DETAILED DESIGN REPORT FOR BULK CIVIL ENGINEERING SERVICES

(WATER, SEWER, ROADS AND STORMWATER)

PROPOSED TOWNSHIPS TIGANE EXTENSION 7 AND TIGANE EXTENSION 8, HARTBEESFONTEIN, KLERKSDORP MATLOSANA

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Issue 1

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ISSUE & REVISION RECORD

QUALITY APPROVAL

	Capacity	Name	Signature	Date
By Author	Candidate Civil Engineer	Michael Benhura		25/09/2020
Approved by Design Centre Leader	Project Leader	R. W. Salim		25/09/2020
Approved by Project Engineer	Project Engineer	P.P Madumo Pr.Tech (ECSA) Professional Reg. No.:2015305049		25/09/2020
Accepted and Approved (City of Matlosana Local Municipality)				

This report has been prepared in accordance with Rajasamway Family Holdngs cc Consultant Quality Management System.

REVISION RECORD

Revision Number	Objective	Change	Date
00	Issued to Client	Issued for Approval	29/09/2020

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1 Introduction

1.1 Appointment

Rajasamway Family Holdings has been appointed by MXN Development Construction to prepare a Detailed Design Report for Bulk Civil Engineering Services for the proposed new Tigane Extension 7 and Tigane Extension 8 Developments regarding civil engineering services for purpose of establishing housing developments. The Development falls within the jurisdiction of City of Matlosana Local Municipality.

Tigane Extension 7 and 8 development will consist of 1583 RDP (Extension 7) houses constructed on 51.573 ha of land and 1494 RDP (Extension 8) houses constructed on 46.774 ha of land. The proposed development will be served by road network, sewer network, water supply network as well as storm water collection network.

The project is aimed at addressing the current housing needs of Tigane as a whole while creating a large number of work opportunities over the next five to seven years and beyond.

2 Project Details

2.1 Project Name

The project is referred to as Proposed Township Tigane Extension 7 and 8 Development. Tigane Extension 7 and 8 Development includes the development of the area situated approximately 31km's north-west of the Central Business District (CBD) of Klerksdorp, adjacent to R503 provincial road.

2.2 Locality

Tigane Extension 7 is located on a portion of Portion 100 of the farm Nooitgedacht No.434-IP. Tigane Extension 8 is located on a portion of the Remaining Extent of the farm Uraan No. 295-IP. The Tigane Extension 7 & 8 Precinct Area is situated approximately 31km's north-west of the CBD of Klerksdorp, adjacent to R503 provincial road, in the jurisdiction of City of Matlosana Local Municipality. All the properties are owned by City of Matlosana Local Municipality.

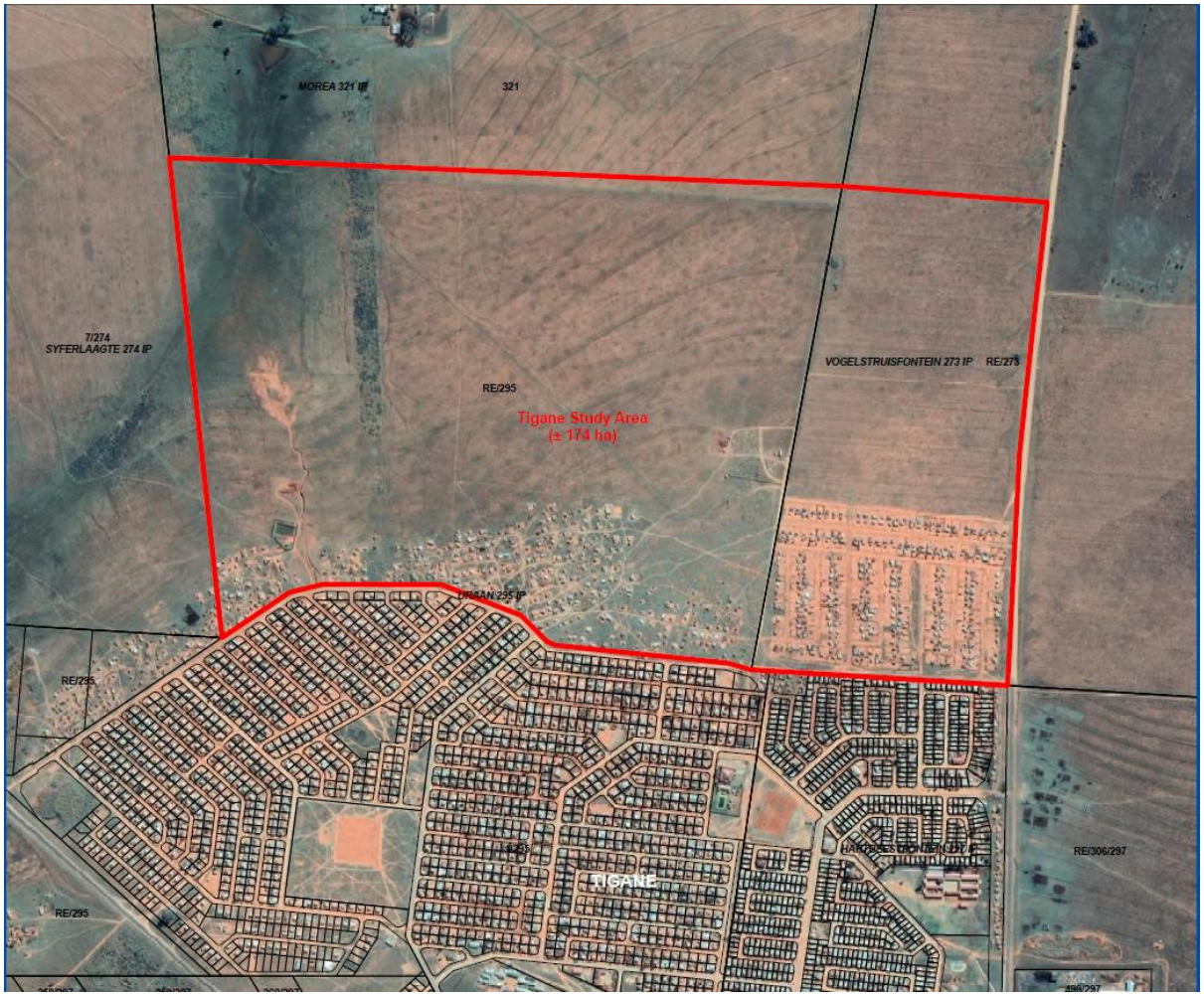

Figure 1: Locality map

3 Site Description

3.1 Existing zoning

The land on which the proposed township is to be established is currently partially zoned “Agricultural” and partially “High Potential / Unique Agricultural”. The proposed township will be partially located on a portion of the Remaining Extent of the farm Vogelstruisfontein No. 273-IP and is registered in the name of the City of Matlosana (refer attached Deeds Office Enquiry). The township will also partially be located on a portion of the Remaining Extent of the farm Uraan No 295-IP which is also registered in the name of the City of Matlosana (refer attached Windeed Deeds Office Enquiry).

3.2 Proposed development

The total site for Tigane Extension 7 is about 90.4978 hectares and that for Tigane Extension 8 is 75.6273ha *(see annexure A for township establishment layouts)*. The proposed development will comprise of the following;

3.2.1 Tigane Extension 7

1. Residential
    a. 1583 residential 1 ervens covering 51.573ha
2. Community Facilities
    a. 2 Crèches ervens covering 0.3025ha
    b. 2 Churches ervens covering 0.3073ha
    c. 1 Community Facility erven covering 0.1614ha
    d. 1 Cemetery erven covering 11.0775ha
    e. 1 Primary School erven covering 3.0775ha
3. Business
    a. 3 Business 1 ervens covering 0.4452ha
4. 6 Park ervens covering 3.3415ha
5. Streets covering 16.9013ha

3.2.2 Tigane Extension 8

1. Residential
    a. 1494 residential 1 ervens covering 46.774ha
2. Community Facilities
    a) 2 crèches ervens covering 0.2419ha
    b) 2 Church ervens covering 0.3361ha
    c) 1 Community Facility erven covering 0.1571ha
3. Business
    b. 1 Business 1 erven covering 0.3742ha
4. Five (5) Park ervens covering 10.2376ha
5. One (1) Municipal erven covering 1.6042ha
6. Streets covering 16.9013ha

3.3 Topography

3.3.1 Tigane Extension 7

The site is currently occupied by informal settlers. However; a large area which is not occupied is covered by veldt grass. The topography of the site is gently sloping with slopes from the southern direction to the northern direction with average gradients of about 3%. The gradient of the site promotes effective drainage towards the low points where storm water will be daylighted at the north-western corner of the development.

3.3.2 Tigane Extension 8

The site is currently occupied by informal settlers. However; a large area which is not occupied is covered by veldt grass. The topography of the site is gently sloping with slopes from the south-eastern direction to the north-western direction with average gradients of about 4%. The gradient of the site promotes effective drainage towards the low points where storm water will be daylighted at the north-western corner of the development. The proposed development is not affected by a 1:100-year flood line.

3.4 Site Characteristic

3.4.1 Topography

Tigane Extension 7 - The site is currently occupied by informal settlers. However; a large area which is not occupied is covered by veldt grass. The topography of the site is gently sloping with slopes from the southern direction to the northern direction with average gradients of about 3%. The gradient of the site promotes effective drainage towards the low points where storm water will be daylighted at the north-western corner of the development.

Tigane Extension 8 - The site is currently occupied by informal settlers. However; a large area which is not occupied is covered by veldt grass. The topography of the site is gently sloping with slopes from the south-eastern direction to the north-western direction with average gradients of about 4%. The gradient of the site promotes effective drainage towards the low points where storm water will be daylighted at the

north-western corner of the development. The proposed development is not affected by a 1:100-year flood line.

3.4.2 Climate

The climate at region is characterized by summer rainfall with thunderstorms and dry winters with frost. The average temperature is 17.0 °C and average rainfall is 625 mm (Potchefstroom - Agriculture) recorded at the closest weather station to the site. The warmest months are mostly December and January and the coldest are June and July.

3.4.3 Vegetation

The area is typically characterized by sourish mixed bushveld veld type (Acocks, 1988). The site itself is covered by sparse grasslands of which some was used as agriculture land, and few indigenous thorn trees are present on site within the stands.

3.5 Geotechnical Conditions

An engineering geological investigation was conducted on the proposed development site with the aim to assess aspects such as geology, relief and subsoil conditions which may influence the planned urban development in the area. The following was concluded from the investigations;

1. The proposed development of Tigane Extensions 7 and 8, Hartbeesfontein, Klerksdorp Matlosana, about 174 ha in size was investigated to determine the engineering geological properties that will influence the planned township development.

2. The area is underlain by quartzite, conglomerate & greywacke, of the Bothaville Formation, Platberg Group of the Ventersdorp Supergroup. Surficial deposits include quaternary calcrete and colluvium, covering the lithology on site.

3. Some problems are foreseen regarding the excavatability to 1,5m depth on portions of the site.

4. Special care must be taken to ensure adequate surface drainage to prevent the accumulation of water next to structures. A concrete apron of at least 1,0m around structures are prescribed, and we recommend no gardening around structures to keep the moisture content as stable as possible.

5. Zoning of the site revealed zones with constraints regarding the **compressibility, as well as the expansive properties of the soil, and shallow rock and core stones may hamper the placement of services**.

6. The following Zones were identified:

Modified Normal to Special Development:

Site Class C2/2A: Hillwash comprising orange to dark reddish brown silty clayey sand sometimes with fine gravel represents a medium to highly collapsible soil, with thickness in excess of 0,75m, and an expected range of up to 15mm of total soil movement measured at surface, form this zone on site. Foundations will therefore require modified normal foundation techniques such as lightly reinforced strip footings or reinforced boxed steel in slightly widened strip foundations, the use of split construction techniques or articulation joints at all internal and external doors and openings with light reinforcement (brickforce) in masonry, or soil replacement by an engineered fill soil raft with a COLTO classification of G5 or better, by removing all or part of the expansive horizon to 1,0m beyond the perimeter of the structure and replacing with inert backfill, compacted to 93%MOD ASSHTO density at or near optimum moisture content, where after normal strip footing foundations can be used. Site drainage, a concrete apron of 1,0m around all structures and plumbing and service precautions are advised. It is classified as C2 in terms of the NHBRC guidelines (1995) or the SAICE Code of practice (1995) and 2A after the classification for urban development (Partridge, Wood & Brink).

Suitable for development with precaution

Site Class PR: Quartzite rock outcrop and sub-outcrop will restrict excavatability required during service installation as well as foundation excavations. Blasting or difficult excavation operations will dramatically increase the development cost in this zone.

Site Class PQ: Areas where small quarries or filling or dumping of spoil were identified must be rehabilitated before any construction can be allowed, and backfilling with an engineer's material with a COLTO classification of G5 or better may improve the developability of these zones, but these operations will dramatically increase the development cost in this zone.

Undevelopable:

Site Class PD/PDM: Perennial drainage features where the 1:100 year flood line (PD) will determine or specify the allowable distance of development from rivers, usually at least 32m from the center of the river with areas to perennial wetness where seasonal marshy conditions may be encountered (PDM).

7. Special construction techniques must be used to enable proper development including the use of compaction techniques with steel reinforcement or soil rafts and even piled foundations or stiffened or cellular rafts as described.

8. This investigation was done to reveal the geotechnical properties on site with the techniques as described to form our opinion. Although every possible factor during the investigation was dealt with, it is possible to encounter variable local conditions. This will require the inspection of foundations by a competent person to verify expected problems.

4 Design Guidelines

- *Guidelines for Human Settlement Planning and Design*, 2005 published by the CSIR
- *SANS 10400:2011 The Application of the National Building Regulations* published in terms of the National Building Regulations and Building Standards Act, 1977 (Act No. 103 of 1977)
- UTG 1 - *Guidelines for the Geometric Design of Urban Arterial Roads*
- TRH4: 1996 – *Structural Design of Flexible Pavements*
- UTG2: 1987 – *Structural Design of Segmented Block Pavements for Southern Africa*

- City of Johannesburg Complete Streets Design Guideline
- Minimum road design guidelines for Housing Development adopted by The City Council of Matlosana
- FOURIE, P.J., 2006. Soil Laboratory test report: TEST REPORT: S06-0286B by SOILLAB PTY LTD
- VAN DER MERWE, D.S., 2019. Engineering geological investigation to determine the potential for township development for Tigane Extensions 7 and 8 Township Development, Hartbeesfontein, Klerksdorp Matlosana, Northwest Province. Georeferenced: 2626DC Klerksdorp, GEOSET cc, CK 99/65610/23. Report number: GS201908T.
- Technical and Design Report for Bulk Water Supply to Tigane Extension 7 and 8 dated July 2020

5 Availability of Bulk Services

5.1 Water

'Make reference to Bulk Water Layout Drg. No. TIG-CIV-100'

5.1.1 Water Source

The potable water for the Tigane is obtained from the Midvaal Water Company purification works next to the Vaal River near Vaal Reefs town.

5.1.2 Water Purification works

The treatment works which abstracts raw water from the Vaal River has enough extra capacity to cater for the demand of the proposed new Tigane Ext 7 and Ext 8 development.

5.1.3 Service reservoirs

Tigane is serviced by the Hartbeesfontein Reservoirs. The total capacity of the reservoirs is 18.5ML broken down as follows;

i. Reservoir 1 - 3.5ML
ii. Reservoir 2 – 5ML
iii. Reservoir 3 – 10ML

The Hartbeesfontein Reservoirs have been designed to provide in the future development of Tigane.

There are two existing elevated steel water towers in Tigane for pressure with the following capacities;

i. Tank 1 - 0.25ML
ii. Tank 2 – 0.5ML

5.1.4 Supply pipelines and pump systems

The rising main conveying potable water to the Hartbeesfontein reservoirs has a pipe diameter of 300mm. From the outlet of the Hartbeesfontein Reservoir, water gravitates to the Tigane Pump station through a 250mm diameter gravity main. From the Tigane Pump Station, the water is pump to the Tigane Pressure Tanks through a 200mm diameter rising main. The water from the tanks gravitates to Tigane through a 160mm diameter gravity main.

5.2 Sewer

'Make reference to Bulk Sewer Layout Drg. No. TIG-CIV-300'

The proposed Tigane Extension 7 and 8 settlements fall within an area serviced by the Hartbeesfontein Wastewater Treatment Plant (WTP). The Hartbeesfontein Wastewater Treatment Plant is owned and operated by City of Matlosana. The proposed Tigane Extension 7 and 8 settlements will discharge their sewer into the Hartbeesfontein WTP. The Hartbeesfontein WTP was upgraded to 8 ML/day in 2013. Currently it is receiving 3.8 ML/day. This implies that it has spare capacity of 4.2 ML/day.

5.2.1 Bulk Services

Through our site visit and inspection that was conducted on the 29th of June 2020 in the company of municipal personnel, it was established that the Hartbeesfontein/Tigane outfall sewer is in a fair condition.

5.3 Roads

'Make reference to Access Roads and Storm Water Layout Drg. No. TIG-CIV-200'

Access to the proposed development through intersections and primary roads according to the town planning layout is indicated on the attached plan which is self-explanatory. More than one access is available to each of the development areas via

the Hartbeesfontein Provincial road (R503), and various other primary and secondary routes interlinked with the existing road network of Hartbeesfontein.

The pavement design of the Primary Roads marked as Roads marked in red on the attached plan will be designed for category UB s described in the UTG Design manuals but modified to use SoilTech MK III soil stabiliser, AsphaltTech polymer Seal and AsphaltTech Primer. All other secondary roads will be designed to category UC and again modified to use SoilTech MK III soil stabiliser, AsphaltTech polymer Seal and AsphaltTech Primer. Where possible surface runoff exceeds the permissible cross-section capacity of the Primary Roads, sub-surface pipe drainage system shall be installed.

5.4 Stormwater

The proposed development will drain storm water run-off towards the natural low lying water-course on the north-western side of the development through the road network in combination with sub-soil drainage pipe network system. A formalised system will discharge the bulk storm-water in a north western direction as indicated on the appended plan.

5.5 Solid Waste

The Matlosana Municipality will extend its existing refuse removal service to include the new development areas. The refuse will be dumped and managed at the formal licenced dumping site of Klerksdorp which has the capacity to receive the additional refuse.

6 Level of Service and Design Guidelines

The standard for all services will be in accordance with the guidelines for the *Human Settlement Planning and Design* as published by the CSIR.

6.1 Outline Scheme

This outline scheme is in accordance with the above standards. The Design Standards also need to be approved by City of Matlosana Local Municipality and as such will be done in consultation with their Technical people.

6.2 Water Reticulation

There is a need to determine if the existing water services in the immediate area to the proposed development have enough capacity to service new development.

All calculations are based on Red Book and PW 345 Standards.

Anticipated extra Water Demand (in excess of the existing Development) using the water demand for the proposed development.

Based on the *Human Settlement Planning and Design* as published by the CSIR:

Table 1; Design Criteria

Item No.	Design Element	Criteria
1	Residential 1 - Average Annual Daily Demand (AADD) for stand size 270m^2-400m^2.	350l/d
3	Instantaneous Peak Factor Demand (IPF)	3.6
4	Liner flow velocity under conditions of domestic peak flows	Min 0.6m/s Max (internal) 1.2m/s Max (bulk) 3.6m/s
5	Pipe type	uPVC
6	Minimum pipe class for bulk water pipelines	Class 16
7	Minimum pipe class for internal water reticulation pipelines	Class 12
7	Boundary roughness (K-Value)	0.1mm
8	Flow Formulae	D'Arcy Weissbach
9	Service reservoir, receiving from one source	48 hours of AADD
10	Elevated tank with pump and standby pump	4 hours PF

6.2.1 Water Demand Calculation

6.2.1.1 Assumptions

Design period: 20 years

Population growth rate: 1.04% (*Rural Development Plan-Dr. Kenneth Kaunda District Municipality (2017)*)

Equation 1: Future Water Demand (F)

$$= \boldsymbol{P}(\mathbf{1} + \boldsymbol{GR})^{\boldsymbol{N}}$$

P = present water demand

GR = growth rate (% per year) divided by 100

N = number of years between F and P

6.2.1.2 Calculations

The detailed calculations are as follows;

Table 2: Stands Classification and AADD (REDBOOK Section J, Table J.2) Tigane Ext.7

Land Use		Stand Size	Water Demand (unit AADD)Range	Water Demand (unit AADD)	No.	Consumption (AADD)kl/d
Residential 1	High density, small sized (waterborne sanitation)	270m^2 to 400m^2	0.30 to .40kl/unit/d	0.35kl/unit/d	1583	554.05
Businesses						
Business 1		0.4452ha		21kl/ha/d	3	9.3492
Community Facilities						
Church		0.3073ha		12kl/ha	2	3.6875
Crèche		0.3025ha		12kl/ha	2	3.63
Community facility		0.1614ha		12kl/ha	1	1.9368
Primary School		3.0775ha		20kl/ha	1	61.55
Cemetery		11.0775		12kl/ha	1	132.93
Park		3.3415ha		12kl/ha	6	40.098
Initial Water Demand*						**807.23kl/d**

* **Total Water Consumption per day (kl/day)**

Table 3: Stands Classification and AADD (REDBOOK Section J, Table J.2) Tigane Ext.8

Land Use		Stand Size	Water Demand (unit AADD)Range	Water Demand (unit AADD)	No.	Consumption (AADD)kl/d
Residential 1	High density, small sized (waterborne sanitation)	270m^2 to 400m^2	0.30 to .40kl/unit/d	0.35kl/unit/d	1494	522.9
Businesses						
Business 1		0.3742ha		21kl/ha/d	1	7.8582
Community Facilities						
Church		0.3361ha		12kl/ha	2	4.0332
Creche		0.2419ha		12kl/ha	2	2.9028
Community facility		0.1571ha		12kl/ha	1	1.8852
Park		10.2376ha		12kl/ha	1	122.8512
Municipal		1.6042ha		20kl/ha	1	32
Initial Water* Demand)						**694.43kl/d**

The combined AADD for Tigane Extension 7 and 8 is

= 807.23kl/d + 694.43kl/d = 1501.66kl/d

Therefore, Ultimate Water Demand

$F = 1501.66\ (1 + (1.04/100))^{20}$ kl/d

= 1846.88kl/d

6.2.2 Bulk Water Sizing Pipe sizing

6.2.2.1 Total water consumption Calculation

Combined Consumption Tigane Ext. 7 & 8 upon 20 years' design life

Ultimate Water Demand = 1846.88kl/d

Peak Hour Consumption (PHC) = Peak Hourly Factor x Ultimate Water Demand

= 3.6 x 1 846 880l/d/86400

= 76.95l/s

Total water consumption = PHC + Total Fire Flow (TFF_{fh})

= 76.953l/s + 25l/s(Table J.17 – Moderate risk 2)

= 101.953l/s

6.2.2.2 Pipe Diameter Sizing

Maximum velocity	= 3.6m/s
Total water consumption	= 101.953l/s
A	= Q/V
	= 101 953l/s
	3.6m/s
	= 28 320.77mm²
Pipe Diameter	= √(4A/π)
	= √ ((4x28 320.77)/π)
	= 189.32mm

Therefore, the recommended pipe diameter is 200mm

i. ***A 200mm diameter (ID) pipe will have sufficient capacity to service the proposed development in the next 20 years.***
ii. ***The existing 250mm diameter gravity mains from the Hartbeesfontein reservoirs to Tigane Pump Station has sufficient capacity to service the prosed development.***
iii. ***A new 200mm diameter rising main needs to be constructed from the Tigane Pump Station to the proposed new Tigane Ext. 7 & 8 elevated steel water tanks.***
iv. ***Two (2) New 160mm diameter gravity mains needs to be constructed from the proposed Tigane Ext. 7 & 8 elevated water towers to Tigane Extension 7 and Extension 8 respectively.***

6.2.3 Reservoir sizing

Combined Consumption Tigane Ext. 7 & 8 upon 20 years' design life

Ultimate Water Demand	= 1846.88kl/d
Requirement for 48hr storage	= 1846.88 kl/d x 2
	= 3693.76ML

The Hartbeesfontein Reservoir with a combined capacity of 18.5ML have got spare capacity to cater for the proposed development.

Provide for 4 hour of PF on the elevated tanks:

1. *Initial Water Demand*

PF = P_f x (AADD)

= 3.6 * 1501.66kl/d

= 5405.976kl/day

Elevated tanks
(without power generator) = 5405.976kl/day x 4/24days

= 900.996kl

Two (2) 0.5ML elevated Pres Pressure Towers should be constructed to service Tigane Extension 7 & 8 with the initial water demand.

2. *Ultimate Water Demand (20 years)*

PF = P_f x (AADD)

= 3.6 * 1846.88kl/d

= 6648.768kl/day

Elevated tanks (without power generator) = 6848.768kl/day x 4/24days

= 1141.46kl

An additional one 0.5ML elevated Pres Pressure Towers should be constructed in the future to add on the two (2) Pres Pressure Towers to service Tigane Extension 7 & 8 with the future water demand.

In principle, an additional 1.5ML of storage is required to cater for the proposed development.

6.3 Sewer Reticulation

The proposed Tigane Extension 7 and 8 settlements will discharge their sewer into the existing bulk sewer system in Tigane. 2 new sewer pump stations on the lower north western part and north eastern part of Tigane Ext. 8 and Ext 7 will be constructed to pump sewer to the existing bulk sewer system in Tigane since the major part of the development is on a low-lying area with respect to the Tigane.

Table 4: Design Criteria (Sewer Reticulation)

Item No.	Design Element	Criteria
1	High density, small sized (270m^2 to 400m^2)	%AADD = 92.5%, 0.325kl/unit/d
2	Business sites	The peak flow from the businesses, community facilities and taxi rank (after 08:00 and before 16:00), does not flow at the same time as the peak flow from the erven (before 08:00 and after 16:00), This also applies to the parks and therefore no provision needs to be made for simultaneous peak flows. The approach used is to ignore the peak flows of the businesses and church.
3	Peak Factor	2.5
4	Allowance for infiltration	15%
5	Capacity of Sewer	Pipes may run full at the Total Design Flow, which includes the peak and infiltration flows
6	Sewer pipe type	uPVC Class 34 solid wall
7	Minimum velocity	0.7m/s
8	Maximum velocity	2.5m/s
9	Minimum pipe diameter	160mm
10	Minimum depth of cover	0,6m minimum at head, 1,2m generally
11	Minimum gradients	1:120 for 100mm dia. 1:200 for 150mm dia. 1:300 for 200mm dia. 1:500 for 300mm dia.
12	Maximum manhole spacing	100m
13	Manholes	Precast concrete rings at 80 meters c/c

6.3.1 Bulk Sewer Pipe Sizing

6.3.1.1 Assumptions - Bulk Sewer Pipe Sizing

Design period: 20 years

Population growth rate: 1.04% (*Rural Development Plan - Dr. Kenneth Kaunda District Municipality (2017)*)

Equation 2: Future Water Demand (F)

$$= \boldsymbol{P}(\mathbf{1} + \boldsymbol{GR})^{\boldsymbol{N}}$$

P = present sewer demand

GR = growth rate (% per year) divided by 100

N = number of years between F and

6.3.1.2 Calculations Bulk Sewer Pipe Sizing

NB: The peak flow from the businesses (after 08:00 and before 16:00), does not flow at the same time as the peak flow from the erven (before 08:00 and after 16:00), This also applies to the church and therefore no provision needs to be made for simultaneous peak flows. The approach used is to ignore the peak flows of the businesses and church.

Table 5: Tigane Ext.7 Stands Classification and AADD (REDBOOK Section K, Table K.4)

Land Use		Stand Size	Water Demand (unit AADD)	No.	Sewer flow (Unit PDDWF)		PDDWF (kl/d)	IPWWF (Allow for 15% Infiltration)kl/d
					%AADD	**kl/unit/d**		
Stands for low-income housing (waterborne sanitation)	Residential 1 - High density, small sized	270m^2 to 400m^2	0.35kl/unit/d	1583	92.5%	0.325	514.475kl/d	591.646kl/d
Businesses								
Business 1		0.4452ha	21kl/ha/d	1	80%	16.8kl/ha/d	7.4794 kl/d	8.601kl/d
Community Facilities								
Primary School		3.0775ha	20kl/ha/d	1	80%	16kl/ha/d	49.24kl/d	56.626kl/d
Creche		0.3025ha	20kl/ha/d	1	80%	16kl/ha/d	4.84kl/d	5.566kl/d
Church		0.3073ha	20kl/ha/d	1	80%	16kl/ha/d	4.917kl/d	5.654kl/d
Community facility		0.1614ha	13kl/ha/d	1	80%	10.4kl/ha/d	1.679kl/d	1.930kl/d
Parks/Play Areas		3.3415ha	12kl/ha	6	n/a	n/a	n/a	n/a
Cemetery		11.0775ha	12kl/ha	1	n/a	n/a	n/a	n/a
Initial Wastewater Demand - Total Wastewater Demand per day (l/s								**7.75l/s**
Initial Wastewater Demand - Total Wastewater Demand per day (kl/day)								**670.023kl/d**

Table 6: Tigane Ext.8 Stands Classification and AADD (REDBOOK Section K, Table K.4)

Land Use		Stand Size	Water Demand (unit AADD)	No.	Sewer flow (Unit PDDWF)		PDDWF (kl/d)	IPWWF (Allow for 15% Infiltration)kl/d
					%AADD	**kl/unit/d**		
Stands for low-income housing (waterborne sanitation)	Residential 1 - High density, small sized	270m^2 to 400m^2	0.35kl/unit/d	1494	92.5%	0.325	485.55kl/d	558.383kl/d
Businesses								
Business 1		0.3742ha	21kl/ha/d	1	80%	16.8kl/ha/d	6.28656 kl/d	7.230kl/d
Community Facilities								
Creche		0.2419ha	20kl/ha/d	1	80%	16kl/ha/d	3.8704kl/d	4.451kl/d
Church		0.3361ha	20kl/ha/d	1	80%	16kl/ha/d	5.3776kl/d	6.184kl/d
Community facility		0.1571ha	13kl/ha/d	1	80%	10.4kl/ha/d	1.63384kl/d	1.879kl/d
Parks/Play Areas		10.2376ha	12kl/ha	1	n/a	n/a	n/a	n/a
Municipal		1.6042ha	12kl/ha	1	n/a	n/a	n/a	n/a
Initial Wastewater Demand - Total Wastewater Demand per day (l/s								**6.69l/s**
Initial Wastewater Demand - Total Wastewater Demand per day (kl/day)								**578.127kl/d**

The combined IPWWF for Tigane Extension 7 and 8 is

670.23kl/d + 578.127kl/d = 1248.357kl/d = 14.45l/s

Therefore,

Ultimate Wastewater Demand in 20 years, F

F = 1248.357 (1 + (1.04/100))^{20}

= 1535.33kl/d

= 17.77l/s

The total expected daily effluent runoff (Wet Weather Flow) from Tigane Extension 7 and Extension 8 to the Hartbeesfontein WWTP including infiltration is 1248.357kl/d (or 14.45l/s avg)

The total expected daily effluent runoff (Wet Weather Flow) from Tigane Extension 7 to the Hartbeesfontein WWTP in the next 20years including infiltration is 1535.33kl/d (or 17.77l/s avg)

Peak Flow = 1248.357kl/d *2.5

= 3120.8925kl/d (or 36.12/s)

The Ultimate Peak Flow (20years)

= 1535.33kl/d *2.5

= 3838.325kl/d (or 44.43l/s)

6.3.1.3 Ultimate sewer pipe size

Slope = $\frac{\Delta Elevation}{Length}$ = $\frac{1530-1520}{430}$ = 0.0233 = 1:43

Manning's formula: $v = \frac{1}{n} r^{2/3} s^{1/2}$

Pipe flowing full: $Q = (A)\frac{1}{n} r^{2/3} s^{1/2}$ Where: $A = \pi D^2/4$ r = $D/4$

$$0.04443 = (\frac{\pi D^2}{4})\frac{1}{0.013}(\frac{D}{4})^{2/3}(0.0233)^{1/2}$$

$$0.012042 = D^2 x (D)^{2/3}$$

$D = (0.012042)^{3/8}$ = 0.190m = 190mm

From the pipe manufacturer table, the nearest size on the table is 200mm Class 34 PVC – U Sewer Pipe. Therefore, a **200mm diameter bulk sewer pipe will be required to convey the combined Ext 7 and 8 sewer to the existing bulk sewer network in Tigane.**

6.3.1.4 Existing Bulk Sewer Pipe (Connection Pipeline)

The existing sewer bulk pipeline that the proposed development will connecting into has a pipe diameter of 200mm. The existing connection bulk sewer pipe has sufficient capacity to cater for the sewer flow from the proposed development.

6.3.2 Existing Hartbeesfontein Wastewater Treatment Plant

The existing Hartbeesfontein Wastewater Treatment Plant has a design capacity of 8ML/d. Currently it is receiving 6ML/d of raw sewage from Tigane and Hartbeesfontein.

The proposed development will generate an ultimate waste water flow of 1.54ML/d. This implies that the existing Hartbeesfontein Wastewater Treatment Plant will have sufficient capacity to cater for sewer inflow from the proposed development for the next 20 years.

6.4 Roads

6.4.1 Access

Access to the proposed development through intersections and primary roads according to the town planning layout is indicated on the attached plan which is self-explanatory. More than one access is available to each of the development areas via the Hartbeesfontein Provincial road (R503), and various other primary and secondary routes interlinked with the existing road network of Hartbeesfontein.

The pavement design of the Primary Roads marked as Roads marked in red on the attached plan will be designed for category UB as described in the UTG Design manuals but modified to use SoilTech MK III soil stabiliser, AsphaltTech polymer Seal and AsphaltTech Primer. All other secondary roads will be designed to category UC and again modified to use SoilTech MK III soil stabiliser, AsphaltTech polymer Seal and AsphaltTech Primer.

6.4.2 Classification of Roads

The classification of roads is shown in the tables below.

6.4.3 Pavement Design

The proposed pavement design will be based on anticipated traffic volumes and ground conditions. The design life of the proposed pavement is 20 years on provision that repairs to the surface will be made where necessary in order to maintain its skid resistance and permeability during the design life of the road.

Table 7:Pavement Design for Secondary Roads

Description	Function
Wearing course	30mm AsphalTech Seal.
Base	150mm thick G8 (C3) or better insitu natural gravel stabilized with 0.75% SoilTeck Mk.III polymer binder compacted to 97% of modified AASHTO density
Sub base	150mm thick G8/G9 or better insitu natural gravel semi-stabilized with SoilTeck Mk.III migration from the Base layer compacted to 95% of modified AASHTO density.
Subgrade(Roadbed)	Rip and compact insitu material 150mm thick and compact to 93% of modified AASHTO density.

Table 8: Pavement Design for the Primary Roads

Description	Function
Wearing course	30mm AsphalTech Polymer Seal.
Base	150mm G6 stabilized with Soiltek MkIII @ 1.5/m2 and compacted to 97% MOD AASHTO.
Sub base	150mm G7 natural gravel semi-stabilized with Soilteck Mk.III migration from the Base layer compactd to 95% of modified AASHTO density.
Subgrade(Roadbed)	Rip and compact insitu material 150mm thick and compact to 93% of modified AASHTO density.

6.5 Storm water

The proposed development will drain storm water run-off towards the natural low lying water-course on the north-western side of the development through the road network in combination with sub-soil drainage pipe network system. A formalised system will discharge the bulk storm-water in a north western direction as indicated on the appended plan.

6.6 Solid Waste

The Matlosana Municipality will extend its existing refuse removal service to include the new development areas. The refuse will be dumped and managed at the formal licenced dumping site of Klerksdorp which has the capacity to receive the additional refuse.

7 Mechanical

7.1 PUMP SIZING

In order to select a pump two types of data are required:

- Product/Fluid data which includes viscosity, density/specific gravity, temperature, flow characteristics, vapour pressure and solids content.
- Performance data which includes capacity or flow rate, and inlet/discharge pressure/head. Different fluids have varying characteristics and are usually pumped under different conditions. It is therefore very important to know all relevant product and performance data before selecting a pump.

Typical selection criteria for pumps are their design data (flow rate or capacity Q, discharge head H, speed of rotation n and NPSH), the properties of the fluid pumped, the application, the place of installation and the applicable regulations, specifications, laws and codes

The Main design features for classification are:

- The number of stages (single stage / multistage),
- The position of the shaft (horizontal / vertical)
- The pump casing (radial, e. g. volute casing / axial, e. g. tubular casing)
- The number of impeller entries (single entry / double entry)
- The type of motor (dry motor / dry rotor motor, e. g. submerged motor / wet rotor motor, e. g. canned motor, submersible motor).

NB: *Water in this report is considered a Newtonian fluid therefore viscosity remains constant regardless of shear forces applied to the fluid.*

7.1.1 PROPOSED WATER PUMP STATION

PUMP SIZING PARAMETERS

ITEM	**DESCRIPTION**
Fluid Density	1000kg/m^3
Fluid Viscosity	0, 0017Pa.s
Flow rate	1500L/min (90,00m^3/hr)
Pipe Diameter	250mm Steel
Head	26m
Frictional Pipe loss	0,00881m frictional loss/m
Reynolds Number	1,50 Expo +05
Pipe Roughness	0,0015mm
Pump efficiency	Design Efficiency 55% at 1 specific gravity of water
Shaft Position	Horizontal
Number of impeller entries	Single Entry

Pump efficiency of between 0, 50 to 0, 75 the design flow is to be 90,00m^3/hr or 1500L/min

Length of Pipe 1523m

7.1.2 DETERMING TOTAL HEAD.

ITEM	**DESCRIPTION**
Design Discharge Head	26.0m
Flow rate	(1500L/min)

7.1.3 MAJOR AND MINOR PIPE LOSSES

In fluid flow, friction loss (or skin friction) is the loss of pressure or “head” that occurs in pipe due to the effect of the fluid's viscosity near the surface of the pipe or duct.

Factors considered in determining the major losses for the system

- Friction coefficient for the pipes. This was taken to be 140 for steel pipes
- Hydraulic diameter of the pipe
- The flow of the fluid (water) which was determined as 1,5m/s
- Acceleration due to gravity which is a constant value

The other factors that where considered where the minor losses of the pipe work due to fitting such as valves and gauges along the line. In determining the minor losses, the following factors where considered:

- The flow of the fluid (water) which was determined as 1,5m/s
- Acceleration due to gravity which is a constant value
- Minor Loss Coefficient at 0,2

Total Head

Total head for the system (H)

$$H = (26m) + \text{Major Losses} + \text{Minor Losses}$$

- Major Losses were calculated to be 18.00m (for 2.0 km)
- Minor Losses were calculated to be 26,00m

7.1.4 DETERMING PUMP POWER

After determining the head for the system, the next step is to determine the power of the centrifugal pump.

Factors considered in determining the power of a centrifugal pump

- Flow rate at (90,00m^3/hr)
- Density of Fluid at 1000kg/m^3
- Total Head of 70,00m
- Design Head (70m x 1.3)

- Pump efficiency at 0,75

$$P = \frac{90{,}0\ x\ 1000\ x\ 9{,}81\ x\ 91}{3{,}6\ x\ 10e6\ x\ 0{,}75}$$

P = 29.8 KW

Recommended Pump Power (29.8x1.2) = 35.76 KW

7.1.5 PARAMETERS IN SELECTING PUMP TYPE

The following parameters shall be used in selecting the pump type

ITEM	**DESCRIPTION**
Fluid Density	1000kg/m^3
Fluid Viscosity	0,0017Pa.s
Flow rate	(90,00m^3/hr)
Head	70
Frictional Head loss/Pipe Velocity	0,83/s
Reynolds Number	1,50 Expo +05
Pipe Roughness	0,0015mm
Recommended Pump Size	90,00m^3/hr at 70,00m head with a drive Power of 37Kw
Pump efficiency	Design Efficiency 75% at 1 specific gravity of water
Number of Stages	Double
Shaft Position	Horizontal
Number of impeller entries	Single Entry

7.1.6 CONTROLS

Typical pump stations are controlled by sensors to allow smooth operation of the stations and prevent dry running of pumps. Dry running occurs if the pumps are oversized and/or are pumping more than the inflow. In most cases to avoid this level sensors or float switches are employed to control pumping action of the Pumps Effects of dry running of pumps will result in overheating of pump internals (Bearings, shafts, seals, impeller) which consequently seizes the pump.

In most cases, reservoirs are fitted with level sensors connected to the control panel of the pump station that is the Motor Control Centre. The level sensors actuate the pumps when required when the level of water as reached a certain upper and or lower threshold level which is determined by the tank designs.

7.1.7 SENSORS TO BE UTILISED IN CONTROLLING AND MONITORING PUMPS

ITEM	DESCRIPTION
1	Stainless steel level senor to wireless controlled for both elevated tanks and reservoir
2	Float Switch as a backup to the level sensors which are wireless controlled to the Motor Control Centre in the Pump station
3	Pressure Sensors
4	Flow Meters
5	Temperature Sensors

7.2 PROPOSED NEW SEWER PUMP STATION EXT 8

PUMP SIZING PARAMETERS

ITEM	DESCRIPTION
Fluid Density	1400kg/m^3
Fluid Viscosity	0, 0017Pa.s
Flow rate	1200L/min (72,00m^3/hr)
Pipe Diameter	160mm
Head	31m
Frictional Pipe loss	0,00881m frictional loss/m
Reynolds Number	1,50 Expo +05
Pipe Roughness	0,0015mm
Pump efficiency	Design Efficiency 75%
Shaft Position	Vertical
Number of impeller entries	Single Entry

Pump efficiency of between 0, 50 to 0, 80 the design flow is to be 72,00m^3/hr or 1200L/min

Length of Pipe 2455m

7.2.1 DETERMING TOTAL HEAD.

ITEM	DESCRIPTION
Design Discharge Head	31.0m
Flow rate	(1200L/min)

7.2.2 MAJOR AND MINOR PIPE LOSSES

Total Head

Total head for the system (H)

H = (31m) + Major Losses + Minor Losses

- Major Losses were calculated to be 21.60m (for 2.455 km)
- Minor Losses were calculated to be 10,00m

7.2.3 DETERMING PUMP POWER

After determining the head for the system, the next step is to determine the power of the submersible pump.

Factors considered in determining the power of a centrifugal pump

- Flow rate at (72,00m^3/hr)
- Density of Fluid at 1400kg/m^3
- Total Head of 62,60m
- Design Head (62,6m x 1.3)
- Pump efficiency at 0,75

$$P = \frac{72{,}0\ x\ 1200\ x\ 9{,}81\ x\ 62{,}60}{3{,}6\ x\ 10e6\ x\ 0{,}75}$$

P = 19.65 KW

Recommended Pump Power (19.65x1.2) = 23.59 KW

7.2.4 PARAMETERS IN SELECTING PUMP TYPE

The following parameters shall be used in selecting the pump type

ITEM	DESCRIPTION
Fluid Density	1200kg/m^3
Fluid Viscosity	0,0017Pa.s
Flow rate	(72,00m^3/hr)
Head	70
Frictional Head loss/Pipe Velocity	0,83/s
Reynolds Number	1,50 Expo +05
Pipe Roughness	0,0015mm
Recommended Pump Size	72,00m^3/hr at 70,00m head with a drive Power of 22Kw
Pump efficiency	Design Efficiency 75% at 1 specific gravity of water
Shaft Position	Vertical
Number of impeller entries	Single Entry

7.2.5 CONTROLS

Typical pump stations are controlled by sensors to allow smooth operation of the stations and prevent dry running of pumps. Dry running occurs if the pumps are oversized and/or are pumping more than the inflow. Float switches shall be used in the sump to actuate the pump and stop the pump. The pumps shall be actuated when the pit is ¾ full and shall be stopped when the sump is ¼ empty.

7.3 EXISTING SEWER PUMP STATION EXT 7

PUMP SIZING PARAMETERS

ITEM	DESCRIPTION
Fluid Density	1200kg/m^3
Fluid Viscosity	0, 0017Pa.s
Flow rate	1200L/min (72,00m^3/hr)
Pipe Diameter	160mm
Head	12m
Frictional Pipe loss	0,00881m frictional loss/m
Reynolds Number	1,50 Expo +05
Pipe Roughness	0,0015mm
Pump efficiency	Design Efficiency 75%
Shaft Position	Vertical
Number of impeller entries	Single Entry

Pump efficiency of between 0, 50 to 0, 80 the design flow is to be 72,00m^3/hr or 1200L/min

Length of Pipe 1480m

7.3.1 DETERMING TOTAL HEAD.

ITEM	**DESCRIPTION**
Design Discharge Head	12.0m
Flow rate	(1200L/min)

7.3.2 MAJOR AND MINOR PIPE LOSSES

Total Head

Total head for the system (H)

H = (12m) + Major Losses + Minor Losses

- Major Losses were calculated to be 13.04m (for 2.455 km)
- Minor Losses were calculated to be 10,00m

7.3.3 DETERMING PUMP POWER

After determining the head for the system, the next step is to determine the power of the submersible pump.

Factors considered in determining the power of a centrifugal pump

- Flow rate at (72,00m^3/hr)
- Density of Fluid at 1200kg/m^3
- Total Head of 35,04m
- Design Head (35,04m x 1.3)
- Pump efficiency at 0,75

$$P = \frac{72{,}0\ x\ 1200\ x\ 9{,}81\ x\ 45{,}56}{3{,}6\ x\ 10e6\ x\ 0{,}75}$$

P = 14.30 KW

Recommended Pump Power (14.30x1.2) = 17.2 KW

7.3.4 PARAMETERS IN SELECTING PUMP TYPE

The following parameters shall be used in selecting the pump type

ITEM	**DESCRIPTION**
Fluid Density	1200kg/m^3
Fluid Viscosity	0,0017Pa.s
Flow rate	(72,00m^3/hr)
Head	45
Frictional Head loss/Pipe Velocity	0,83/s
Reynolds Number	1,50 Expo +05
Pipe Roughness	0,0015mm
Recommended Pump Size	72,00m^3/hr at 45,00m head with a drive Power of 16Kw
Pump efficiency	Design Efficiency 75% at 1 specific gravity of water
Shaft Position	Vertical
Number of impeller entries	Single Entry

7.3.5 CONTROLS

Typical pump stations are controlled by sensors to allow smooth operation of the stations and prevent dry running of pumps. Dry running occurs if the pumps are oversized and/or are pumping more than the inflow. Float switches shall be used in the sump to actuate the pump and stop the pump. The pumps shall be actuated when the pit is ¾ full and shall be stopped when the sump is ¼ empty.

8 Pump Station Sump Design

8.1 PUMP STATION DESIGN PHILOSOPHY

8.1.1 Design Criteria (Ex 7 & 8)

The design criterion is guided by Guideline for Human Settlement Planning and Design documentation

a)	Sewage Generation	600l/dwelling
b)	Sewage flow peak factor	2.5
c)	Extraneous flow (as percentage of DWF)	15%
d)	Number of pump starts per hour	4
e)	Emergency storage capacity	4xDWF

8.1.2 Special Considerations (Ex 7 & 8)

The design criterion is guided by Guideline for Human Settlement Planning and Design documentation

The following special considerations should be made on the pumping station to optimise the operations of the pumping station:

- Provide a stainless-steel screening basket at the sewage sump inlet
- The pump station layout arrangement is a wet well equipped with float switches for controlling pump start and stop regime and suction pipes and a dry well equipped with the pump and motor, switch gear, dewatering pump and associated delivery pipework.
- Adopt emergency **storage of 4 hours** at average daily sewage flow (Dry Weather Flow) to allow attendance to any pump failure or other events impacting on the functionality of the pump station, before spillage/overflowing into adjacent water streams commences.
- The volume of the wet well should be large enough to provide at least 5 minutes of pump running time to prevent overheating of the motor, but not too large in order to prevent septic conditions in the wet well.

8.2 DESIGNED INFRASTRUCTURE

8.2.1 Design Data; Extension 7

Parameter	Symbol	Unit	Estimated Current Value (2019)	Comments
Number of stands		No	644	
Estimated Average Daily Sewage Flow	DWF	m^3/day	839	
Infiltration (15%)		m^3/day	126	
Peak Factor	PF	----	2.5	
Wet Weather Flow (Peak Flow)	WWF	m^3/hour	18.72	
Wet Weather Flow (Peak Flow)	WWF	Litres/s	5.2	
Design Pump Capacity	----	Litres/s	10	
Pump total head	H	m	21.134	

The sewage pump pumping capacity required to cater for the total sewage flow to be generated is 5.5 litres per second.

8.2.2 Design Data; Extension 8

Parameter	Symbol	Unit	Estimated Current Value (2019)	Comments
Number of stands		No	1920	
Estimated Average Daily Sewage Flow	DWF	m^3/day	498.528	
Infiltration (15%)		m^3/day	74.7792	
Peak Factor	PF	----	2.5	
Wet Weather Flow (Peak Flow)	WWF	m^3/hour	55.08	
Wet Weather Flow (Peak Flow)	WWF	Litres/s	15.3	
Design Pump Capacity	----	Litres/s	25	
Pump total head	H	m	43.195	

The sewage pump pumping capacity required to cater for the total sewage flow to be generated is 15.3 litres per second

8.3 Sump and Pumps

Extension 7

Adopting 4 pump starts per hour, sump size is computed as follows;

Top Water Level (TWL) is set such that there is sufficient volume between this level and bottom water level to limit the number of pump starts per hour to an acceptable number (adopt 4 per hour).

Volume is determined as shown below-

$V = 900Q_p/S$ (litres)
Where;
V = Control Volume (L)
Q_p = Pump Capacity (L/s)
S = Allowable number of starts per hour
Adopting a pump capacity at 5.2 l/s (peak flow is satisfied)
V=900*5.2/4 = 1180litres
= 1.17 m^3

Extension 8

Adopting 4 pump starts per hour, sump size is computed as follows;

Top Water Level (TWL) is set such that there is sufficient volume between this level and bottom water level to limit the number of pump starts per hour to an acceptable number (adopt 4 per hour).

Volume is determined as shown below-
$V = 900Q_p/S$ (litres)
Where;
V = Control Volume (L)
Q_p = Pump Capacity (L/s)
S = Allowable number of starts per hour
Adopting a pump capacity at 15.3 l/s (peak flow is satisfied)
V=900*15.3/4 = 3442.5litres
= 3.44 m^3

8.3.1 SUMP WELL LAYOUT (Ext 7 & 8)

The top water level is set **650 mm** below the invert of the incoming sewer to accommodate installation of the stainless-steel screening basket and avoid the possibility of surcharging the sewer.

8.3.2 EMERGENCY STORAGE

Extension 7

A minimum of 4 hours storage at DWF conditions

Thus, emergency storage is 28.2 m3 (4hours)

Therefore, the total sump volume is 28.2 +1.17 = 29.37 cubic metres

Adopt sump volume = 40m^3

Extension 8

A minimum of 4 hours storage at DWF conditions

Thus emergency storage is 83.088 m^3 (4hours)

Therefore, the total sump volume is 83.088 +3.44 = 86.528 cubic metres

Adopt sump volume =90m^3

8.3.3 SUMP DIMENSIONS

Extension 7

Volume, V is 40 m^3

Depth (sump bottom to overflow level);	Adopt 5.64m
Width;	Adopt 3.0m
Length	4.0m
Suction lift	About 4.7m

Extension 8

Volume, V is 90 m^3

Depth (sump bottom to overflow level);	Adopt 3.5m
Width;	Adopt 4.0m
Length	6.5m
Suction lift	About 4.7m

8.3.4 PUMPSTATION OPERATING LEVELS

Operating Levels in the Wet Well (Extension 7)

Elevation(m)	Operation
1509.350	Top Water Level in Wet Well
1509.350	Back up Float- Standby Pumps start and emergency alarm is set off.
1509.250	Duty Pump Start - cut in level
1508.152	Duty Pump Stops - cut off level
1508.152	Bottom Water Level
1508.092	Finished Floor Level of the Wet Well

Operating Levels in the Wet Well (Extension 8)

Elevation(m)	Operation
1523.389	Top Water Level in Wet Well
1523.389	Back up Float- Standby Pumps start and emergency alarm is set off.
1523.289	Duty Pump Start - cut in level
1522.539	Duty Pump Stops - cut off level
1522.539	Bottom Water Level
1522.479	Finished Floor Level of the Wet Well

8.3.5 PUMPING STATION PIPEWORK

Extension 7

- Use 90mm diameter steel pipe
- Provide double hinged long body **non-return valves** on the delivery mains. Long body non return valves offer unobstructed full-way flow when open and they have the ability to shear fibrous matter upon closure. Double hinged non-return valves to be used as single hinged are more prone to staying partially open when any solids rest on the sealing face.
- Provide gate valves after the non-return valves to facilitate isolation of non-return valves in the event of maintenance required.

Extension 8

- Use 200mm diameter steel pipe
- Provide double hinged long body **non-return valves** on the delivery mains. Long body non return valves offer unobstructed full-way flow when open and they have the ability to shear fibrous matter upon closure. Double hinged

non-return valves to be used as single hinged are more prone to staying partially open when any solids rest on the sealing face.

- Provide gate valves after the non-return valves to facilitate isolation of non-return valves in the event of maintenance required.

8.3.6 INLET SCREENING (Ext. 7 and 8)

- Provide stainless steel basket at the sewage sump discharge point. The stainless-steel basket is for protecting the pumping equipment by entrapping detrimental material such as rags, plastics etc. The bar spacing will be approximately 40mm

8.4 ELECTRICAL SUPPLY AND INSTRUMENTATION

8.4.1 Electrical Supply (Ext. 7 and 8)

Eskom power lines (3 phase) will be constructed, approximately 2000m and a transformer installed. The main switchboard will direct the power to operate the pumps, pump controls and other electrical equipment.

8.4.2 Instrumentation and Control

8.4.2.1 Operating Levels (Ext. 7 and 8)

The top water level (TWL) in the wet well is set at 650mm below the invert level of the incoming sewer and the bottom water level (BWL) in the wet well is set 300mm below the TWL. 3 Number float regulators are to be used; 1 for start, 1 for stop and 1 for emergency start.

8.4.2.2 Instrumentation (Ext. 7 and 8)

- **Pump Operation**

  - The switches for each pump will facilitate both automatic and manual operation of the pump.

  - All available pumps share the duty - ie the duty pump will alternate between available pumps whenever the cut-in level is reached. This will be facilitated by an automatic change over switch with a manual overriding operation capacity.

- **Switchgear and Control Gear Assemblies**

  All pumping station assemblies will be equipped with the following:

  - Electricity Supply Meters
  - Incoming Power Supply
  - Station Control Unit
  - Motor Starter Units
  - Lightning protection facility

  The controls, switches and indicating lights contained in the switchboard include:

8.4.2.3 Electricity Supply Meters (Ext. 7 and 8)

These are the property of the Electricity Supply Authority. They record the energy consumption of the pumping station.

8.4.2.4 Incoming Power Supply (Ext. 7 and 8)

The incoming power supply distributes power to all the control and starter units. Power is 3 phase and is supplied by the Electricity Supply Authority. Main Features include:

i) **Main Switch** - for control of the incoming power supply.

ii) **Voltmeter** - for measuring the voltage of the incoming power supply.

iii) **Phase Failure Relay** - to detect the failure of one or more of the 3 phases, or phase reversal of the Electricity Supply Authorities power supply.

iv) **Circuit Breakers** - for protection of equipment by limiting the current supplied to the various circuits.

v) **General Purpose Outlet** - double 10 ampere general purpose outlet.

8.4.2.5 Station Control Unit (Ext. 7 and 8)

The station control unit houses all the control equipment for automatic operation of the station. This unit may include:

i) **Duty Selector Switch** - selects the duty and standby pumps when manual operation is overriding the automatic operation of the pumps.

ii) **Programmable Logic Controller (PLC)** - The duty of the pumps is determined by the PLC software. All available pumps share the duty - ie the duty pump will alternate between available pumps whenever the cut-in level is reached.

iii) **Override Button** - can be used while the operation is in the automatic mode, to simulate that the sewage level has reached pump cut-in level at any time the sewage level is above BWL. Pressing this button will start the standby pump which will pump down to BWL and then automatically switch off.

8.4.2.6 Motor Starter Units (Ext. 7 and 8)

Each pump is controlled by a motor starter unit which houses all the motor protection equipment and alarm lights. For submersible pumps the equipment includes:

i) **Control Selector Switch** - selects the control mode for the pump. It has three settings:

A. ON - manual operation. When selected the pump will operate independently of any automatic control and not shut down when sewage level drops below BWL. NOTE: dry running may damage the pumps. Care should be taken, therefore, not to allow the level of the wet well to drop too low.

B. OFF - the pump will not start

C. AUTO - automatic operation. When selected pump operating will be controlled by the level regulators.

ii) **Thermal Overload (Motor Overcurrent) -** the overload will trip and cut out the pump when a predetermined current is exceeded for a predetermined time. The pump will remain inoperative until the fault has been rectified and overcurrent relay reset.

iii) **Motor Over temperature (Thermistor) Indication Light**- the indication light remains off while ever the motor operating temperature is below the pre-set thermistor temperature level. Once exceeded, the pump is cut out and the indication light turns on. The pump should not be started again until the fault has been rectified. The thermistor relay must also be reset, after the fault has been found.

vi) **Ammeter** - indicates the current drawn by the pump motor. If the indicated current is above that shown on the engraved pump details plate, the pump should be checked immediately for the cause of overloading.

vii) **Drive Fault Indication Light** - used to indicate a fault condition which occurs when a pump is called to operate and does not start in a predetermined time.

viii) **Level Display** - 4 digit loop powered digital level display to indicate the level in the wet well.

8.5 Potable Water (Ext.7 and 8)

The sewage pump station to be supplied with piped treated/potable water for wet well cleaning. Cleaning of wet wells is a function required regularly and at relatively short intervals (recommended on a weekly basis). Ideally this function should be carried out from ground level by directing an adequate water jet at the walls of the well and entry would not, therefore, be necessary.

A minimum available pressure of 20 metres at a flow rate of 0.70 L/s is required at the pumping station. A 25 mm service will suffice for the designed pumping station.

8.6 Sanitary System (Ext.7 and 8)

Sanitary wastewater from the pumping station ablution facility (wash sinks, drains and toilet) will drain directly into the wet well. The drain pipe into the wet well will be equipped with a check valve to prevent sewage backflow.

8.7 Security and Parking (Ext.7 and 8)

A 1.8m high steel palisade fencing will be erected around all the sewage pump stations. A locked gate will be provided to permit vehicular access to the site including a parking lot for at least 3 vehicles.

8.8 Pumping Mains

Extension 7

A 90mm diameter uPVC pumping main, 751.7m long is proposed.

Extension 8

A 160mm diameter uPVC pumping main, 1567.7m long is proposed

8.9 DESIGN SEWAGE PUMPING MAIN SEWER MODEL RESULTS

TIGANE EXTENSION 8 SEWAGE PUMP STATION PUMPING MAINS DESIGN					
n/n	**Description**	**Symbol**	**Unit**	**Design Value**	**Comment**
	Bar-Colebrok white equation				
1	Static Head	H	m	10	
2	Internal diameter	D	mm	79.8	
3	Diameter	D	m	0.0798	
4	Cross sectional area of pipe	A	m^2	0.005	
5	**Discharge**	**Q**	**m^3/sec**	**0.005**	
6	**Discharge**	**Q**	**L/S**	**5.2**	
7	Velocity	V	m/s	1.040	
8	Length of inlet pipe	Linlet	m	751.7	
9	Pipe roughness coefficient	ε	mm	0.003	uPVC - 0.06
10	Relative roughness	ε		0.0000	
11	Kinematic viscosity	γ	m2/sec	0.0000012	1.2
12	Reynolds number	Re		69139.99	
13	1/SQT of labda (f)			7.1604829	
14	SQR of labda (f)			0.1396554	
15	Labda (friction factor)			0.0195036	
16	Frictional losses	hl	m	10.12	
17	Bends (0x45 degrees) 0x0.45			0.000	
18	Inlet k factor			1.000	
19	2x90 degree bend k factor			0.900	
20	Exit k factor	hlbend	m	0.000	
21	Sum of k factor			1.900	
22	Total en+inlet=local	hlocal		0.105	v^2/29*k
23	Total head losses	Htmax	m	10.227	
24	Static head + frictional losses		m	20.122	
25	Or total head losses as 10% of static and frictional on L		m	1.012	
26	**Total pumping head**		**m**	**21.134**	
27	Discharge per Pump	q	m3/sec	**0.01**	
28	Fluid Specific Gravity	s		**1.200**	
29	Gravity	g	m/s2	**9.810**	
30	Hydraulic Power		KW	**1.294**	
31	Estimated Pump Efficiency		η	0.6	
32	Estimated Motor Efficiency		η	0.6	
33	Combined Pump and Motor Efficiency		η	0.64	
34	**Required Power**		**KW**	**2.02**	

TIGANE EXTENSION 7 SEWAGE PUMP STATION PUMPING MAINS DESIGN					
n/n	**Description**	**Symbol**	**Unit**	**Design Value**	**Comment**
	Bar-Colebrok white equation				
1	Static Head	H	m	33	
2	Internal diameter	D	mm	141.8	
3	Diameter	D	m	0.1418	
4	Cross sectional area of pipe	A	m^2	0.016	
5	**Discharge**	**Q**	**m^3/sec**	**0.015**	
6	**Discharge**	**Q**	**L/S**	**15.3**	
7	Velocity	V	m/s	0.969	
8	Length of inlet pipe	Linlet	m	1567.7	
9	Pipe roughness coefficient	ε	mm	0.003	uPVC - 0.06
10	Relative roughness	ϵ		0.0000	
11	Kinematic viscosity	γ	m2/sec	0.0000012	1.2
12	Reynolds number	Re		114483.81	
13	1/SQT of labda (f)			7.5543147	
14	SQR of labda (f)			0.1323747	
15	Labda (friction factor)			0.0175231	
16	Frictional losses	hl	m	9.27	
17	Bends (0x45 degrees) 0x0.45			0.000	
18	Inlet k factor			1.000	
19	2x90 degree bend k factor			0.900	
20	Exit k factor	hlbend	m	0.000	
21	Sum of k factor			1.900	
22	Total en+inlet=local	hlocal		0.091	v^2/29*k
23	Total head losses	Htmax	m	9.359	
24	Static head + frictional losses		m	42.268	
25	Or total head losses as 10% of static and frictional on L		m	0.927	
26	**Total pumping head**		**m**	**43.195**	
27	Discharge per Pump	q	m3/sec	**0.02**	
28	Fluid Specific Gravity	s		**1.200**	
29	Gravity	g	m/s2	**9.810**	
30	Hydraulic Power		KW	**7.780**	
31	Estimated Pump Efficiency		η	0.6	
32	Estimated Motor Efficiency		η	0.6	
33	Combined Pump and Motor Efficiency		η	0.64	
34	**Required Power**		**KW**	**12.16**	

➢ Node pressure results (Extension 7)

Id	Name	Elevation	Head	Pressure	Discharge
15		1527.85	1550.44	2.21	-5.20
16		1528.05	1549.98	2.15	0.00
17		1533.72	1544.40	1.05	0.00
18		1537.35	1538.82	0.14	0.00
19		1537.35	1537.94	0.06	5.20

- **Node pressure results (Extension 8)**

Node Id	Name	Elevation	Head	Pressure	Discharge
1		1511.35	1555.96	4.37	-15.30
2		1511.24	1555.75	4.36	0.00
3		1516.33	1554.02	3.69	0.00
4		1517.35	1553.76	3.57	0.00
5		1524.64	1551.94	2.68	0.00
6		1525.35	1551.75	2.59	0.00
7		1531.65	1550.32	1.83	0.00
8		1531.27	1549.62	1.80	0.00
9		1534.66	1548.78	1.38	0.00
10		1535.89	1548.49	1.24	0.00
11		1539.59	1546.81	0.71	0.00
12		1543.17	1545.56	0.23	0.00
13		1544.12	1544.99	0.09	0.00
14		1544.25	1544.83	0.06	15.30

- **Pipe flow velocity results (Extension 7)**

Pipe Id	Node From	Node To	Length, m	Diameter, mm	Flow, l/s	Velocity, m/s	Loss, m/pipe length	Gradient
14	15	16	27.448	90	5.20	1.04	0.46	16.63
15	17	18	335.460	90	5.20	1.04	5.58	16.63
16	16	17	335.499	90	5.20	1.04	5.58	16.63
17	18	19	53.244	90	5.20	1.04	0.89	16.63

- **Pipe flow velocity results (Extension 8)**

Pipe Id	Node From	Node To	Length, m	Diameter, mm	Flow, l/s	Velocity, m/s	Loss, m/pipe length	Gradient
1	1	2	29.951	160	15.30	0.97	0.21	7.10
2	2	3	243.490	160	15.30	0.97	1.73	7.10
3	3	4	37.027	160	15.30	0.97	0.26	7.10
4	4	5	256.268	160	15.30	0.97	1.82	7.10
5	5	6	25.725	160	15.30	0.97	0.18	7.10
6	6	7	202.109	160	15.30	0.97	1.43	7.10
7	7	8	99.244	160	15.30	0.97	0.70	7.10
8	8	9	118.343	160	15.30	0.97	0.84	7.10
9	9	10	39.660	160	15.30	0.97	0.28	7.10
10	10	11	237.931	160	15.30	0.97	1.69	7.10
11	11	12	175.117	160	15.30	0.97	1.24	7.10
12	12	13	80.488	160	15.30	0.97	0.57	7.10
13	13	14	22.381	160	15.30	0.97	0.16	7.10

Installation of self-priming sewage pump, complete with electric motor, 150mm diameter suction and delivery lines, electric cables, control panel and pump changeover automation.

The above infrastructure installation works are tabulated below;

Extension 7

Works Description	Unit	Quantity
Sewage Pump and Pumpstation		
10l/s, 25m head, Gormann Rupp or similar approved complete with complete with electric motor, 150mm diameter suction and delivery lines, electric cables, control panel and pump changeover automation	No	1
Pumphouse complete with gantry beam and supports and gantry crane and accessories	sum	1

Extension 8

Works Description	Unit	Quantity
Sewage Pump and Pumpstation		
25l/s, 45m head, Gormann Rupp or similar approved complete with complete with electric motor, 150mm diameter suction and delivery lines, electric cables, control panel and pump changeover automation	No	1
Pumphouse complete with gantry beam and supports and gantry crane and accessories	sum	1

8.10 Offsite Gravity Mains

Extension 7

A 160mm diameter uPVC offsite gravity sewer, 310.532m long is proposed

Extension 8

A 200mm diameter uPVC offsite gravity sewer, 1281.531m long is proposed

9 Annexures

ANNEXURE A

(DESIGNS)