOF SLAB	-BOTTOM	-40mm
	-TOP	-30mm
WALLS	-INSIDE	-40mm
	-OUTSIDE	-40mm



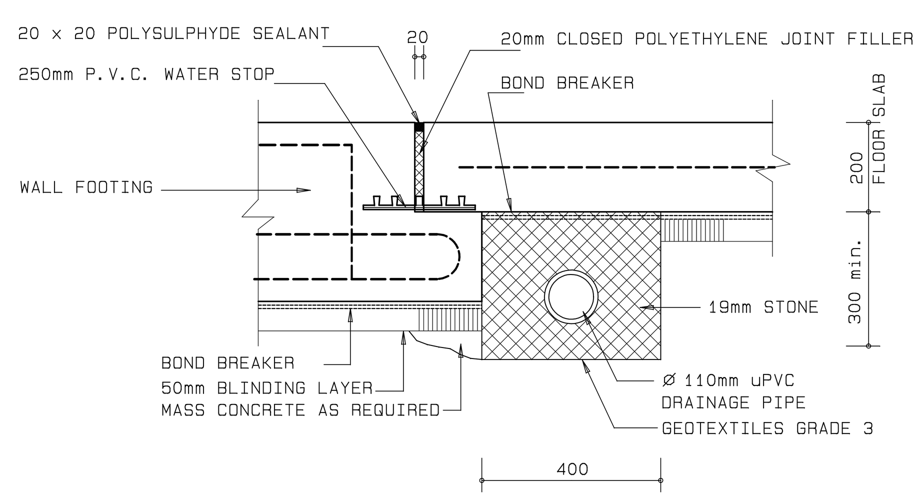
FLOOR PLAN
SCALE 1:100



ROOF PLAN
SCALE 1:100

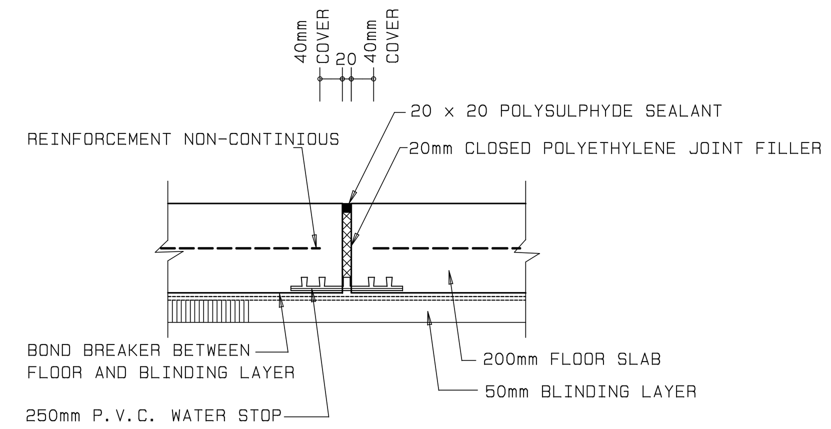


SECTION A
SCALE 1:50



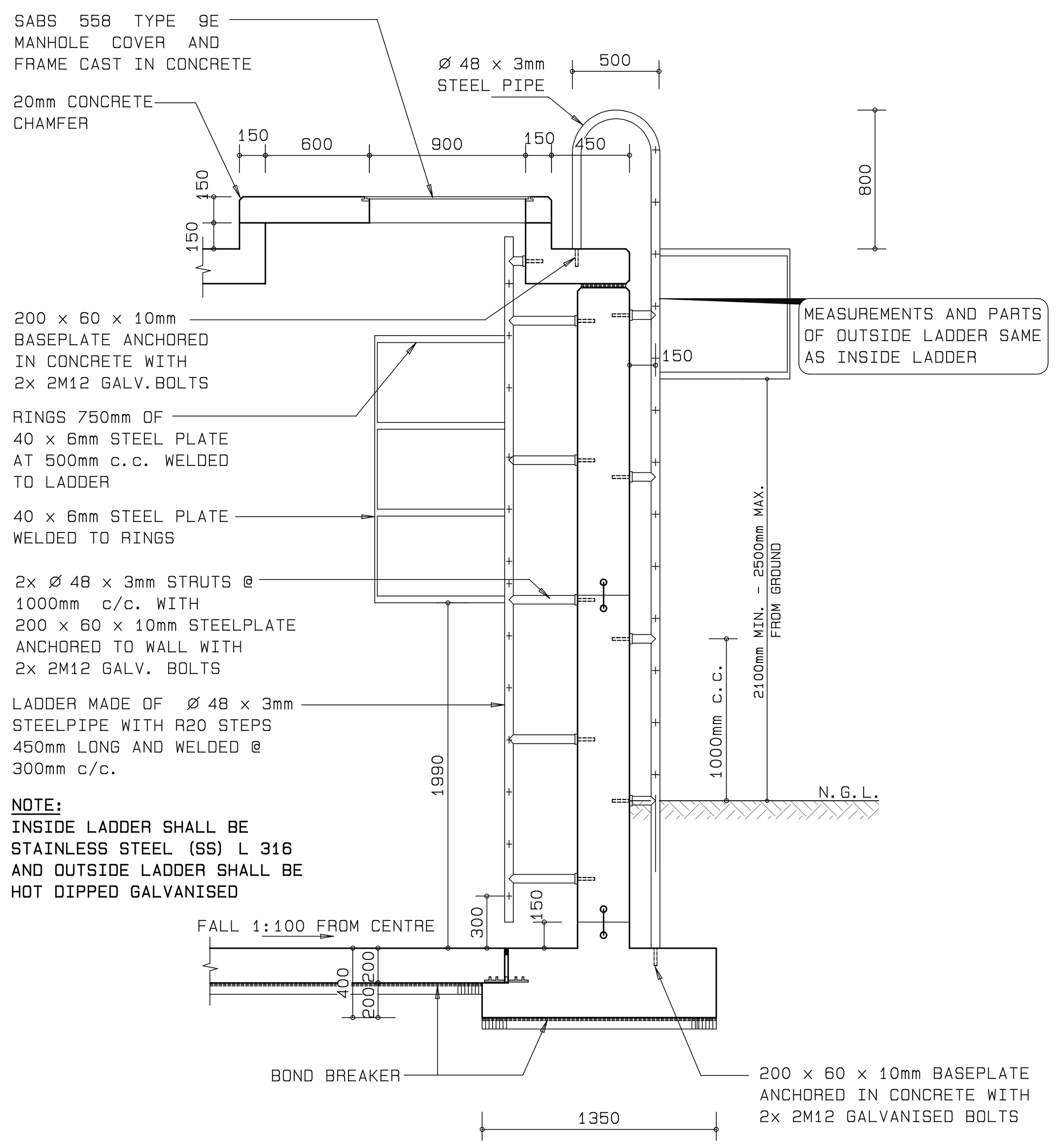
TYPICAL SECTION OF DRAINAGE TRENCH

SECTION B
SCALE 1:10



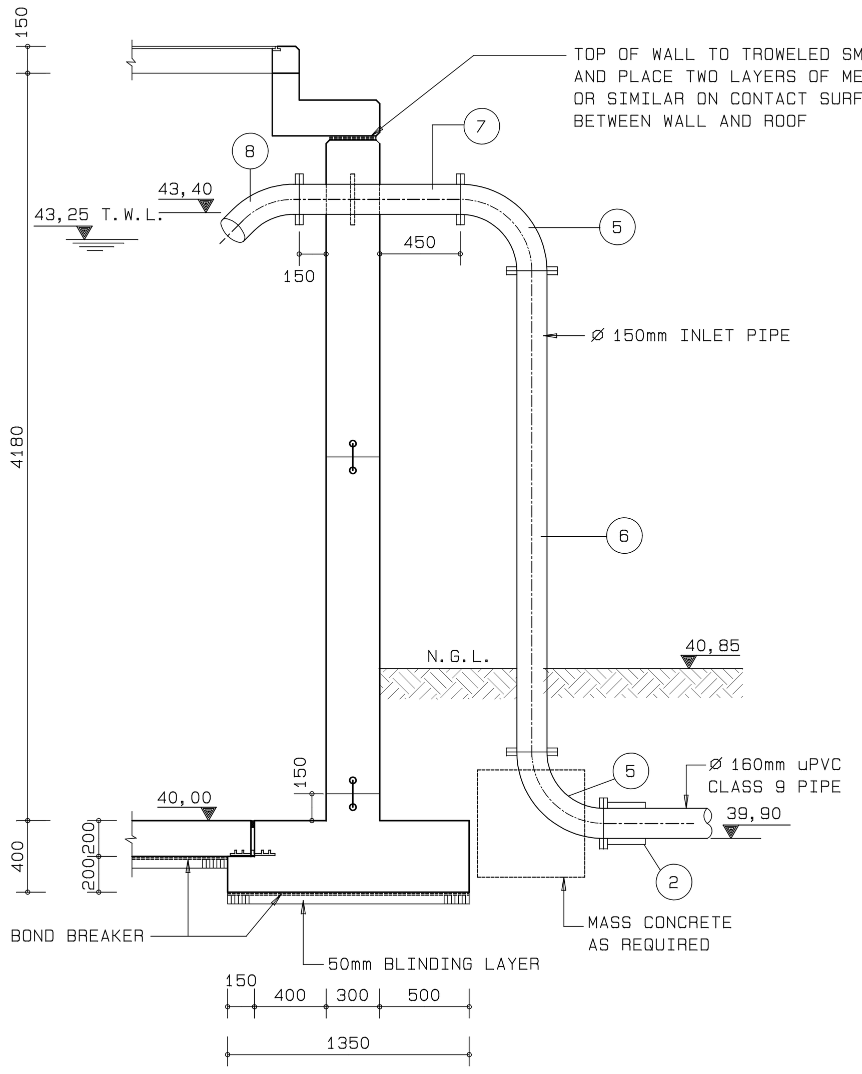
TYPICAL EXPANSION JOINT

SECTION C
SCALE 1:10



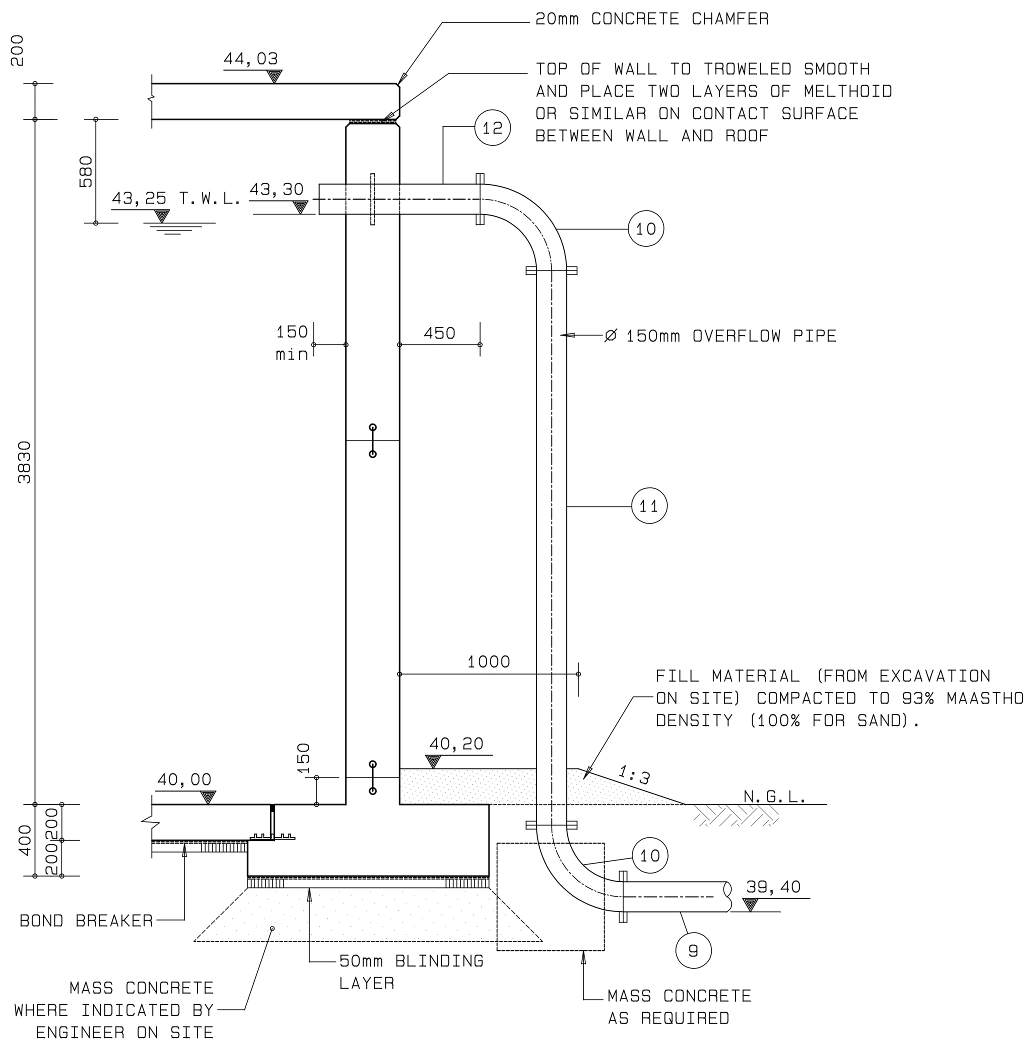
DETAIL OF LADDERS

SECTION J -/3
SCALE 1:25



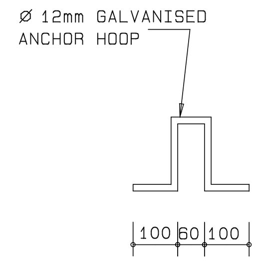
SECTION THROUGH INLET PIPE

SECTION E -/3
SCALE 1:25

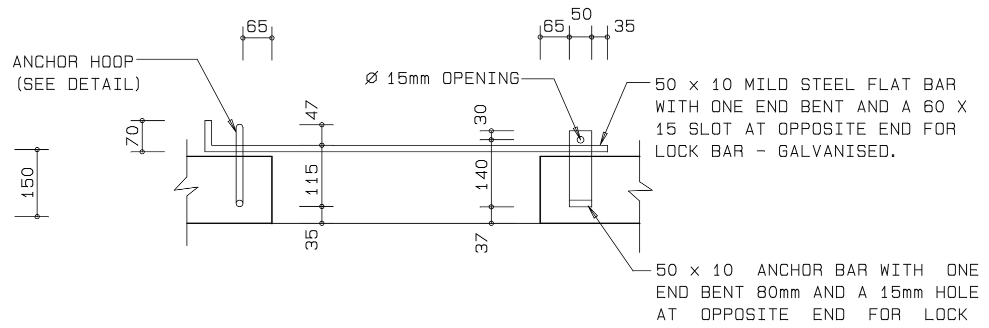


SECTION THROUGH OVERFLOW PIPE

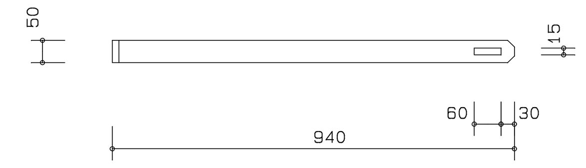
SECTION G -/3
SCALE 1:25



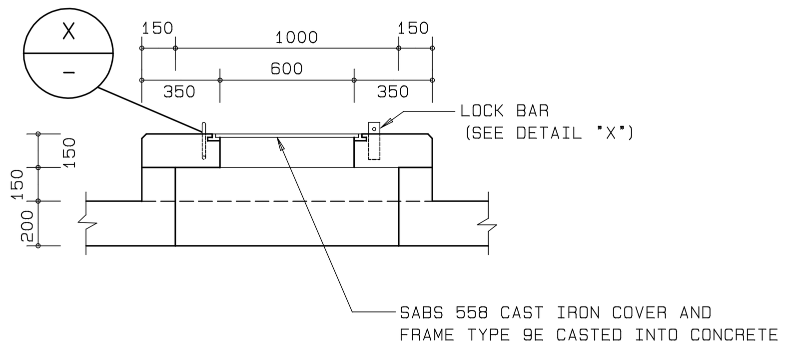
ANCHOR HOOP DETAIL
SCALE 1:10



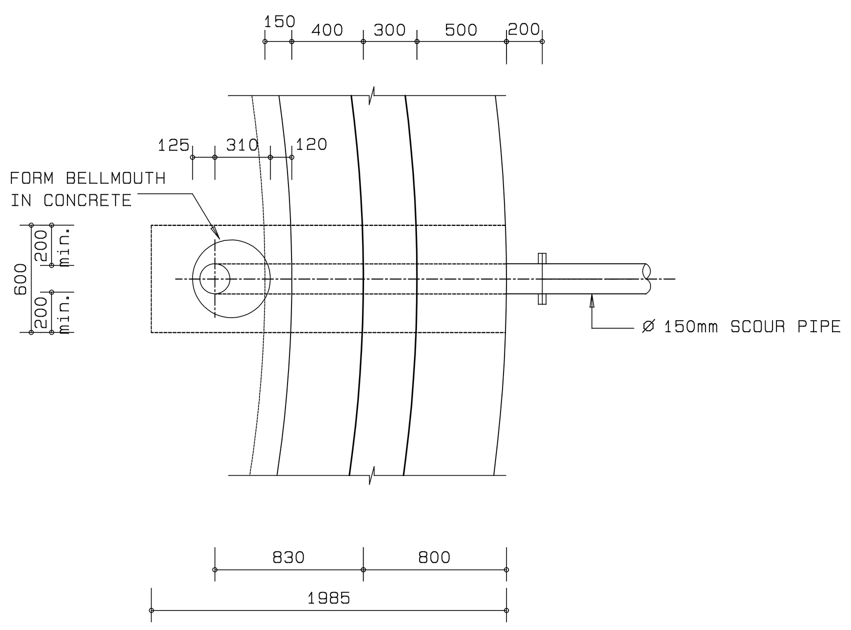
DETAIL X -
SCALE 1:10



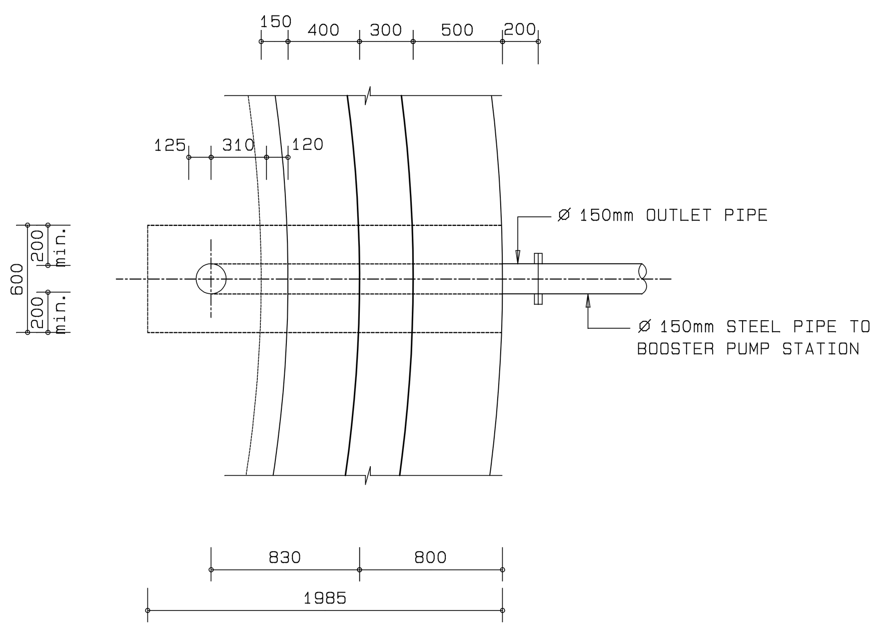
LOCK BAR DETAIL
SCALE 1:10



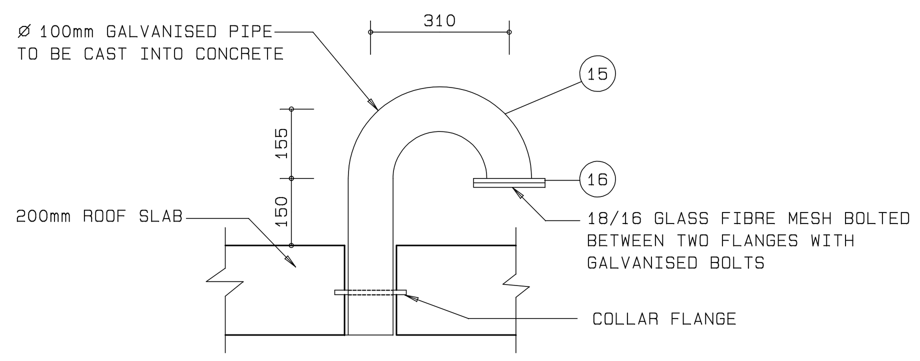
SECTION H -/3
SCALE 1:10



PLAN OF SCOUR PIPE
SCALE 1:25

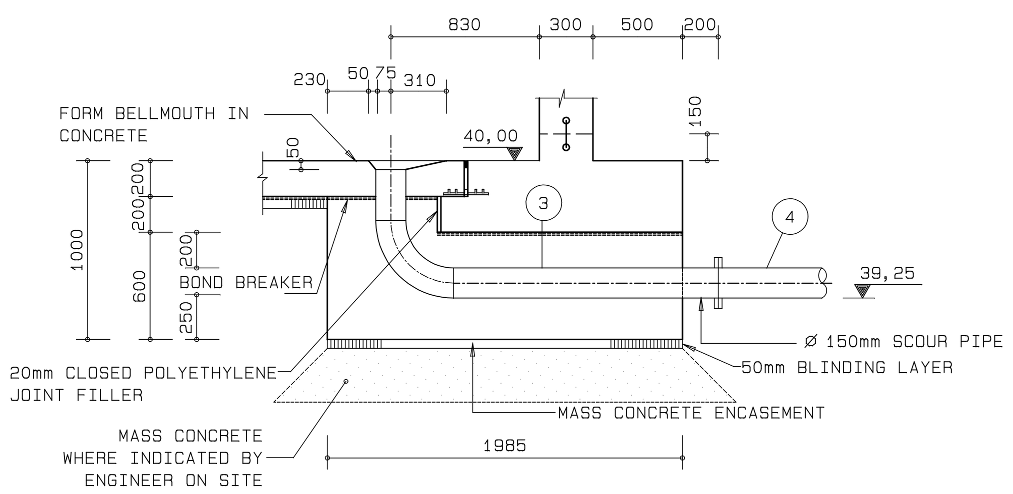


PLAN OF OUTLET
SCALE 1:25



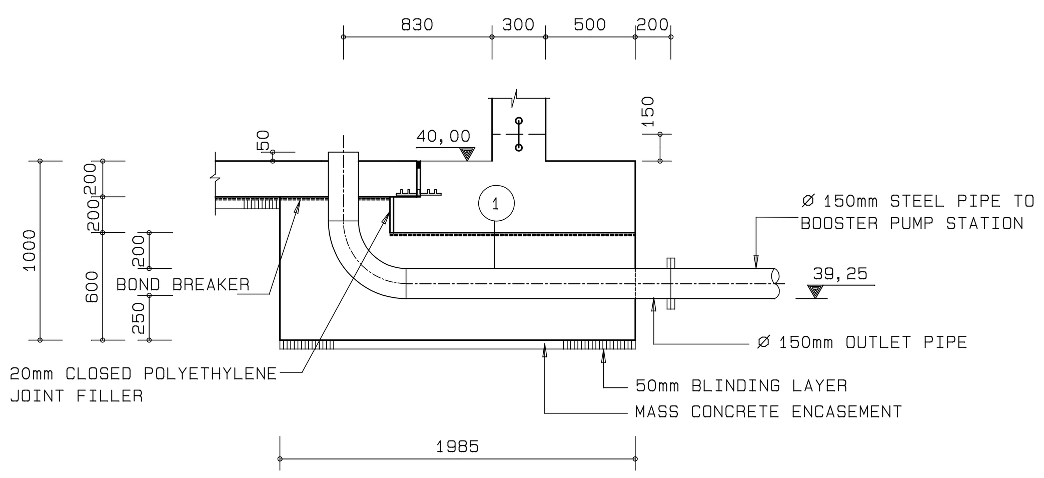
DETAIL OF AIR VENTS (8 OFF)
SCALE 1:10

SECTION L -/3
SCALE 1:25



SECTION THROUGH SCOUR PIPE

SECTION D -/3
SCALE 1:25



SECTION THROUGH OUTLET PIPE

SECTION F -/3
SCALE 1:25

Notes

STANDARD OF CONCRETE FINISHES

a) CLASSIFICATION OF THE CONCRETE FINISHES IS AS SPECIFIED.
b) ALL UNFORMED CONCRETE SURFACES TO BE WOOD FLOAT FINISHED UNLESS OTHERWISE SHOWN.
c) ALL UNFORMED CONCRETE BEARING SURFACES TO BE STEEL TROWEL FINISHED
d) FLOOR TO BE CAST IN PANES AS SHOWN ON THE DRAWING.
e) KNOWLEGDE SHOWN BE OBTAIN AND PRECAUTION TAKEN AGAINST MATERIALS THAT ARE USED IN THE CONCRETE MIXTURE THAT CAUSES A VARIATION IN THE COLOUR OF, OR IN THE TEXTURE OF THE EXPOSED CONCRETE SURFACES.
f) STRIPPING OF THE SHUTTERING TO BE APPROVED BY THE ENGINEER.
g) PROVIDE ALL EXPOSED CONCRETE CORNERS WITH A 20x20mm CHAMFER UNLESS OTHERWISE SHOWN.

WATERSTOPS

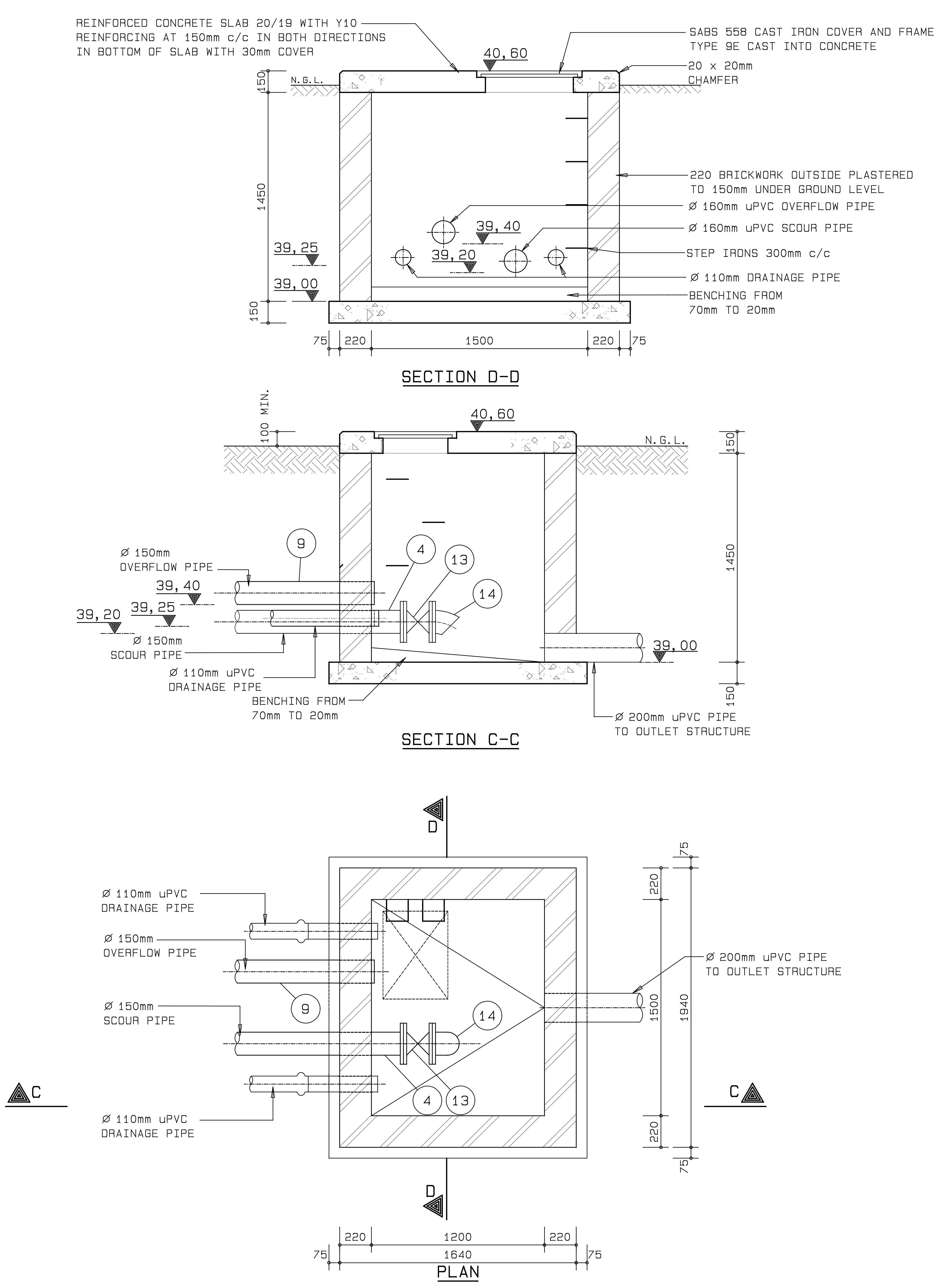
WATERSTOPS TO BE INSTALLED ACCORDING THE PROJECT SPECIFICATIONS.

FOR DETAIL OF STEEL PIPES, VALVES AND FITTINGS SEE SCHEDULE X IN TENDER DOCUMENT.

ALL STEEL ITEMS TO BE HOT DIPPED GALVANISED IN ACCORDANCE WITH SABS 763.

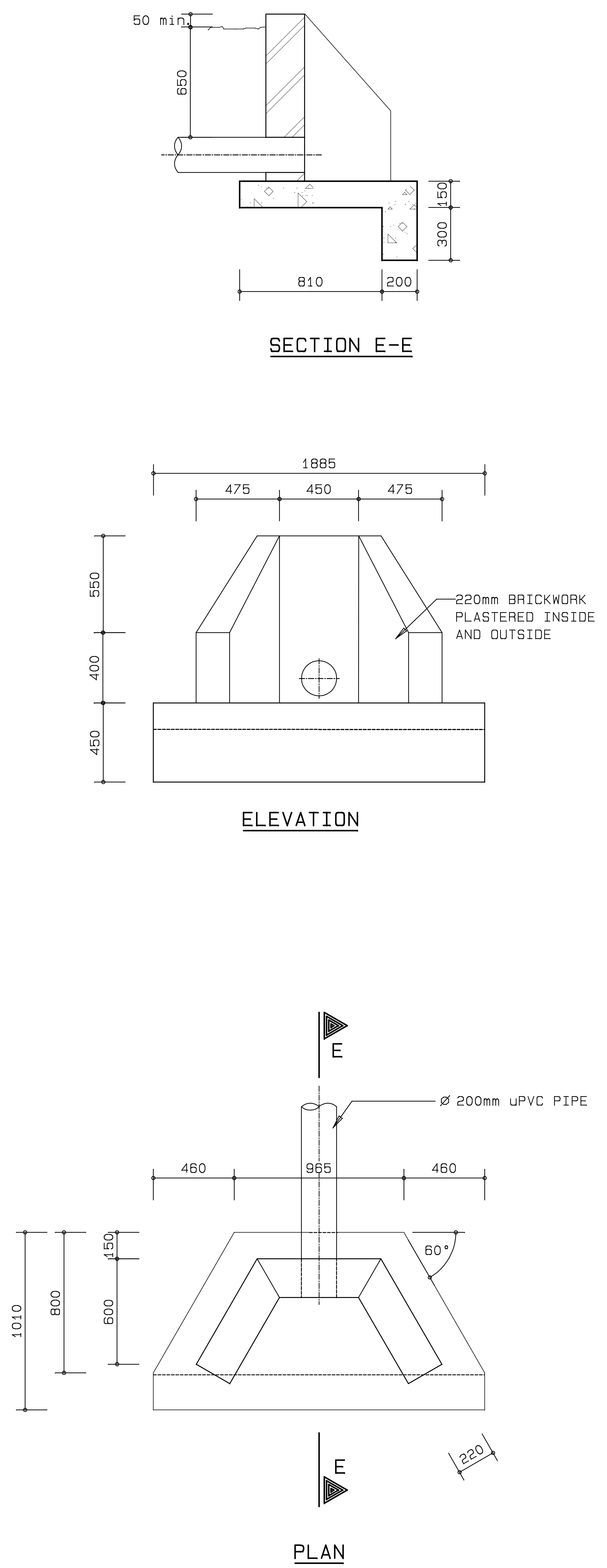
SCALE FOR REDUCED PLAN
0 10 20 30 40 50
50mm ON ORIGINAL DRAWING

Notes



OVERFLOW CHAMBER

SCALE 1:25



OUTLET STRUCTURE

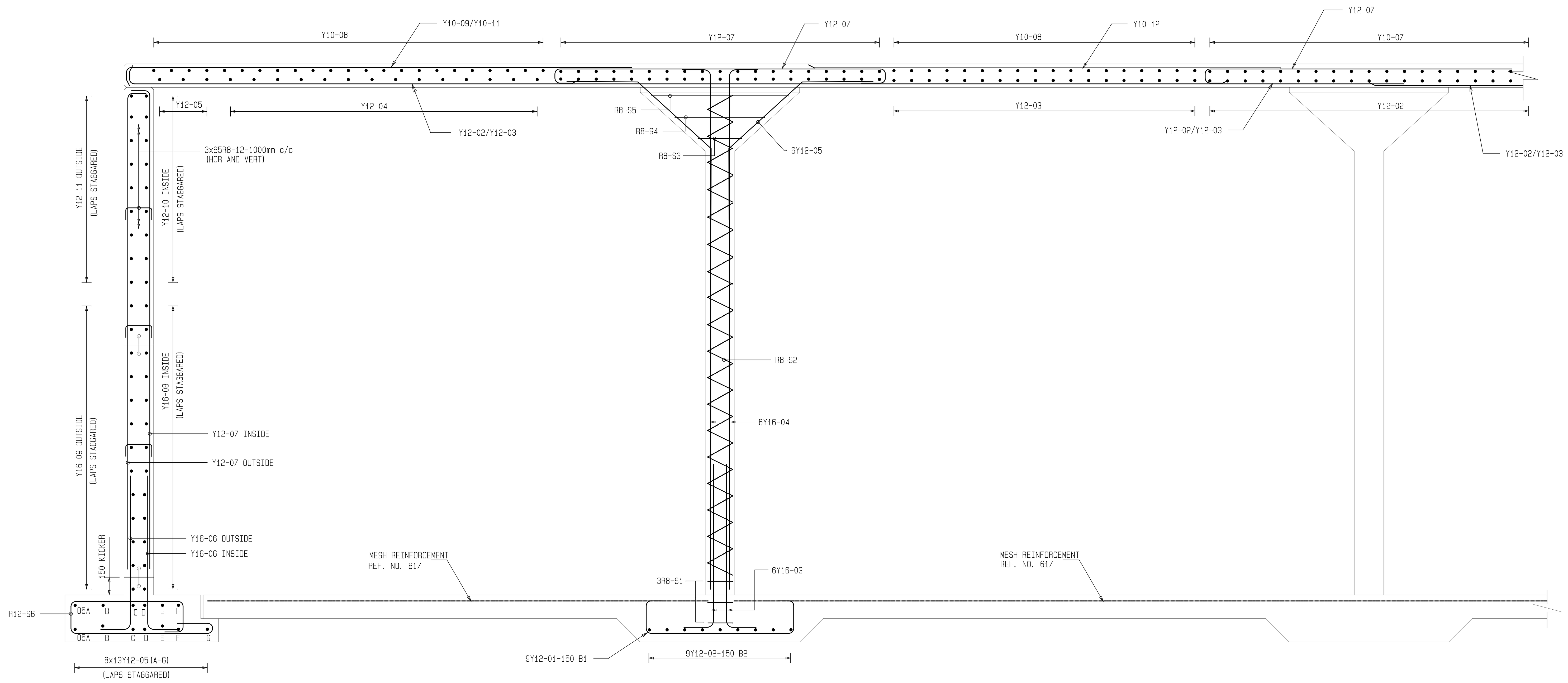
SCALE 1:25

SCALE FOR REDUCED PLAN

0 10 20 30 40 50 60 70 80 90 100

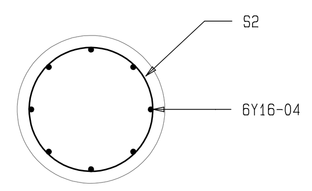
100mm ON ORIGINAL PLAN

Notes

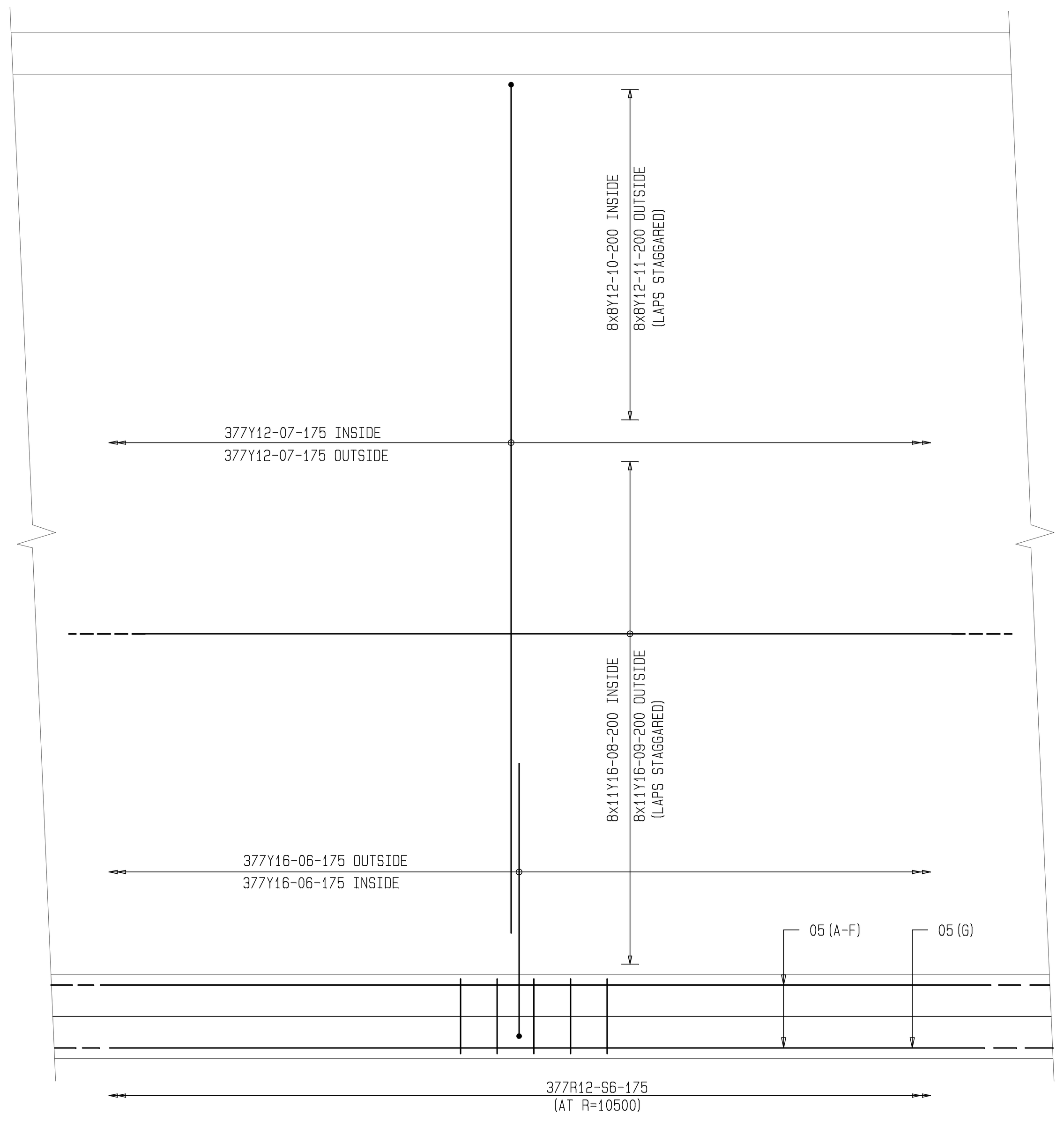


SECTION (A ../8)

SCALE 1: 20



HORIZONTAL SECTION
OF COLUMN



ELEVATION ON WALL FROM INSIDE

SCALE 1:20

MEMBER	NUMBER OF MEMBER	BARS PER MEMBER	DIA	LENGTH	TOTAL NO.	MARK	CODE	BENDING A	B	C	D	E/r
OPENING IN ROOF 1500x 1000	1	30	R12	650	30	13	85	300	250	75		
		4	Y16	1700	4	14	38	300	1150			
		4	Y16	1650	4	15	20					
		8	Y16	1000	8	16	20					
SLAB OVER OPENING 1800x 1300x150	1	6	Y12	1700	6	01	20					
		6	Y12	1200	6	02	20					
		10	Y12	250	10	03	20					
		4	Y12	650	4	04	20					

	8	10	12	16	20	25	32	40	TOT	
R	494		1226						1720	Date
Y		1012	10035	5450					16497	Det.
TOT	494	1012	11261	5450					18217	Drw. Ref.
										Job No.

MEMBER	NUMBER OF MEMBER	BARS PER MEMBER	DIA	LENGTH	TOTAL NO.	MARK	CODE	BENDING A	B	C	D	E/r
COLUMN FOUND. 1350x 1350x 400	9	9	Y12	1950	81	01	55	130	275	1250	275	
		9	Y12	1900	81	02	55	130	250	1250	250	
		6	Y16	1600	54	03	37	250				
		3	R8	800	27	S1	99	170	A = I.D.			
COLUMNS 250 DIA.	9	6	Y16	4200	54	04	37	250				
		2	R8	5300	18	S2	86	170	200	2050		
		6	Y12	2050	54	05	49	600	600		425	425
		1	R8	1500	9	S3	99	400				
		1	R8	2800	9	S4	99	800	A = I.D.			
		1	R8	4000	9	S5	99	1200				
WALL FOUNDATION 1350x400	1	16	Y12	9350	16	05A	65	9350	700 LAPS STAGGARED			10990
		16	Y12	9150	16	05B	65	9150				10735
		16	Y12	8950	16	05C	65	8950				10485
		16	Y12	8850	16	05D	65	8850				10355
		16	Y12	8750	16	05E	65	8750				10200
		16	Y12	8600	16	05F	65	8600				10060
		8	Y12	8400	8	05G	65	8400				9810
		377	R12	3100	377	S6	75	300	85	1200	270	950
		754	Y16	1600	754	06	37	250				
WALL REINF. 250 THICK	1	754	Y12	3750	754	07	34	3600				
		88	Y16	9050	88	08	65	9050	900 LAP STAGGARED			10355
		88	Y16	9150	88	09	65	9150				10525
		64	Y12	8850	64	10	65	8850	700 LAP STAGGARED			10355
		64	Y12	8950	64	11	65	8950				10525
		195	R8	350	195	12	38	100	185			
FLOOR SLAB 200 THICK	1	MESH REINFORCEMENT REF. NO. 617 = 323m ²= 1993 kg										
ROOF SLAB BOTTOM 200 THICK	1	8	Y12	10100	8	01A	34	9950				
		8	Y12	10050	8	01B	34	9900				
		8	Y12	10000	8	01C	34	9850				
		8	Y12	9900	8	01D	34	9750				
		8	Y12	9850	8	01E	34	9700				
		8	Y12	9750	8	01F	34	9600				
		8	Y12	9700	8	01G	34	9550				
		8	Y12	9600	8	01H	34	9450				
		8	Y12	9500	8	01I	34	9350				
		8	Y12	9400	8	01J	34	9250				
		8	Y12	9300	8	01K	34	9150				
		8	Y12	9250	8	01L	34	9100				
		8	Y12	9100	8	01M	34	8950				
		8	Y12	9000	8	01N	34	8850				
		8	Y12	8900	8	01O	34	8750				
		8	Y12	8800	8	01P	34	8650				
		8	Y12	8700	8	01Q	34	8550				
		8	Y12	8550	8	01R	34	8400				
		8	Y12	8450	8	01S	34	8300				
		52	Y12	10950	52	02A	34	10800				
		24	Y12	10900	24	02B	34	10750				
		8	Y12	10850	8	03A	34	10700				
		8	Y12	10800	8	03B	34	10650				
		8	Y12	10800	8	03C	34	10650				
		8	Y12	10750	8	03D	34	10600				
		8	Y12	10700	8	03E	34	10550				
		8	Y12	10650	8	03F	34	10500				
		8	Y12	10600	8	03G	34	10450				
		8	Y12	10550	8	03H	34	10400				
		8	Y12	10500	8	03I	34	10350				
		8	Y12	10400	8	03J	34	10250				
		8	Y12	10350	8	03K	34	10200				
		8	Y12	10300	8	03L	34	10150				
		8	Y12	10200	8	03M	34	10050				
		8	Y12	8250	8	04A	34	8100				
		8	Y12	8050	8	04B	34	7900				
		8	Y12	7850	8	04C	34	7700				
		8	Y12	7650	8	04D	34	7500				
		8	Y12	7450	8	04E	34	7300				
		8	Y12	7200	8	04F	34	7050				
		8	Y12	6950	8	04G	34	6800				
		8	Y12	6700	8	04H	34	6550				
		8	Y12	6450	8	04I	34	6300				
		8	Y12	6150	8	04J	34	6000				
		8	Y12	5800	8	04K	34	5650				
		8	Y12	5450	8	04L	34	5300				
		8	Y12	5050	8	04M	34	4900				
		8	Y12	4650	8	04N	34	4500				
		4	Y12	7100	4	05A	35	6800				
		4	Y12	6300	4	05B	35	6000				
		4	Y12	4950	4	05C	35	4650				
		350	R12	550	350	06	83	150	100	150		
ROOF SLAB TOP 200 THICK	1	342	Y12	3050	342	07	38	200	115			
		380	Y10	3100	380	08	38	200	115			
		8	Y10	3650	8	09A	38	200	100			
		8	Y10	3500	8	09B	38	200	100			
		8	Y10	3350	8	09C	38	200	100			
		8	Y10	3200	8	09D	38	200	100			
		8	Y10	3050	8	09E	38	200	100			
		8	Y10	2850	8	09F	38	200	100			
		8	Y10	2650	8	09G	38	200	100			
		8	Y10	2450	8	09H	38	200	100			
		8	Y10	2200	8	09I	38	200	100			
		8	Y10	1950	8	09J	38	200	100			
		8	Y10	2450	8	10A	38	200	100			
		8	Y10	2350	8	10B	38	200	100			
		8	Y10	2150	8	10C	38	200	100			
		8	Y10	1900	8	10D	38	200	100			
		8	Y10	1700	8	10E	38	200	100			
		8	Y10	1450	8	10F	38	200	100			
		16	Y10	4400	16	11A	38	200	100			
		24	Y10	4450	24	11B	38	200	100			
		120	Y10	3900	120	12	20					