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GCS Geotechnical
(Pty) Ltd

- *Dolomite Stability Investigations*
- *Geotechnical Monitoring*
- *Rockfall Protection Systems*
- *Rock Engineering*
- *Geotechnical Investigations*

Report on a Dolomite Stability Investigation for Unitas Park Ext 16 in Unitas Park, Gauteng

Client: PHUMAF

Reference: 19-0916.047DSIR01

Dated: 29 January 2021

Report on a Dolomite Stability Investigation for Unitas Park Ext 16 in Unitas Park, Gauteng

Reference: 19-0916.047DSIR01	**Dated: 29 January 2021**

TABLE OF CONTENTS

1. INTRODUCTION AND SCOPE OF REPORT 4

2. GENERAL GEOLOGY AND EXISTING INFORMATION 4

3. FIELDWORK 5

4. SITE GEOLOGY 6

4.1 General Geology of the Area 6

4.2 Transported 6

4.3 Residual Shale 6

4.4 Residual Chert 6

4.5 Residual Syenite 6

4.6 Shale Bedrock 6

4.7 Chert Bedrock 6

4.8 Syenite Bedrock 6

4.9 WAD 7

4.10 Dolomite Bedrock 7

5. GROUNDWATER AND HYDROGEOLOGICAL COMPARTMENTS 7

6. SEISMICITY 7

7. DOLOMITE STABILITY ASSESSMENT 8

7.1 Previous Dolomite Stability Investigations 8

7.2 Project Dolomite Stability Investigation 9

7.2.1 Project Percussion Drilling 9

7.3 Dolomite Stability Evaluation 11

7.3.1 General Site Geotechnical Conditions 11

7.3.2 Zonal Demarcation 11

7.3.3 Zone A 12

7.3.4 Zone B 13

7.3.5 Zone C 14

7.4 Summary of Dolomite Risk Assessment 14

8. DEVELOPMENT RECOMMENDATIONS 16

8.1 Proposed Development and Appropriate 'D' Designations 16

9. CONCLUSIONS 16

10. RECOMMENDATIONS 17

Appendix A : Gravity Survey Report
Appendix B-1 : Project Borehole Profiles
Appendix B-2 : Existing Borehole Profiles
Appendix C : Water Precautionary Measures
Appendix D : Monitoring

Figures : Zoned Site Plan & Geological Map

Report on a Dolomite Stability Investigation for Unitas Park Ext 16 in Unitas Park, Gauteng

Reference: 19-0916.047DSIR01	**Dated: 29 January 2021**

EXECUTIVE SUMMARY

This report contains the results of a dolomite stability investigation (DSI) and assessment carried out for the proposed residential development at Unitas Park Ext 16 in Unitas Park, Gauteng. The purpose of this report is to assess the potential for dolomite instability and potential sinkhole formation in relation to the proposed development.

Holistically, the subsoil conditions encountered over the site generally comprise a thin cover of transported material underlain by residual chert, residual shale, residual syenite potentially shale bedrock, shale bedrock, syenite bedrock, chert bedrock, and finally underlain by weathered to fresh dolomite. The water table was measured at between 10.9 m and 20.8 m with the OWL that possibly resided at an assumed depth of around 50 m to 55 m below surface.

The drilling results of this investigation have been utilised, together with the current gravity survey and three previous drilling investigations. This data was analysed to determine the inherent hazard class (IHC) of the entire site and ascertain the sustainability of the proposed development with respect to the dolomite stability.

All of the borehole results combined have revealed that there is a low to medium risk for small to large sinkholes. The entire site can be classed as IHC 1-4//1-4 with a dolomite area designation of D2-D4. A summary is provided below:

Zone	Sinkhole	IHC	Building Class	Designation	IHC (Zone)	Relevant Boreholes
A	Low Risk for Small	1//1	RN1	D2	1//1	GCS (2012): BH03, 04 Intraconsult (2008): 2931, 3823, 4732, 3044, 4027, 4750, 3426, 4655 VGI (2015): 3925/11, 3925/12 Luxton (1976): BH3 GeoStable (2018): GS03, GS04
			RL1	D2 + FPI		
B	Low - Medium Risk for Small-Large	1//1	RN1	D2	1-4//1-4	Intraconsult (2008): 2643, 2648, 2938, 3451
		1//1	RL1	D2 + FPI		
		4//4	RN1, RL1	D4		
C	Medium Risk for Small – Large	4//4	RN1, RL1	D4	3-4//3-4	GCS (2021): BH01, BH02, BH05, BH06, BH07, BH08, BH09, BH11 Intraconsult (2008): 3456, 3948, 4325, 3540, 3621, 4443 VGI (2015): 1544/5, 1544/5

This type of development can only be considered provided the water precautionary measures in Appendix C are adhered to and a D2 or D4 designation (refer to above table) implemented for water ingress prevention and foundations. The available open space has provisionally been assessed in terms of the risk of dolomite instability by using a standard gravity and drilling survey according to SANS 1936-1.

Recommendations for earthworks and drainage to promote any stable and appropriate development (especially applicable to dolomitic terrain) are given.

It is a requirement that this report be presented to the Council for Geoscience for perusal, archiving and the provision of an official Record of Decision. Furthermore, construction supervision by approved dolomite practitioners (geo-professionals and engineers) will be required and also the design and implementation of the required DRMS and DRMP in accordance with SANS 1936-4.

If a RN1 & RL1 type development is considered necessary on IHC 3-4//3-4 land, then a dolomite D4 specialist will be required to oversee the design, construction, preparation and implementation of the required DRMS and DRMP.

Finally, the ground conditions described in this report refer specifically to those encountered in the boreholes put down on site. It is therefore quite possible that conditions at variance with those discussed above can be encountered elsewhere. It is therefore important that ***GCS Geotechnical*** *carry out periodic inspections of the open excavations. Any change from the anticipated ground conditions could then be taken into account to avoid unnecessary expense.* ***In this regard it is important that the construction phase of the project be treated as an augmentation of the geotechnical investigation.***

Report on a Dolomite Stability Investigation for Unitas Park Ext 16 in Unitas Park, Gauteng

Reference: 19-0916.047DSIR01	**Dated: 29 January 2021**

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Report on a Dolomite Stability Investigation for Unitas Park Ext 16 in Unitas Park, Gauteng

Reference: 19-0916.47R01	**Dated: 29 January 2021**

1. INTRODUCTION AND SCOPE OF REPORT

At the request of Mr. Sikelela Mnguni of Phumaf (hereafter referred to as *the client*), GCS Geotechnical (hereafter referred to as GCS) was asked to provide a proposal and cost estimate for the undertaking of a dolomite stability investigation (DSI) for Unitas Park Ext 16 in Unitas Park as part of the rapid land release program (RLRP) on the 21 November 2019. The appointment was accepted and finalized on the 26 October 2020, and fieldwork was conducted on 21 January 2021 due to access issues with the landowner.

The intention of this investigation is to provide a dolomite stability evaluation across the site and to assess (in conjunction with the Council for Geoscience), the suitability of the site in terms of the proposed new development. This report attempts to provide a preliminary dolomite risk zonation for the entire site using existing information together with information gained during this investigation. The purpose of this dolomite stability report is to provide the following information:

- Establish the nature and engineering properties of the underlying soil strata for the entire site.
- Make preliminary recommendations in respect of the foundation design and construction of the proposed new pump station in terms of dolomite stability.
- Draw attention to pertinent ground water conditions.
- Provide an assessment of the dolomite stability using current percussion boreholes over the entire site.
- Finally, to comment on the suitability of the proposed new pump station as it is in relation to the dolomite stability and Inherent Hazard Class (IHC).

The proposed layout of the site is shown in Figure 1.

2. GENERAL GEOLOGY AND EXISTING INFORMATION

The following information was drawn upon for the purposes of the investigation:

- GSSA, 1986: The 1:250 000 Geological Map Series – West Rand – *2626* (1986), as compiled by the South African Geological Survey, 1986;
- DWAF, 1999: The 1:500 000 Hydrogeological Map titled "2526 Johannesburg" as compiled by DWAF, 1999.
- CGS, 2001: The 1:50 000 Geotechnical Map Series 2627DB Vereeniging.
- HDH, 2002: Geotechnical Site Investigations for Housing Developments (Generic Specification GFSH-2, September 2002);
- Luxton, 1976: Report and percussion borehole logs for a project titled "*Unita Park Extension 2 Vereeniging*" written by R.F. Luxton, Hunting, and Associates, project number: 152/75, on 24 March 1976. CGS reference: F659;
- VGI, 2015: Report and percussion borehole logs for a project titled "*Unitas Park Extension 17 On Portion 224 Of The Farm Houtkop 594-IQ : Dolomite Stability Feasibility Investigation*" written by VGI Consult, project number: VGI3925, on 24 November 2015. CGS reference: F4783;
- Intraconsult, 2008: Report and percussion borehole logs for a project titled "*GFSH-2, Phase 1 Dolomite Stability Investigations: Lenong: Potion 156 and 203 of Farm Houtkop 594-IQ*" written by Intraconsult Associates, project number: IR874R, on 20 June 2008. CGS reference: F4783;
- GeoStable, 2018: Report and percussion borehole logs for a project titled "*Dolomite Stability and Geotechnical Report On A Portion Of Portion 224 Houtkop 594 IQ, To Be Known As*

Unitas Park Ext 21 Emfuleni Local Municipality" written by GeoStable SA, project number: GS0510 REV 00, in August 2018. CGS reference: F5452;

The table below shows the available published physiographical data pertaining to the site.

Table 2: Summary of Available Desk Study Information

Parameter	Value	Reference
Development	Housing	Phumaf
Site coordinates	26°35'28.47"S/ 27°53'10.80"E	Phumaf
Weinerts N-value	3 to 4	Weinert (1974)
Climatic Region	Moderate	TRH 2 (1978)
Rainfall	650 to 700 mm	2526 Johannesburg (1999) 1:500 000 scale
Temperature	0-26°C	After DWAF (1986)
Evaporation	1625 mm	After DWAF (1986)
Water Balance	Deficit	Schulze (1985)
Weathering Type	Moderate decomposition	Fookes et al (1971) & Embleton et al (1979)
General geology	Sandstone and shale of the Vryheid Formation, Ecca Group, Karoo Supergroup, and chert and dolomite of the Malmani Subgroup, Chuniespoort Group, Transvaal Supergroup.	2626 West Rand (1986) 1:250 000 scale
Soil cover	-	Brink (1985) Vol 4
Origin	-	Brink (1985) Vol 4
Topography	Varying between 2% and 5% or between 1:60 and 1:20.	
Quaternary Catchment	C22F	DWAF (1999)
Hydrogeology	D3: Intergranular and Fractured (0.5-2.0 L/sec) & C5: Karst (>5.0 L/sec)	2526 Johannesburg (1999) 1:500 000 scale
Depth to groundwater	Unknown	Barnard (2000)
Erodibility Index	Low 16-20	WRC (1992)
Seismic Intensity	VI (MMS)	Fernandez et al (1972)
Liquefaction Potential	Likely (peak horizontal acceleration 100-200 cm/s2)	Welland (2002)

The site is located within the town of Unitas Park in Gauteng. The site is approximately 154 ha in size and slopes gently towards an unnamed drainage path that follows the R54 along the south western boundary. The site is covered by grass in the southern and western portion while the remainder of the site is an active maize farm.

3. FIELDWORK

The initial fieldwork **for this investigation** was carried out on 17 November 2020 and comprised a detailed gravity survey at a spacing of 30 m grid over entire site, and is included in Appendix A.

Ten rotary percussion boreholes were also drilled across the site as part of a deep geotechnical investigation. A copy of the borehole logs is included in Appendix B-1 and the positions are shown on Figure 1. The coordinates of the borehole drilled during this investigation are given in Table 3 below:

Table 3: Summary of Borehole Coordinates (WGS84)

No	S – coordinate	E – coordinate	Depth (m)
BH01	26°37'05.24"S	27°54'22.47"E	31
BH02	26°37'17.31"S	27°54'33.83"E	13
BH03	26°37'11.46"S	27°54'10.87"E	20
BH04	26°37'13.43"S	27°54'05.63"E	21
BH05	26°37'34.16"S	27°54'10.85"E	36
BH06	26°37'06.90"S	27°54'18.00"E	31
BH07	26°37'13.32"S	27°54'27.71"E	53
BH08	26°37'30.70"S	27°53'54.19"E	41
BH09	26°37'32.08"S	27°54'03.49"E	30
BH11	26°37'42.98"S	27°53'57.21"E	52

4. SITE GEOLOGY

4.1 General Geology of the Area

The site is found to be underlain by a layer of transported material which in turn is underlain by residual chert and potential residual shale. This is underlain by chert bedrock and potential shale bedrock that has been intruded by syenite. This is underlain by dolomite bedrock of the Malmani Subgroup, Chuniespoort Group, Transvaal Supergroup at between 13 m and >60 m below EGL. The dolomite bedrock described above is solid with penetration rates greater than 3 min/m. There appears to be a mantle of weathered & altered dolomite (WAD) just above the dolomite bedrock.

4.2 Transported

The horizon is typically orange brown to medium brown to red brown, silty sandy gravelly clay. It is found from surface to depths of between 1 m and 3 m and is found across the site.

4.3 Residual Shale

The residual shale is typically orange brown speckled red and grey, slightly sandy gravelly clay. The residual shale is found at depths between 3 m and 5 m.

4.4 Residual Chert

The residual chert is typically red brown speckled orange, silty gravely clay. The residual chert is found at depths between 1 m and 4 m.

4.5 Residual Syenite

The residual syenite is typically orange brown speckled light and dark grey to light orange brown, clayey gravel to gravelly silt. The residual chert is found at depths between 1 m and 4 m.

4.6 Shale Bedrock

Shale bedrock comprises generally orange brown speckled red and grey to dusky light brown mottled grey and red, completely to moderately weathered rock. It is seen to overlie the dolomite and chert at depths of >20 m.

4.7 Chert Bedrock

Chert bedrock comprises generally dark grey brown to dark brown mottled orange and white to light brown to light grey, highly to slightly weathered rock. It is seen to overlie the dolomite at depths of between 6 m and >30 m.

4.8 Syenite Bedrock

Syenite bedrock comprises generally dark grey stained red to orange brown, highly to moderately weathered rock. It is seen to overlie the dolomite and chert at depths of between 5 m and 23 m as well as intruding into the chert bedrock.

4.9 WAD

The weathered and altered dolomite (WAD) is seen to occur just above the dolomite bedrock or in thin lenses within the chert bedrock and is between 1 m and 4 m thick with some penetration rates <15 min/m.

4.10 Dolomite Bedrock

Fresh dolomite bedrock comprised as dark to light grey, slightly weathered rock with penetration rates of >3min/m and is found occurring at depths of between 13 m and >60 m.

5. GROUNDWATER AND HYDROGEOLOGICAL COMPARTMENTS

The drilling results from the dolomite stability investigation indicate that a varying groundwater table is present across the site with an average resting water level of 14.1 mbgl. This is summarised below in Table 5:

Table 5: Summary of Resting Water Levels in Boreholes

No	Depth to water (mbgl)
BH01	20.8
BH02	>13.0 (dry)
BH03	>20.0 (dry)
BH04	10.9
BH05	15.7
BH06	13.2
BH07	12.5
BH08	12.3
BH09	12.1
BH11	14.9

The rest water level implies that potential receptacles or caves within the dolomite bedrock (that may receive eroded material) will be water filled and are therefore unlikely to receive eroded material to form a sinkhole. **The base level of erosion is at this water level.**

The 1:500 000 hydrogeological map series (2526 Johannesburg, dated 1999) documents that the site overlies both intergranular and fractured, and karst aquifers as having a typical borehole yield of 0.5-2.0 *l/s* and >5.0 *l/s* respectively. The quality of the groundwater is represented by the conductivity range of 0-70 mS/m. The map also shows concentrated groundwater usage for irrigation purposes.

The site resides in the Lower Klip River North dolomitic groundwater compartment and shows an average decrease in water level from 51.2 mbgl in August 1987 to 53.9 mbgl in April 2009. This is probably caused by the increase in irrigation surrounding the site.

6. SEISMICITY

The site is represented by a seismic intensity of VI (MMS) and the expected maximum peak horizontal ground acceleration is 100-200 cm/s², due mainly to mining activity on the Reef and a fault that runs north south through the site. This is confirmed by the updated relevant SANS seismicity code which estimates the peak ground acceleration to be 0.15g (CGS, 2003) in the area, with a 10% probability of being exceeded in the next 50 years.

7. DOLOMITE STABILITY ASSESSMENT

The site dolomite D classes are provided based on the type of structures envisaged (generally residential). The site is to include single storey structures and structures up to 3 storeys. The densities provided by the client fit into two designations of structures and are summarised below in Table 7:

Table 7: Summary of Land Use Designations

Designation	Description
RN1	Up to 60 dwelling houses per hectare with stands larger than 150 m2, and a population of < 300 people per hectare
RL1	≤ 3 storeys with 80 to 120 units per hectare and a population not exceeding 600 people per hectare

7.1 Previous Dolomite Stability Investigations

Investigations at the Council of Geological Sciences (CGS) revealed that three previous dolomite drilling investigations have been undertaken in the area. These include a report written by Intraconsult in 2008 (CGS report reference: F4783), a report written by VGI Consult in 2015 (CGS report reference: F4783, a report written by R.F Loxton, Hunting, and Associates in 1976 (CGS report reference: F659), and a report written by GeoStable SA cc in 2018 (CGS report reference: F5452). During drilling, air flush samples and penetration times were taken at intervals of 1 m and any air losses, minimal resistance to drilling and cavities were recorded where present. Water strikes were recorded during drilling when encountered. Recovered samples were logged by a registered engineering geologist.

CGS report F4783 by Intraconsult included eighteen boreholes for a potential residential development within the site. The depths of these boreholes range between 18 m and 60 m, with dolomite being encountered in BH 3540, 3621, 4037, 4325, and 4443.

CGS report F4783 by VGI Consult included four boreholes for a proposed residential development within the site. The depth of these boreholes was 60 m, with dolomite not being encountered in any of them.

CGS report reference F659 included one borehole for a proposed residential development within the site. The depth of this borehole was 22 m, with dolomite not being encountered.

CGS report reference F5452 included two boreholes for a proposed residential development within the site. The depth of these boreholes was 60 m, with dolomite not being encountered.

The existing borehole logs across the site can be found in Appendix B-2 and a summary of the boreholes drilled can be seen below in Table 7.1:

Table 7.1: Summary of Desk Study

CGS Report No	BH No	Dolomite Bedrock (mbgl)	IHC	Dolomite 'D' Designation
F4783 (Intraconsult)	2643	>60	1-4//1-4	D2-D4
	2648	>60	1-4//1-4	D2-D4
	2931	>60	1//1	D2
	2938	>60	1-4//1-4	D2-D4
	3044	>57	1//1	D2
	3426	>60	1//1	D2
	3451	>60	1-4//1-4	D2-D4
	3456	>57	4//4	D4
	3540	27-33	4//4	D4
	3621	22-28	4//4	D4
	3832	>60	1//1	D2
	3948	>60	4//4	D4
	4037	38-44	1//1	D2
	4325	34-40	4//4	D4
	4443	12-18	3//3	D4
	4655	>60	1//1	D2
	4732	>60	1//1	D2
	4750	>44	1//1	D2
F4783 (VGI)	1544/5	>60	4//4	D4
	3925/01	>60	4//4	D4
	3925/11	>60	1//1	D2
	3925/12	>60	1//1	D2
F659	BH3	>22	2//2	D2
F5452	GS03	>60	1//1	D2
	GS04	>60	1//1	D2

***Please note that Footprint Investigations (FPI's) will be required for building class RL1.**

7.2 Project Dolomite Stability Investigation

7.2.1 Project Percussion Drilling

Eleven rotary percussion boreholes were drilled during this dolomite stability investigation. During drilling, air flush samples and penetration times were taken at intervals of 1 m and any air losses, minimal resistance to drilling and cavities were recorded where present. Water strikes were recorded during drilling when encountered. Recovered samples were logged by a registered engineering geologist.

Borehole logs can be found in Appendix B-1 and a summary of the borehole logs is shown in Table 7.2.1 below:

Table 7.2.1: Summary of Borehole Data

BH No	Wad (m-m)	Chert (m-m)	Dolomite (mbgl)	Water Level (mbgl)	Gravity Signal	Penetration Rate (s/m)			Air Loss			IHC	D-Designation**	Dolomite Zone
						Cavity	0-10	10-15	Slight	Med	Total			
GCS (2021)														
01	-	2-11,27-31	>31	20.8	High	-	-	-	-	-	-	4//4	D4	C
02	-	1-6	6-13	-	High	-	-	-	-	-	-	3//3	D4	C
03	-	-	>20	-	Low	-	-	-	12-20	-	-	2//2	D2	A
04	-	-	>20	10.9	Low – Medium	-	-	-	-	-	-	2//2	D2	A
05	-	1-36	>36	15.7	Medium – High	-	-	-	-	-	-	4//4	D4	C
06	-	8-17,23-31	>31	13.2	Medium	-	-	-	-	-	-	4//4	D4	C
07	31-36	12-20	45-53	12.5	Medium	-	33-36	31	33-36,45,51-53	31-33	-	4//8	D4	C
08	-	2-18,24-41	>41	12.3	Medium	-	-	-	-	-	-	4//4	D4	C
09	-	0-6,15-30	>30	12.1	Medium – High	-	-	-	-	-	-	4//4	D4	C
11	-	0-5,20-40	40-52	14.9	Medium	-	-	-	-	-	-	4//4	D4	C
Intraconsult (2008)														
2643	-	-	>60	34	Medium	-	-	-	-	-	-	1-4//1-4	D2-D4	B
2648	-	-	>60	34	Medium	-	-	-	-	-	-	1-4//1-4	D2-D4	B
2931	-	-	>60	34	Low	-	-	-	-	-	-	1//1	D2	A
2938	-	-	>60	38	Medium	-	-	-	-	-	-	1-4//1-4	D2-D4	B
3044	-	29-30,40-51	>57	36	Medium – High	-	-	-	-	-	-	1//1	D2	A
3426	-	-	>60	34	Low	-	-	-	-	-	-	1//1	D2	A
3451	-	-	>60	31	Medium	-	-	-	-	-	-	1-4//1-4	D2-D4	B
3456	-	9-57	>57	29	High	-	-	-	-	-	-	4//4	D4	C
3540	-	6-27	27-33	-	Medium	-	-	-	-	-	-	4//4	D4	C
3621	-	2-21	22-28	-	High	-	-	-	-	-	-	4//4	D4	C
3832	-	-	>60	32	Low	-	-	-	-	-	-	1//1	D2	A
3948	-	7-22,30-60	>60	31	Medium	-	-	-	-	-	-	4//4	D4	C
4037	-	30-38	38-44	32	Medium	-	-	-	-	-	-	1//1	D2	A
4325	-	10-34	34-40	31	Medium – High	-	-	-	-	-	-	4//4	D4	C
4443	-	2-12	12-18	-	Medium – High	-	-	-	-	-	-	3//3	D4	C
4655	-	-	>60	27	Medium	-	-	-	-	-	-	1//1	D2	A
4732	-	-	>60	31	Low	-	-	-	-	-	-	1//1	D2	A
4750	-	-	>44	28	Low	-	-	-	-	-	-	1//1	D2	A
VGI Consult (2015)														
1544/5	-	0-60	>60	-	Medium	-	-	-	-	-	-	4//4	D4	C
3925/01	-	4-16,34-60	>60	24.0	Medium	-	-	-	-	-	-	4//4	D4	C
3925/11	-	31-60	>60	Collapse	Low	-	-	-	-	-	-	1//1	D2	A
3925/12	-	-	>60	23.0	Low	-	-	-	-	-	-	1//1	D2	A
Luxton (1976)														
BH3	-	-	>22	19.1	Low	-	-	-	-	-	-	2//2	D2	A
GeoStable (2018)														
GS03	-	-	>60	12.0	Low	-	-	-	-	-	-	1//1	D2	A
GS04	-	-	>60	16.0	Low	-	-	-	-	-	-	1//1	D2	A

Mbgl = metres below ground level

*** = water strikes measured, boreholes collapsed, and rest water levels were unable to be recorded.**

**** = FPI Required for Building Class RL1 on D2 land**

7.3 Dolomite Stability Evaluation

7.3.1 General Site Geotechnical Conditions

The following geotechnical factors determined during the investigation are considered pertinent to the evaluation of the stability of the site with respect to features associated with dolomitic terrain.

- Slightly weathered and fractured dolomite bedrock was encountered across the site at depths between 6 m and >60 m. The drilling results therefore indicate a mature karst terrain.
- Water strikes were encountered.
- Water levels across the site are anticipated to be between 10.9 m and 20.8 m and relatively shallow ground water is seen across the site. **This is considered a condition positive to stability as this water table represents the base level of potential erosion.** Caverns, if present, within the dolomite bedrock will also likely be water-filled and thus preventing the acceptance of any eroded material from above, which is a positive.
- Much of the upper soil profile above the water table is considered to possess a relatively low permeability and erosion potential and therefore a low to medium with respect to mobilisation, with a fairly steep angle of draw (60 to 80 degrees). This condition generally produces medium-sized sinkholes.
- Dolomite residuum (WAD) was identified in BH07 and is seen to over lie the dolomite bedrock. **This condition is considered negative to the stability of the profile with respect to mobilisation.**
- For the purposes of risk assessment, it has been assumed that small disseminated and interconnected openings (receptacles) occur within the dolomite residuum that was encountered across the site. Such a condition is necessary for the formation of sinkholes and dolines. Likewise, cavities must be assumed to exist within the dolomite bedrock.
- **Slight to medium air loss was encountered in BH0 & 07 just above and within the WAD-rich zones.**
- The relatively flat ground fall (1:20 to 1:60) across the site will not generally encourage the run-off of surface stormwater and is considered a negative in terms of stability but can be mitigated and engineered.
- **The water level variation over 25 years has been recorded as a 2.7 m drop and the OWL has been estimated at a depth around 40-50 m below surface.**

7.3.2 Zonal Demarcation

The site can be demarcated into three zones based on the borehole profiles. The site is underlain by deep shales as well as chert interbedded by syenite, diamictite, and dolomite. This shale unit is either part of the Malmani Subgroup, resulting in the profile being dolomitic, or part of the Karoo Supergroup, resulting in the profile being non-dolomitic.

7.3.2.1 Zone A

Zone A is represented by the following boreholes:

Borehole:		
GCS (2021)		
BH03	BH04	
Intraconsult (2008)		
2931	3823	4732
3044	4027	4750
3426	4655	
VGI (2015)		
3925/11	3925/12	
Luxton (1976)		
BH3		
GeoStable (2018)		
GS03	GS04	

Solid dolomite bedrock was encountered in this zone at a depth of between 38 m and >60 m with no WAD or low-density material greater than 2m above. This area has been classified as ***IHC1//1*** (D2) with a low risk of small sinkhole formation and low risk of subsidence.

7.3.2.2 Zone B

Zone B is represented by the following boreholes:

Borehole:		
Intraconsult (2008)		
2643	2648	2938
3451		

Solid dolomite bedrock was not encountered in this zone to a depth of >60 m with no WAD or low-density material greater than 2m above. This area has been classified as ***IHC1-4//1-4*** (IHC1=D2; IHC4=D4) with a low to medium risk of small to large sinkhole formation and low to medium risk of subsidence. This zone comprises boreholes that encountered issues with the identification of the formation or group. The shale bedrock comprises either Vryheid Formation (Karoo cover) or Malmani Subgroup (dolomitic cover). If the overlying shale is Vryheid Formation, then the zone is IHC1//1, whereas if the shale is Malmani Subgroup, the zone is IHC4//4. Previous logs identified the shale as Vryheid Formation, however the presence of chert fragments throughout the profile opposes with this classification.

7.3.2.3 Zone C

Zone C is represented by the following boreholes:

Borehole:		
GCS (2021)		
BH01	BH02	BH05
BH06	BH07	BH08
BH09	BH11	
Intraconsult (2008)		
3456	3948	4325
3540	3621	4443
VGI (2015)		
1544/5	1544/5	

Solid dolomite bedrock was encountered in this zone at a depth of between 6 m and >60 m with WAD or low-density material greater than 2m in BH07 only. This area has been classified as ***IHC3-4//3-4*** (D4) with a medium risk of small to large sinkhole formation and medium risk of subsidence.

The zones can be analysed in terms of dolomite stability in the following manner:

7.3.3 Zone A

- ***Existing Receptacle Development***

Slight airloss was recorded in BH03 only and no sample loss was not recorded in any of the boreholes. No cavities were recorded in the boreholes. Cavities are, however, assumed to exist within the dolomite bedrock beneath the site and it is highly likely that these cavities may be water-filled due to all the boreholes recording relatively shallow resting water levels.

- ***Mobilising Agencies***

The water table has been measured to be an average of 14.1 m below surface. The original water level (OWL) has been estimated to be about 50 to 55 mbgl. Therefore, the mobilising agencies considered will be the ingress of surface water and possibly leaking services.

- ***Nature of Blanketing Layers***

The karoo and chert cover will likely prove competent. Low-density erodible WAD was not present in any boreholes.

- ***Potential Development Space***

The geotechnical properties would suggest a maximum potential development space that would correspond to a low risk for a small (<2 m Ø) sinkhole. A low risk is associated with subsidence.

- ***Mobilising Potential of Blanketing Layer***

The karoo, syenite, and chert cover found above the dolomite is considered to have a low mobilisation potential due to the moderate to high penetration rates, inherently low permeability and medium density.

- ***Risk of Sinkhole/Doline Development***

There is a low risk for small to large sinkholes and a low risk of subsidence.

- ***Inherent Hazard Class (IHC)***

Zone A can be assigned an IHC of 1//1 and a D2 Designation (SANS 1936-1:2012). The proposed new development is therefore supported with standard precautionary measures.

7.3.4 Zone B

- ***Existing Receptacle Development***

Slight airloss and sample loss was not recorded in any of the boreholes. No cavities were recorded in the boreholes. Cavities are, however, assumed to exist within the dolomite bedrock beneath the site and it is highly likely that these cavities may be water-filled due to all the boreholes recording relatively shallow resting water levels.

- ***Mobilising Agencies***

The water table has been measured to be an average of 14.1 m below surface. The original water level (OWL) has been estimated to be about 50 to 55 mbgl. Therefore, the mobilising agencies considered will be the ingress of surface water and possibly leaking services.

- ***Nature of Blanketing Layers***

The potential karoo and chert cover will likely prove competent. Low-density erodible WAD was not present in any boreholes.

- ***Potential Development Space***

The geotechnical properties would suggest a maximum potential development space that would correspond to a medium risk for a small to large (<2 to 15m Ø) sinkhole. A medium risk is associated with subsidence.

- ***Mobilising Potential of Blanketing Layer***

The potential karoo, syenite, and chert cover found above the dolomite is considered to have a low mobilisation potential due to the moderate to high penetration rates, inherently low permeability and medium density.

- ***Risk of Sinkhole/Doline Development***

There is a medium risk for small to large sinkholes and a medium risk of subsidence.

- ***Inherent Hazard Class (IHC)***

Zone B can be assigned an IHC of 1-4//1-4 and a D2 (IHC1//1 only) or D4 Designation (IHC4//4 only) (SANS 1936-1:2012). The proposed new development on D2 land is therefore supported with standard precautionary measures while D4 land will require **site specific precautionary measures**.

7.3.5 Zone C

- ***Existing Receptacle Development***

Slight to medium airloss and slight sample loss was recorded in BH07 only. No cavities were recorded in the boreholes, but low penetration rates were encountered between 33 m and 36 m. Cavities are, however, assumed to exist within the dolomite bedrock beneath the site and it is highly likely that these cavities may be water-filled due to all the boreholes recording relatively shallow resting water levels.

- ***Mobilising Agencies***

The water table has been measured to be an average of 14.1 m below surface. The original water level (OWL) has been estimated to be about 50 to 55 mbgl. Therefore, the mobilising agencies considered will be the ingress of surface water and possibly leaking services.

- ***Nature of Blanketing Layers***

The potential karoo, syenite, and chert cover will likely prove competent. Low-density erodible WAD was present in BH07 only and had penetration rates of >15 sec/min between 33 m and 36 m.

- ***Potential Development Space***

The geotechnical properties would suggest a maximum potential development space that would correspond to a medium risk for a small to large (<2 to 15m Ø) sinkhole. A medium risk is associated with subsidence.

- ***Mobilising Potential of Blanketing Layer***

The potential karoo, syenite, and chert cover found above the dolomite is considered to have a low mobilisation potential due to the moderate to high penetration rates, inherently low permeability and medium density.

- ***Risk of Sinkhole/Doline Development***

There is a medium risk for small to large sinkholes and a medium risk of subsidence.

- ***Inherent Hazard Class (IHC)***

Zone C can be assigned an IHC of 3-4//3-4 and a D4 Designation (SANS 1936-1:2012). The proposed new development is therefore supported with **site specific precautionary measures**.

7.4 Summary of Dolomite Risk Assessment

The risk assessment is based on certain assumptions, the most important of which are that the dolomite residuum contains potential receptacles and secondly, that the soil would be subjected to a mobilising agency. The most common mobilising agency is ingress of water, which causes sub-surface erosion. The water table represents the base-level of erosion and thus all the unconsolidated soil overlying the dolomite bedrock can be subjected to erosion and mobilisation and this may include a significant amount of WAD (but occurs in limited amounts on this site).

It can be possible to exercise some control over the risk of sinkhole/doline development by providing suitable (and proven) controls to prevent water ingress into the underlying soil horizons. It is essential that a high level of priority be placed on the provision of sound water management procedures in the long term. Recommendations in this regard are given in Appendix C. It is also important to ensure that the procedures adopted for the development do not interfere with the regional water table. **Thus, pumping from boreholes or otherwise lowering of the water table should be discouraged.**

All of the borehole results in each zone have revealed that there is a low to medium risk for small to large sinkholes referring to IHC 1-4//1-4 (D2-D4).

In summary, the site can be represented by IHC 1-4//1-4 (D2-D4 depending on development type). The summary can be seen below in Table 7.4:

Table 7.4: Summary of Proposed Housing Development

Zone	Sinkhole	IHC	Building Class	Designation	IHC (Zone)	Relevant Boreholes
A	Low Risk for Small	1//1	RN1	D2	1//1	GCS (2012): BH03, 04 Intraconsult (2008): 2931, 3823, 4732, 3044, 4027, 4750, 3426, 4655 VGI (2015): 3925/11, 3925/12 Luxton (1976): BH3 GeoStable (2018): GS03, GS04
			RL1	D2 + FPI		
B	Low - Medium Risk for Small-Large	1//1	RN1	D2	1-4//1-4	Intraconsult (2008): 2643, 2648, 2938, 3451
		1//1	RL1	D2 + FPI		
		4//4	RN1, RL1	D4		
C	Medium Risk for Small – Large	4//4	RN1, RL1	D4	3-4//3-4	GCS (2021): BH01, BH02, BH05, BH06, BH07, BH08, BH09, BH11 Intraconsult (2008): 3456, 3948, 4325, 3540, 3621, 4443 VGI (2015): 1544/5, 1544/5

In terms of the IHC 1-4//1-4 assessment for the site, collectively, the proposed development (Building Class RL1 & RN1) is considered suitable provided the water precautionary measures listed in Appendix C are adhered to and the foundation recommendations listed below are implemented.

The following also applies:

- Structures built on dolomitic terrain of IHC 1//1 with dolomite bedrock between 38 m and >60 m with a D2 dolomite area designation (as per the above table) will require precautionary measures, in accordance with the requirements of SANS 1936-3, that are intended to prevent the concentrated ingress of water into the ground.
- Structures built on dolomitic terrain of IHC 3-4//3-4 with dolomite bedrock between 6 m and >60 m with a D4 dolomite area designation (as per the above table) are unlikely to result in a tolerable hazard if the precautionary measures required in terms of SANS 1936-3 are adhered to. Site-specific precautionary measures are required. **The development is not supported as this would attract a D4 classification and the additional precautionary measures suggested for D2/3 would not reduce the risk to manageable levels. If considered necessary, then the development will require the assistance of a dolomite D4 specialist to oversee the design, construction and implementation of the DRMS and DRMP.**
- Where possible the invert excavation level to the soil mattress foundation solution should be moistened to OMC before being compacted to receive the excavated material (supplemented by a coarser fraction) in compacted layers of 150mm maximum thickness to not less than 95% MADD at approximately +/-2% of optimum moisture content. Strict compaction control should be carried out to ensure that the required density is achieved.
- It should be remembered that due to the negative bulking factor produced by compaction (typically up to 30% reduction), extra material may have to be borrowed from cut excavations elsewhere on the site to complete construction of the bedding layer and backfilling, or if not available, identified and purchased from a nearby commercial source.

In terms of the Inherent Hazard Class 1-4//1-4 for the entire site, the proposed development is considered to be suitable and appropriate provided the D2 or D4 dolomite area designation restrictions are implemented.

8. DEVELOPMENT RECOMMENDATIONS

8.1 Proposed Development and Appropriate 'D' Designations

It is understood that the proposed development will be a residential development. In view of the dolomite stability assessment (which has determined that the entire site is characterised by an IHC 1-4//1-4) the proposed development is considered suitable providing the required precautionary measures according to the dolomite D designation are employed.

In terms of the dolomite area designations (SANS 1936-1:2012), an appropriate D2 or D4 Designation should be enforced over the site as per Table 7.4.

A dolomite area designation D2 and D4 state the following:

D2 – "*General precautionary measures, in accordance with the requirements of SANS 1936-3, that are intended to prevent the concentrated ingress of water into the ground, are required."*

D4 – *"The precautionary measures required in terms of SANS 1936-3 are unlikely to result in a tolerable hazard. Site-specific precautionary measures are required."*

This report will be perused in detail by the CGS and an official Record of Decision (RoD) will be provided.

9. CONCLUSIONS

This report contains the results of a stability assessment carried out for the Unitas Park Ext 16 in Unitas Park, Gauteng. The purpose of this report is to assess the potential for dolomite instability and potential sinkhole formation.

Holistically, the subsoil conditions encountered over the site generally comprise a thin cover of transported material underlain by residual chert, residual shale, residual syenite potentially shale bedrock, shale bedrock, syenite bedrock, chert bedrock, and finally underlain by weathered to fresh dolomite. The water table was measured at between 10.9 m and 20.8 m with the OWL that possibly resided at an assumed depth of around 50 m to 55 m below surface.

The drilling results of this investigation have been utilised, together with the current gravity survey and three previous drilling investigated. This data was analysed to determine the inherent hazard class (IHC) of the entire site and ascertain the sustainability of the proposed development with respect to the dolomite stability.

All of the borehole results combined have revealed that there is a low to medium risk for small to large sinkholes. The entire site can be classed as IHC 1-4//1-4 with a dolomite area designation of D2-D4. A summary is provided below:

Zone	Sinkhole	IHC	Building Class	Designation	IHC (Zone)	Relevant Boreholes
A	Low Risk for Small	1//1	RN1	D2	1//1	GCS (2012): BH03, 04 Intraconsult (2008): 2931, 3823, 4732, 3044, 4027, 4750, 3426, 4655 VGI (2015): 3925/11, 3925/12 Luxton (1976): BH3 GeoStable (2018): GS03, GS04
			RL1	D2 + FPI		
B	Low - Medium Risk for Small-Large	1//1	RN1	D2	1-4//1-4	Intraconsult (2008): 2643, 2648, 2938, 3451
		1//1	RL1	D2 + FPI		
		4//4	RN1, RL1	D4		
C	Medium Risk for Small – Large	4//4	RN1, RL1	D4	3-4//3-4	GCS (2021): BH01, BH02, BH05, BH06, BH07, BH08, BH09, BH11 Intraconsult (2008): 3456, 3948, 4325, 3540, 3621, 4443 VGI (2015): 1544/5, 1544/5

10. RECOMMENDATIONS

This type of development can only be considered provided the water precautionary measures in Appendix C are adhered to and a D2 or D4 designation (refer to above table) implemented for water ingress prevention and foundations. The available open space has provisionally been assessed in terms of the risk of dolomite instability by using a standard gravity and drilling survey according to SANS 1936-1.

Recommendations for earthworks and drainage to promote any stable and appropriate development (especially applicable to dolomitic terrain) are given.

It is a requirement that this report be presented to the Council for Geoscience for perusal, archiving and the provision of an official Record of Decision. Furthermore, construction supervision by approved dolomite practitioners (geo-professionals and engineers) will be required and also the design and implementation of the required DRMS and DRMP in accordance with SANS 1936-4.

If a RN1 & RL1 type development is considered necessary on IHC 3-4//3-4 land, then a dolomite D4 specialist will be required to oversee the design, construction, preparation and implementation of the required DRMS and DRMP.

Finally, the ground conditions described in this report refer specifically to those encountered in the boreholes put down on site. It is therefore quite possible that conditions at variance with those discussed above can be encountered elsewhere. It is therefore important that ***GCS Geotechnical*** carry out periodic inspections of the open excavations. Any change from the anticipated ground conditions could then be taken into account to avoid unnecessary expense. **In this regard it is important that the construction phase of the project be treated as an augmentation of the geotechnical investigation.**

Nino Welland, Pr. Eng., Pry Sci Nat
Director
For ***GCS Geotechnical***

Dale Franklin, Pr.Sci.Nat
Associate Engineering Geologist

APPENDIX A
Gravity Survey Report

APPENDIX B-1
Project Borehole Profiles

HOLE No: BH01
Sheet 1 of 1

JOB NUMBER: 000

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

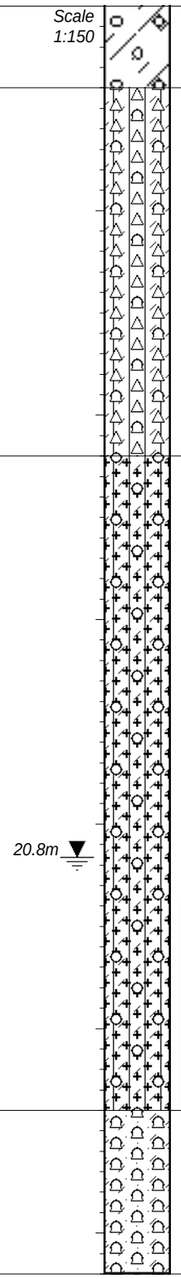
ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

GCS Geotechnical Engineering

HOLE No: BH01
Sheet 1 of 1

JOB NUMBER: 000

Penetration rate (min/m)	Rate (min & sec)	Air return (%)	Sample return (%)
1 2 3 4 5		25 50 75	25 50 75
	0.22		
	0.38		
	0.29		
	0.38		
	0.18		
	0.22		
	0.27		
	0.29		
	0.31		
	0.46		
	0.56		
	0.59		
	0.37		
	0.41		
	0.22		
	0.29		
	0.44		
	0.55		
	0.49		
	0.56		
	1.04		
	1.05		
	0.51		
	0.39		
	0.34		
	0.59		
	0.36		
	0.31		
	0.46		
	0.51		
	0.44		



REDUCED LEVEL

0.00 — Medium brown speckled orange, sandy (10%) gravelly (20%) CLAY (70%). Interpreted as Transported.

2.00 — Light grey to medium grey, gravelly (10%) clayey (15%) SILT (75%) with chert fragments, highly weathered due to penetration rates of between 0:18 and 0:56 min/m. Interpreted as CHERT. Malmani Subgroup.

11.00 — Dark grey stained red, slightly gravelly (10%) clayey (25%) SILT (65%) with syenite fragments, highly to moderately weathered due to penetration rates of between 0:22 and 1:05 min/m. Interpreted as SYENITE.

27.00 — Medium brown to dark grey, clayey (10%) sandy (10%) GRAVEL (80%) with chert fragments, highly weathered due to penetration rates of between 0:31 and 0:51 min/m. Interpreted as CHERT. Malmani Subgroup.

31.00

NOTES

1) Water Table at 20.8m.
2) No Groundwater Strike.
3) Final Depth at 31.0m.
4) No Zone of penetration rates <15sec/m.
5) Coordinates and elevations were recorded using a hand held GPS. Map datum is WGS84 Lo29.

CONTRACTOR : Hennie Erwee
MACHINE : 1900kPa 27.6m3/min
DRILLED BY : Jack
PROFILED BY : Dale Franklin

TYPE SET BY :
SETUP FILE : BH1PG-A3.SET

INCLINATION :
DIAM : 165 mm
DATE : 21/01/2021
DATE : 21/01/2021

DATE : 02/02/2021 13:30
TEXT : ..nitasParkExt16BHLogs.txt

ELEVATION :
X-COORD : 27 54 22.47"E
Y-COORD : 26 37 05.24"S

HOLE No: BH01

HOLE No: BH02
Sheet 1 of 1

JOB NUMBER: 000

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

HOLE No: BH02
Sheet 1 of 1

JOB NUMBER: 000

Penetration rate (min/m)	Rate (min & sec)	Air return (%)	Sample return (%)	REDUCED LEVEL
0.42				-5
0.33				
0.29				
0.26				
0.48				
1.01				
2.01				-10
3.55				
3.58				
3.39				
4.01				
3.58				
3.08				

1 2 3 4 5 — 25 50 75 — 25 50 75

Scale 1:150

0.00 Orange brown, gravelly (10%) CLAY (90%). Interpreted as Transported.

1.00 Light orange, slightly gravelly (5%) clayey (20%) SILT (75%). Interpreted as Residual Chert and Syenite.

6.00 Light to dark grey, clayey (10%) sandy (10%) GRAVEL (80%) with dolomite fragments, positive HCl reaction, slightly weathered due to penetration rates of between 3:08 and 4:01 min/m. Interpreted as DOLOMITE. Malmani Subgroup.

13.00

NOTES

1) No Water Table.
2) No Groundwater Strike.
3) Final Depth at 13.0m.
4) No Zone of penetration rates <15sec/m.
5) Coordinates and elevations were recorded using a hand held GPS. Map datum is WGS84 Lo29.

CONTRACTOR : Hennie Erwee
MACHINE : 1900kPa 27.6m3/min
DRILLED BY : Jack
PROFILED BY : Dale Franklin

TYPE SET BY :
SETUP FILE : BH1PG-A3.SET

INCLINATION :
DIAM : 165 mm
DATE : 21/01/2021
DATE : 21/01/2021

DATE : 02/02/2021 13:30
TEXT : ..nitasParkExt16BHLogs.txt

ELEVATION :
X-COORD : 27 54 33.83"E
Y-COORD : 26 37 17.31"S

HOLE No: BH02

HOLE No: BH03
Sheet 1 of 1

JOB NUMBER: 000

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

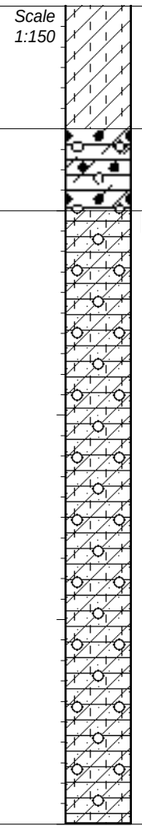
HOLE No: BH03
Sheet 1 of 1

JOB NUMBER: 000

Penetration rate (min/m)	Rate (min & sec)	Air return (%)	Sample return (%)
0.26			
0.31			
0.32			
0.36			
0.41			
1.11			
1.24			
1.02			
1.40			
1.34			
1.46			
0.22			
1.03			
1.10			
1.33			
1.24			
1.39			
1.59			
1.22			
1.54			

1 2 3 4 5 — 25 50 75 — 25 50 75

REDUCED LEVEL



Red brown, silty (20%) CLAY (80%). Interpreted as Transported.

Orange brown speckled red and grey, slightly sandy (5%) gravelly (15%) CLAY (80%) with sale and ferricrete fragments, highly weathered due to use of clay cutter. Interpreted as SHALE. Vryheid Formation.

Dusky light brown mottled grey and red, slightly sandy (5%) gravelly (15%) silty (20%) CLAY (60%) with shale fragments, highly weathered due to use of clay cutter. Interpreted as SHALE. Vryheid Formation.

NOTES

1) No Water Table.
2) No Groundwater Strike.
3) Final Depth at 20.0m.
4) No Zone of penetration rates <15sec/m.
5) Clay cutter used between 4.0--12.0m.
6) Coordinates and elevations were recorded using a hand held GPS. Map datum is WGS84 Lo29.

CONTRACTOR : Hennie Erwee
MACHINE : 1900kPa 27.6m3/min
DRILLED BY : Jack
PROFILED BY : Dale Franklin

TYPE SET BY :
SETUP FILE : BH1PG-A3.SET

INCLINATION :
DIAM : 165 mm
DATE : 21/01/2021
DATE : 21/01/2021

DATE : 02/02/2021 13:30
TEXT : ..nitasParkExt16BHLogs.txt

ELEVATION :
X-COORD : 27 54 10.87"E
Y-COORD : 26 37 11.46"S

HOLE No: BH03

HOLE No: BH04
Sheet 1 of 1

JOB NUMBER: 000

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

GCS Geotechnical Engineering

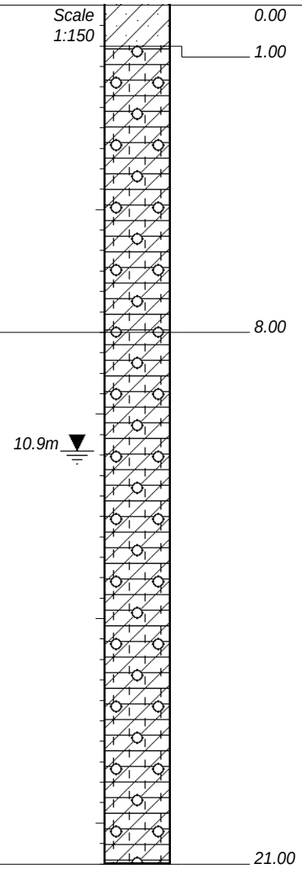
HOLE No: BH04
Sheet 1 of 1

JOB NUMBER: 000

Penetration rate (min/m)	Rate (min & sec)	Air return (%)	Sample return (%)
0.25			
0.34			
0.58			
0.59			
1.24			
1.59			
1.07			
1.24			
1.18			
1.10			
1.15			
1.11			
1.21			
1.22			
1.41			
0.51			
1.01			
1.12			
1.36			
1.41			
2.03			

1 2 3 4 5 — 25 50 75 — 25 50 75

REDUCED LEVEL



0.00 — Dark red brown, sandy (20%) CLAY (80%). Interpreted as Transported.

1.00 — Dark yellow brown, slightly gravelly (3%) silty (7%) CLAY (90%) with quartz and shale fragments, completely to highly weathered due to use of the clay cutter. Interpreted as SHALE. Vryheid Formation.

8.00 — Light yellow brown, slightly gravelly (3%) silty (7%) CLAY (90%) with shale fragments, completely to highly weathered due to use of the clay cutter. Interpreted as SHALE. Vryheid Formation.

21.00

NOTES

1) Water Table at 10.9m.
2) No Groundwater Strike.
3) Final Depth at 21.0m.
4) No Zone of penetration rates <15sec/m.
5) Clay cutter used between 7.0--16.0m.
6) Coordinates and elevations were recorded using a hand held GPS. Map datum is WGS84 Lo29.

CONTRACTOR : Hennie Erwee
MACHINE : 1900kPa 27.6m3/min
DRILLED BY : Jack
PROFILED BY : Dale Franklin
TYPE SET BY :
SETUP FILE : BH1PG-A3.SET

INCLINATION :
DIAM : 165 mm
DATE : 21/01/2021
DATE : 21/01/2021
DATE : 02/02/2021 13:30
TEXT : ..nitasParkExt16BHLogs.txt

ELEVATION :
X-COORD : 27 54 05.63"E
Y-COORD : 26 37 13.43"S

HOLE No: BH04

HOLE No: BH05
Sheet 1 of 2

JOB NUMBER: 000

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

HOLE No: BH05
Sheet 1 of 2

JOB NUMBER: 000

Penetration rate (min/m)	Rate (min & sec)	Air return (%)	Sample return (%)
0.37			
0.41			
0.36			
0.28			
0.56			
0.59			
1.03			
1.12			
1.01			
1.37			
1.15			
1.01			
1.03			
0.32			
0.46			
0.49			
0.52			
0.38			
0.28			
0.42			
1.26			
1.28			
1.26			
1.09			
1.12			
1.00			
1.25			
1.09			
1.06			
1.31			
1.21			
1.22			
1.33			

Scale 1:150

REDUCED LEVEL

15.7m

0.00	Red brown, gravelly (20%) CLAY (80%). Interpreted as Transported.
1.00	Orange brown speckled medium to dark grey, gravelly (40%) CLAY (60%) with chert fragments, highly weathered due to penetration rates of between 0:28 and 0:59 min/m. Interpreted as CHERT. Malmani Subgroup.
6.00	Pale orange brown, gravelly (10%) silty (30%) CLAY (60%) with chert fragments, highly to moderately weathered due to penetration rates of between 1:01 and 1:37 min/m. Interpreted as CHERT. Malmani Subgroup.
9.00	Light and dark grey, silty (10%) sandy (15%) GRAVEL (75%) with chert fragments, highly to moderately weathered due to penetration rates of between 0:28 and 1:28 min/m. Interpreted as CHERT. Malmani Subgroup.
27.00	Medium to dark grey, silty (5%) gravelly (30%) SAND (65%) with chert fragments, moderately weathered due to penetration rates of between 1:06 and 1:25 min/m. Interpreted as CHERT. Malmani Subgroup.
29.00	Light and dark grey, silty (10%) sandy (15%) GRAVEL (75%) with chert fragments, moderately weathered due to penetration rates of between 1:21 and 1:34 min/m. Interpreted as CHERT. Malmani Subgroup.

HOLE No: BH05
Sheet 2 of 2

JOB NUMBER: 000

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

HOLE No: BH05
Sheet 2 of 2

JOB NUMBER: 000

1.24
1.28
1.34

-35

36.00

NOTES

1) Water Table at 15.7m.
2) No Groundwater Strike.
3) Final Depth at 36.0m.
4) No Zone of penetration rates <15sec/m.
5) Coordinates and elevations were recorded using a hand held GPS. Map datum is WGS84 Lo29.

1 2 3 4 5		25 50 75	25 50 75	
Penetration rate (min/m)	*Rate (min & sec)*	*Air return (%)*	*Sample return (%)*	*REDUCED LEVEL*

CONTRACTOR : Hennie Erwee
MACHINE : 1900kPa 27.6m3/min
DRILLED BY : Jack
PROFILED BY : Dale Franklin

TYPE SET BY :
SETUP FILE : BH1PG-A3.SET

INCLINATION :
DIAM : 165 mm
DATE : 21/01/2021
DATE : 21/01/2021

DATE : 02/02/2021 13:30
TEXT : ..nitasParkExt16BHLogs.txt

ELEVATION :
X-COORD : 27 54 10.85"E
Y-COORD : 26 37 34.16"S

HOLE No: BH05

HOLE No: BH06
Sheet 1 of 1

JOB NUMBER: 000

ROCK FABRIC	GRAIN SIZE	JOINT ROUGHNESS	ROCK HARDNESS
MF -massive	FG -fine grained	SLJ-slickensided	EHR-extremely hard rock
BF -bedded	MG -medium grain	SJ -smooth	VHR-very hard rock
FF -foliated	CG -coarse grain	RJ -rough	HR -hard rock
CF -cleaved			MHR-medium hard rock
SF -schistose	JOINT SPACING	JOINT SHAPE	SR -soft rock
GF -gneissose	VCJ-very close spacg	CUR-curvilinear	VSR-very soft rock
LF -laminated	CJ -close spacing	PLA-planar	
	MJ -medium spacing	UND-undulating	
	WJ -wide spacing	STE-stepped	
	VWJ-very wide spacng	IRR-irregular	

HOLE No: BH06
Sheet 1 of 1

JOB NUMBER: 000

Penetration rate (min/m)	Rate (min & sec)	Air return (%)	Sample return (%)	REDUCED LEVEL
0.38				
0.41				
0.59				
1.12				
1.10				-5
0.35				
0.58				
0.39				
0.59				
1.03				-10
1.10				
1.14				
1.56				
0.46				
0.32				-15
0.46				
1.21				
1.43				
1.53				-20
1.55				
1.27				
1.06				
1.03				-25
0.56				
1.03				
1.51				
0.48				
0.37				-30
0.32				
0.29				
0.37				
1 2 3 4 5		25 50 75	25 50 75	

Scale 1:150

13.2m

0.00	Red brown, gravelly (5%) sandy (10%) CLAY (85%). Interpreted as Transported.
2.00	Orange brown speckled dark grey, clayey (10%) GRAVEL (90%) with ferricrete nodules. Residual Syenite.
5.00	Orange brown, sandy (15%) gravelly (25%) CLAY (65%) with syenite fragments, highly weathered due to penetration rates of between 0:35 and 0:58 min/m. Interpreted as SYENITE.
8.00	Light grey, gravelly (10%) clayey (20%) SILT (70%) with chert fragments, highly to moderately weathered due to penetration rates of between 0:32 and 1:56 min/m. Interpreted as CHERT. Malmani Subgroup.
17.00	Light orange brown, gravelly (15%) clayey (20%) SILT (65%) with syenite fragments, moderately weathered due to penetration rates of between 1:03 and 1:55 min/m. Interpreted as SYENITE.
23.00	Light to medium grey, gravelly (10%) clayey (10%) SILT (80%) with chert fragments, highly to moderately weathered due to penetration rates of between 0:29 and 1:51 min/m. Interpreted as CHERT. Malmani Subgroup.
31.00	

NOTES

1) Water Table at 13.2m.
2) No Groundwater Strike.
3) Final Depth at 31.0m.
4) No Zone of penetration rates <15sec/m.
5) Coordinates and elevations were recorded using a hand held GPS. Map datum is WGS84 Lo29.

CONTRACTOR : Hennie Erwee
MACHINE : 1900kPa 27.6m3/min
DRILLED BY : Jack
PROFILED BY : Dale Franklin

TYPE SET BY :
SETUP FILE : BH1PG-A3.SET

INCLINATION :
DIAM : 165 mm
DATE : 21/01/2021
DATE : 21/01/2021

DATE : 02/02/2021 13:30
TEXT : ..nitasParkExt16BHLogs.txt

ELEVATION :
X-COORD : 27 54 18.00"E
Y-COORD : 26 37 06.90"S

HOLE No: BH06

HOLE No: BH07
Sheet 1 of 2

JOB NUMBER: 000

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

GCS Geotechnical Engineering

HOLE No: BH07
Sheet 1 of 2

JOB NUMBER: 000

Penetration rate (min/m)	Rate (min & sec)	Air return (%)	Sample return (%)	REDUCED LEVEL	Scale 1:150		
	0.35					0.00	Dark brown speckled orange and grey, sandy (5%) clayey (20%) GRAVEL (75%). Interpreted as Transported.
	0.32					1.00	
	0.29						Red brown speckled orange, silty (10%) gravelly (15%) CLAY (75%). Interpreted as Residual Chert.
	0.36					2.00	
	0.22			-5			Light grey to medium grey, sandy (5%) gravelly (20%) SILT (75%), highly weathered due to penetration rates of between 0:22 and 0:44 min/m. Interpreted as CHERT. Malmani Subgroup.
	0.41						
	0.31						
	0.39						
	0.56					8.00	Light orange brown, slightly gravelly (5%) clayey (10%) SILT (85%), highly weathered due to penetration rates of between 0:39 and 0:56 min/m. Interpreted as CHERT. Malmani Subgroup.
	0.44			-10			
	0.39						
	0.40						
	0.27				12.5m	12.00	Light orange with dusky red bands at 15m & 20m, slightly gravelly (5%) clayey (20%) SILT (75%) with syenite fragments, highly weathered due to penetration rates of between 0:17 and 0:34 min/m. Interpreted as SYENITE.
	0.24						
	0.17			-15			
	0.26						
	0.32						
	0.34						
	0.26						
	0.28			-20		20.00	Dark orange brown, slightly gravelly (5%) clayey (30%) SILT (65%) with syenite fragments, highly weathered due to penetration rates of between 0:16 and 0:55 min/m. Interpreted as SYENITE.
	0.21						
	0.55						
	0.41						
	0.33						
	0.29			-25			
	0.38						
	0.40						
	0.36						
	0.28						
	0.55			-30			
	0.16					31.00	
	0.10						
	0.18						
1 2 3 4 5		25 50 75	25 50 75				

HOLE No: BH07
Sheet 2 of 2

JOB NUMBER: 000

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

GCS Geotechnical Engineering

HOLE No: BH07
Sheet 2 of 2

JOB NUMBER: 000

Rate (min & sec)
0.06
0.05
0.10
3.01
1.48
1.36
1.01
1.19
1.16
1.24
2.06
1.50
2.59
1.01
3.46
3.39
3.01
3.16
3.59
3.03

Penetration rate (min/m): 1 2 3 4 5
Air return (%): 25 50 75
Sample return (%): 25 50 75

REDUCED LEVEL

-35
-40
-45
-50

37.00

Dark brown, gravelly (30%) SILT (70%) with chert and dolomite fragments, very low penetration rates of between 0:05 and 0:18 min/m with a dolomite floater at 37.0m. Interpreted as WAD.

45.00

Dark brown, GRAVEL (100%) due to water washing out fines, with chert and dolomite fragments (+HCl reaction), moderately weathered due to penetration rates of between 1:01 and 2:06 min/m. Interpreted as Interbedded CHERT and DOLOMITE. Malmani Subgroup.

Dark to medium grey, GRAVEL (100%) due to water washing out fines, with dolomite fragments (+HCl reaction), moderately to slightly weathered due to penetration rates of between 1:01 and 3:59 min/m. Interpreted as DOLOMITE. Malmani Subgroup.

53.00

NOTES

1) Water Table at 12.5m.
2) No Groundwater Strike.
3) Final Depth at 53.0m.
4) Zone of penetration rates <15sec/m at 32.0m and 34.0-- 36.0m.
5) Coordinates and elevations were recorded using a hand held GPS. Map datum is WGS84 Lo29.

CONTRACTOR : Hennie Erwee
MACHINE : 1900kPa 27.6m3/min
DRILLED BY : Jack
PROFILED BY : Dale Franklin
TYPE SET BY :
SETUP FILE : BH1PG-A3.SET

INCLINATION :
DIAM : 165 mm
DATE : 21/01/2021
DATE : 21/01/2021
DATE : 02/02/2021 13:30
TEXT : ..nitasParkExt16BHLogs.txt

ELEVATION :
X-COORD : 27 54 27.71"E
Y-COORD : 26 37 13.32"S

HOLE No: BH07

HOLE No: BH08
Sheet 1 of 2

JOB NUMBER: 000

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

HOLE No: BH08
Sheet 1 of 2

JOB NUMBER: 000

Penetration rate (min/m)	Rate (min & sec)	Air return (%)	Sample return (%)	REDUCED LEVEL	Scale 1:150		
	0.39					0.00	Red brown, gravelly (20%) silty (20%) CLAY (60%). Interpreted as Transported.
	0.22						
	0.29					2.00	
	0.34						Light grey to medium brown, silty (20%) sandy (25%) GRAVEL (55%) with chert fragments, highly weathered due to penetration rates of between 0:29 and 0:34 min/m. Interpreted as CHERT. Malmani Subgroup.
	0.41					4.00	
	0.37			-5			Light grey brown, gravelly (15%) clayey (25%) SILT (60%) with chert fragments, highly weathered due to penetration rates of between 0:22 and 0:58 min/m. Interpreted as CHERT. Malmani Subgroup.
	0.34						
	0.22						
	0.51						
	0.58			-10		10.00	
	1.10						Pale red to pale red brown, gravelly (10%) clayey (20%) SILT (70%) with chert fragments, highly weathered due to penetration rates of between 0:227 and 0:47 min/m. Interpreted as CHERT. Malmani Subgroup.
	0.47				12.3m		
	0.33						
	0.39						
	0.29			-15			
	0.27						
	0.34						
	0.28						
	0.26					18.00	
	0.35			-20			Orange brown, slightly gravelly (5%) clayey (15%) SILT (80%) with syenite fragments, highly weathered due to penetration rates of between 0:26 and 0:59 min/m. Interpreted as SYENITE.
	0.38						
	0.59						
	0.52						
	0.39					24.00	
	1.01			-25			Medium grey brown, gravelly (20%) silty (20%) SAND (60%) with chert fragments, highly to moderately weathered due to penetration rates of between 0:29 and 1:25 min/m. Interpreted as CHERT. Malmani Subgroup.
	1.17						
	1.25						
	1.01						
	0.29						
	0.31			-30			
	0.48						
	0.49						
	0.30						
1 2 3 4 5		25 50 75	25 50 75				

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

HOLE No: BH08
Sheet 2 of 2

JOB NUMBER: 000

Rate (min & sec)
0.38
0.41
0.31
0.50
0.41
1.09
0.52
0.48

Reduced level: -35, -40

34.00

Medium to dark grey, silty (10%) sandy (20%) GRAVEL (70%) with chert fragments, highly to moderately weathered due to penetration rates of between 0:31 and 1:09 min/m. Interpreted as CHERT. Malmani Subgroup.

41.00

NOTES

1) Water Table at 12.3m.

2) No Groundwater Strike.

3) Final Depth at 41.0m.

4) No Zone of penetration rates <15sec/m.

5) Coordinates and elevations were recorded using a hand held GPS. Map datum is WGS84 Lo29.

1 2 3 4 5 — Penetration rate (min/m) | Rate (min & sec) | 25 50 75 — Air return (%) | 25 50 75 — Sample return (%) | REDUCED LEVEL

CONTRACTOR : Hennie Erwee
MACHINE : 1900kPa 27.6m3/min
DRILLED BY : Jack
PROFILED BY : Dale Franklin

TYPE SET BY :
SETUP FILE : BH1PG-A3.SET

INCLINATION :
DIAM : 165 mm
DATE : 21/01/2021
DATE : 21/01/2021

DATE : 02/02/2021 13:30
TEXT : ..nitasParkExt16BHLogs.txt

ELEVATION :
X-COORD : 27 53 54.19"E
Y-COORD : 26 37 30.70"S

HOLE No: BH08

HOLE No: BH09
Sheet 1 of 1

JOB NUMBER: 000

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

HOLE No: BH09
Sheet 1 of 1

JOB NUMBER: 000

Penetration rate (min/m)	Rate (min & sec)	Air return (%)	Sample return (%)
0.58			
0.49			
0.55			
0.41			
0.59			
0.53			
1.12			
1.01			
0.48			
0.51			
0.59			
0.36			
0.34			
0.41			
0.39			
0.29			
0.31			
0.48			
0.41			
0.58			
0.44			
0.51			
0.48			
0.39			
0.44			
0.46			
1.01			
1.21			
1.00			
1.37			

1 2 3 4 5 — 25 50 75 — 25 50 75

REDUCED LEVEL

Scale 1:150

-5 -10 -15 -20 -25 -30

12.1m

0.00

Light brown mottled light grey, gravelly (15%) sandy (15%) silty (20%) CLAY (50%) with chert fragments, highly to moderately weathered due to penetration rates of between 0:41 and 0:58 min/m. Interpreted as CHERT. Malmani Subgroup.

4.00

Medium brown, gravelly (10%) silty (20%) CLAY (70%) with chert fragments, highly to moderately weathered due to penetration rates of between 0:53 and 0:59 min/m. Interpreted as CHERT. Malmani Subgroup.

6.00

Orange brown, slightly gravelly (5%) sandy (30%) SILT (65%) with syenite fragments, highly to moderately weathered due to penetration rates of between 0:34 and 1:12 min/m. Interpreted as SYENITE.

15.00

Medium to light grey, silty (10%) clayey (10%) sandy (30%) GRAVEL (50%) with chert fragments, highly to moderately weathered due to penetration rates of between 0:29 and 1:37 min/m. Interpreted as CHERT. Malmani Subgroup.

30.00

NOTES

1) Water Table at 12.1m.
2) No Groundwater Strike.
3) Final Depth at 30.0m.
4) No Zone of penetration rates <15sec/m.
5) Coordinates and elevations were recorded using a hand held GPS. Map datum is WGS84 Lo29.

CONTRACTOR : Hennie Erwee
MACHINE : 1900kPa 27.6m3/min
DRILLED BY : Jack
PROFILED BY : Dale Franklin

TYPE SET BY :
SETUP FILE : BH1PG-A3.SET

INCLINATION :
DIAM : 165 mm
DATE : 21/01/2021
DATE : 21/01/2021

DATE : 02/02/2021 13:30
TEXT : ..nitasParkExt16BHLogs.txt

ELEVATION :
X-COORD : 27 54 03.49"E
Y-COORD : 26 37 32.08"S

HOLE No: BH09

HOLE No: BH11
Sheet 1 of 2

JOB NUMBER: 000

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

HOLE No: BH11
Sheet 1 of 2

JOB NUMBER: 000

Penetration rate (min/m)	Rate (min & sec)	Air return (%)	Sample return (%)	REDUCED LEVEL
	0.29			
	0.33			
	0.25			
	0.24			
	0.24			-5
	0.39			
	0.27			
	0.27			
	0.48			
	0.31			-10
	0.43			
	0.24			
	0.22			
	0.31			
	0.29			-15
	0.26			
	0.28			
	0.36			
	0.24			
	0.39			-20
	0.58			
	1.03			
	1.10			
	1.01			
	1.09			-25
	1.03			
	1.16			
	1.20			
	1.29			
	1.37			-30
	2.49			
	3.18			
	1.47			
1 2 3 4 5		25 50 75	25 50 75	

Scale 1:150

14.9m

26.0m

0.00 Light pale red, gravelly (15%) clayey (15%) SILT (70%) with chert fragments, highly weathered due to penetration rates of between 0:24 and 0:33 min/m. Interpreted as CHERT. Malmani Subgroup.

5.00 light orange brown with dusky red band at 10m, gravelly (10%) clayey (10%) SILT (80%) with syenite fragments, highly weathered due to penetration rates of between 0:22 and 0:48 min/m. Interpreted as SYENITE.

16.00 Orange brown, slightly gravelly (3%) silty (20%) SAND (77%) with syenite fragments, highly weathered due to penetration rates of between 0:24 and 0:39 min/m. Interpreted as SYENITE.

20.00 Medium brown speckled dark grey, gravelly (10%) sandy (20%) CLAY (70%) with chert fragments, moderately weathered due to penetration rates of between 0:58 and 1:10 min/m. Interpreted as CHERT. Malmani Subgroup.

25.00 Dark to medium grey, silty (5%) GRAVEL (95%), fines washed out due to water strike, with chert fragments and dolomite band at 31.0--32.0m, moderately to slightly weathered due to penetration rates of between 1:00 and 3:18 min/m. Interpreted as Interbedded CHERT and DOLOMITE. Malmani Subgroup.

HOLE No: BH11
Sheet 2 of 2

JOB NUMBER: 000

ROCK FABRIC	GRAIN SIZE	JOINT ROUGHNESS	ROCK HARDNESS
MF -massive	FG -fine grained	SLJ-slickensided	EHR-extremely hard rock
BF -bedded	MG -medium grain	SJ -smooth	VHR-very hard rock
FF -foliated	CG -coarse grain	RJ -rough	HR -hard rock
CF -cleaved			MHR-medium hard rock
SF -schistose	JOINT SPACING	JOINT SHAPE	SR -soft rock
GF -gneissose	VCJ-very close spacg	CUR-curvilinear	VSR-very soft rock
LF -laminated	CJ -close spacing	PLA-planar	
	MJ -medium spacing	UND-undulating	
	WJ -wide spacing	STE-stepped	
	VWJ-very wide spacng	IRR-irregular	

HOLE No: BH11
Sheet 2 of 2

JOB NUMBER: 000

Rate (min & sec)
1.29
1.48
1.49
1.31
1.09
1.00
1.35
1.26
1.55
3.16
2.46
1.49
1.46
3.22
3.46
2.59
2.58
3.01
3.09

-35
-40
-45
-50

40.00

Dark grey to medium grey, silty (5%) GRAVEL (95%), fines washed out due to water strike, with dolomite fragments, +HCl reaction, moderately to slightly weathered due to penetration rates of between 1:26 and 3:46 min/m. Interpreted as DOLOMITE. Malmani Subgroup.

52.00

NOTES

1) Water Table at 14.9m.
2) Groundwater Strike at 26.0m.
3) Final Depth at 52.0m.
4) No Zone of penetration rates <15sec/m.
5) Coordinates and elevations were recorded using a hand held GPS. Map datum is WGS84 Lo29.

1 2 3 4 5 — Penetration rate (min/m)

Rate (min & sec)

25 50 75 — Air return (%)

25 50 75 — Sample return (%)

REDUCED LEVEL

CONTRACTOR : Hennie Erwee
MACHINE : 1900kPa 27.6m3/min
DRILLED BY : Jack
PROFILED BY : Dale Franklin

TYPE SET BY :
SETUP FILE : BH1PG-A3.SET

INCLINATION :
DIAM : 165 mm
DATE : 21/01/2021
DATE : 21/01/2021

DATE : 02/02/2021 13:30
TEXT : ..nitasParkExt16BHLogs.txt

ELEVATION :
X-COORD : 27 53 57.21"E
Y-COORD : 26 37 42.98"S

HOLE No: BH11

LEGEND
Sheet 1 of 1

JOB NUMBER: 000

	GRAVEL	{SA02}
	GRAVELLY	{SA03}
	SAND	{SA04}
	SANDY	{SA05}
	SILT	{SA06}
	SILTY	{SA07}
	CLAY	{SA08}
	CLAYEY	{SA09}
	SHALE	{SA12}
	DOLOMITE	{SA13}
	BANDS	{SA51}
	SYENITE	{SA17}
	CHERT	{SA21}
	WAD	{SA22}
	FERRICRETE/ferricrete nodules	{SA24}
15.5	PERMANENT WATER TABLE	{SA35}
16.5	WATER SEEPAGE/water strike	{CH50}
	BAND	{SA53}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :
TYPE SET BY :
SETUP FILE : BH1PG-A3.SET

INCLINATION :
DIAM :
DATE :
DATE :
DATE : 02/02/2021 13:30
TEXT : ..nitasParkExt16BHLogs.txt

ELEVATION :
X-COORD :
Y-COORD :

LEGEND
SUMMARY OF SYMBOLS

APPENDIX B-2
Previous Borehole Profiles

Township UNITAS PARK

Page 1

Borehole No BH3

Date September/October, 1975

Peg No _____ Collar Elevation _____

	PLASTICITY ESTIMATE	CLIPS: FINE RATIO BY VOL. (PERCENT)	MAX CHIP SIZE	MIN CHIP SIZE (RANGE (MM))	PENETRATION RATE IN BLOWS PER MM
0m Dry, brown to reddish brown, loose, medium dense, silty sand.	LP				
1m	MP –LP				
2m Damp, brown, reddish brown and yellowish brown (mottled), clayey sand with ferricrete.	"				
3m	"				
4m	"				
5m	"				
6m	"				
7m Dry to damp, light brown to yellowish olive stiff sandy/silty clay. Highly weathered Karroo.	MP				
8m	"				
9m	"				
10m Damp to moist, light brown, light yellowish brown and light grey (mottled), stiff silty clay/clayey silt. Weathered Karroo shale/siltstone.	MP				

Remarks etc.

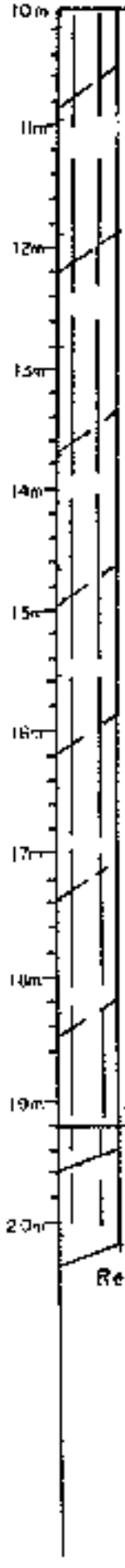
Township UNITAS PARK

Page 2

Borehole No BH3

Date September/October, 1975

Peg No _____ Collar Elevation _____



PLASTICITY ESTIMATE	CHIPS: PERCENTAGE BY VOL. (APPROX.)	MAX. CHIP SIZE	GEN. CHIP FREE MOISTURE (MM)	PENETROMETER RATE TSF
MP				
"				
"				
"				
"				
"				
"				
"				
MP-LP				

Damp to moist, light brown, light yellowish brown and light grey (mottled), stiff silty clay/clayey silt.

Weathered Karroo shale/siltstone.

Wet, light brown to light yellowish brown, soft clayey silt/silty clay.

Remarks etc.

Township UNITAS PARK

Borehole No BH3

Date September/October, 1975

Peg No _____ Collar Elevation _____

PLASTICITY ESTIMATE	CHIPS: (TRUE RATIO BY VOL. APPROX.)	MAX CHIP SIZE	KEN CHIP SIZE NUMBER (MM)	PENETRATION RATE IN METRES PER MIN

20m

2m

Wet, light brown to light yellowish brown, soft clayey silt/silty clay.

22m

End of Hole 72' (21,95 metres)

23m

24m

25m

26m

27m

28m

29m

30m

Remarks etc

DOLOMITE TECHNOLOGY

PERCUSSION BOREHOLE LOG

2015/08/14
02:39 PM
1
Profiel

X= 0.00 Y= 0.00 Z= 0.00 masl

Project no:	1544-DT	Client	**Hans van Heerden**
Project name:	Ged. 156&203 van Plaas Houtkop	Drill contractor:	JK Development
Date drilled:	20080117	Driller:	France
Date profiled:	20080122	**BH NO:**	**BH 1544/5**

Penetr rate	Penetration rate min:s/m	CAV	V SFT	SFT	FAIR H	SOLID	Air loss	DEPTH m	Symbol	Chip size mm	Depth m	DESCRIPTION
0.22			1.0				NONE	1		<5	1	Brown sandy clay with traces of yellow white to brown, moderately weathered sub-angular to rounded chert. Transported / Topsoil. 95% Sandy clay, 5% Chert.
1.17			0.1	0.9			NONE	2	ΔΔΔΔΔΔ	<10		Yellow brown sandy clay with translucent white grey, slightly weathered sub-angular chert. Residual chert. 70% Sandy clay, 30% Chert.
1.21				1.0			NONE	3	ΔΔΔΔΔΔ		3	
1.52				1.0			NONE	4	ΔΔΔΔΔΔ	<5		Greyish brown silty clay with translucent white grey, slightly weathered angular chert. Residual chert. 80% Silty clay, 20% Chert.
1.14				1.0			NONE	5	ΔΔΔΔΔΔ		5	
0.42			0.9	0.1			NONE	6				Light pinkish grey silty clay with minor grey, highly weathered sub-rounded mudrock. Mudrock. 90% Silty clay, 10% Mudrock.
0.49			1.0				NONE	7				
0.35			1.0				NONE	8		<5		
0.41			1.0				NONE	9				
0.45			1.0				NONE	10			10	
0.37			1.0				NONE	11				Light grey to grey, slightly weathered sub-angular to sub rounded mudrock. 100% Mudrock/Siltstone.
0.46			1.0				NONE	12				
1.24			0.1	0.9			NONE	13				
0.41			1.0				NONE	14		<15		
0.53			1.0				NONE	15				
1.24			0.9	0.1			NONE	16				
0.47			1.0				NONE	17				
0.53			1.0				NONE	18			18	
0.40			1.0				NONE	19		<5		Orange brown sandy clay with minor translucent yellow brown to grey, slightly weathered sub-angular chert. Mudrock. 90% Sandy clay, 10% Chert.
0.45			1.0				NONE	20			20	
2.02			0.1	0.9			NONE	21	ΔΔΔΔΔΔ	<10	21	Translucent light grey, unweathered angular chert. 100% Residual chert.
1.21				1.0			NONE	22	ΔΔΔΔΔΔ			
1.24				1.0			NONE	23	ΔΔΔΔΔΔ	<5		Light brown sandy clay with translucent yellow white to grey, unweathered angular chert. Residual chert. 30% Sandy clay, 70% Chert.
0.47			0.9	0.1			NONE	24	ΔΔΔΔΔΔ			
0.48			1.0				NONE	25	ΔΔΔΔΔΔ		25	
0.59			1.0				NONE	26	ΔΔΔΔΔΔ			
1.29			0.1	0.9			NONE	27	ΔΔΔΔΔΔ	<5		Translucent yellow white to grey, unweathered angular chert. 100% Residual chert.
1.04				1.0			NONE	28	ΔΔΔΔΔΔ			
1.18				1.0			NONE	29	ΔΔΔΔΔΔ			
1.00				1.0			NONE	30	ΔΔΔΔΔΔ		30	

Notes:

1. No water encountered. Moist between 21-30m. Dry between 0-22m and 24-30m.
2. Good sample recovery, no sample loss and no air loss.
3. No water used during drilling.
4. Hammer rate generally regular, except between 1-2m, 5-6m, 12-13m, 15-16m, 20-21m, 23-24m and 26-27m, where it was irregular.

Logged by A. Michel
Copyright DOLOMITE TECHNOLOGY

DOLOMITE TECHNOLOGY

PERCUSSION BOREHOLE LOG

2015/08/14
02:39 PM
1
Profiel

X= 0.00 Y= 0.00 Z= 0.00 masl

Project no:	1544-DT	Client	**Hans van Heerden**
Project name:	Ged. 156 & 203 Plaas Houtkop	Drill contractor:	JK Development
Date drilled:	20080117	Driller:	France
Date profiled:	20080122	**BH NO:**	**BH 1544/5cont.**

Penetr rate	Penetration rate min:s/m	CAV	V SFT	SFT	FAIR H	SOLID	Air loss	DEPTH m	Symbol	Chip size mm	Depth m	DESCRIPTION
1.05				1.0			NONE	31	ΔΔΔΔΔΔ			
2.16					0.3	0.7	NONE	32	ΔΔΔΔΔΔ			
2.03					1.0		NONE	33	ΔΔΔΔΔΔ	<5		Light grey sandy clay with translucent light grey to grey, unweathered angular chert. Residual chert. 30% Sandy clay, 70% Chert.
1.54				0.9	0.1		NONE	34	ΔΔΔΔΔΔ			
1.47				1.0			NONE	35	ΔΔΔΔΔΔ			
3.31					0.1	0.9	NONE	36	ΔΔΔΔΔΔ		36	
1.19				0.9	0.1		NONE	37	ΔΔΔΔΔΔ			
1.24				1.0			NONE	38	ΔΔΔΔΔΔ			
1.54				1.0			NONE	39	ΔΔΔΔΔΔ			
1.22				1.0			NONE	40	ΔΔΔΔΔΔ			
1.28				1.0			NONE	41	ΔΔΔΔΔΔ			
1.30				1.0			NONE	42	ΔΔΔΔΔΔ			
1.36				1.0			NONE	43	ΔΔΔΔΔΔ			
2.19					0.5	0.5	NONE	44	ΔΔΔΔΔΔ			
1.24				1.0			NONE	45	ΔΔΔΔΔΔ			
1.16				1.0			NONE	46	ΔΔΔΔΔΔ			
1.26				1.0			NONE	47	ΔΔΔΔΔΔ			
1.19				1.0			NONE	48	ΔΔΔΔΔΔ	<5		Translucent light grey to grey, unweathered angular chert. 100% Residual chert.
1.23				1.0			NONE	49	ΔΔΔΔΔΔ			
1.29				1.0			NONE	50	ΔΔΔΔΔΔ			
1.33				1.0			NONE	51	ΔΔΔΔΔΔ			
1.26				1.0			NONE	52	ΔΔΔΔΔΔ			
1.29				1.0			NONE	53	ΔΔΔΔΔΔ			
1.53				1.0			NONE	54	ΔΔΔΔΔΔ			
1.32				1.0			NONE	55	ΔΔΔΔΔΔ			
1.36				1.0			NONE	56	ΔΔΔΔΔΔ			
1.51				1.0			NONE	57	ΔΔΔΔΔΔ			
1.49				1.0			NONE	58	ΔΔΔΔΔΔ			
1.40				1.0			NONE	59	ΔΔΔΔΔΔ			
1.52				1.0			NONE	60	ΔΔΔΔΔΔ		60	

Notes:

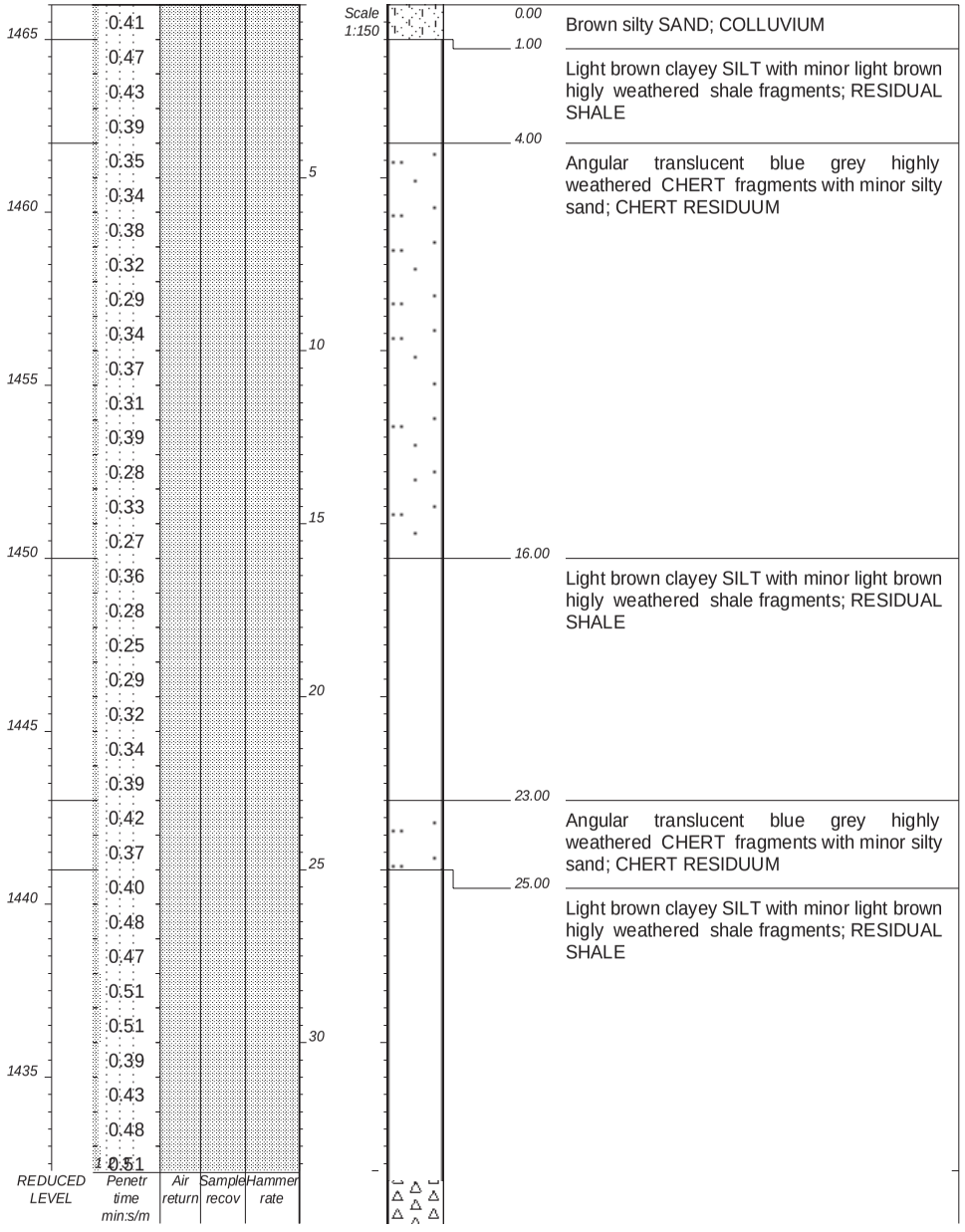
1. Water encountered between 32-33m. Wet between 32-60m. Moist between 30-32m.
2. No air loss and no sample loss, good sample recovery.
3. No water applied during drilling.
4. Hammer rate generally regular, except between 31-32m, 33-34m, 35-36m and 43-44m, where it was irregular.

Logged by A. Michel
Copyright DOLOMITE TECHNOLOGY

SCHULDEN PROPERTIES
UNITAS PARK EXTENSION 17

HOLE No: 3925/01
Sheet 1 of 2

JOB NUMBER: VGI3925



0.00 — Brown silty SAND; COLLUVIUM

1.00 — Light brown clayey SILT with minor light brown higly weathered shale fragments; RESIDUAL SHALE

4.00 — Angular translucent blue grey highly weathered CHERT fragments with minor silty sand; CHERT RESIDUUM

16.00 — Light brown clayey SILT with minor light brown higly weathered shale fragments; RESIDUAL SHALE

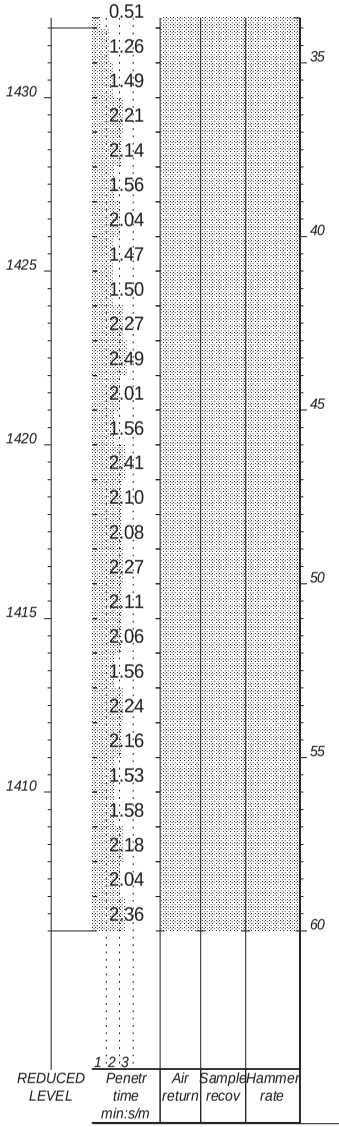
23.00 — Angular translucent blue grey highly weathered CHERT fragments with minor silty sand; CHERT RESIDUUM

25.00 — Light brown clayey SILT with minor light brown higly weathered shale fragments; RESIDUAL SHALE

SCHULDEN PROPERTIES
UNITAS PARK EXTENSION 17

HOLE No: 3925/01
Sheet 2 of 2

JOB NUMBER: VGI3925



34.00 — Angular translucent blue grey highly weathered CHERT fragments with minor silty sand; CHERT RESIDUUM

60.00

NOTES

1) Driller reports solid conditions, hole stopped at 60 m.

2) Groundwater intercepted at 34 m.

3) Groundwater rest level recorded at 24 m on 2015/11/06.

4) Original Dolomite Aquifer Groundwater Level (OWL) ?m AMSL

5) Kliprivier Dolomite Groundwater Compartment

6) No water added

7) Driller reports no air or sample loss.

8) Projection Information: CM 27 degrees, Transverse Mercator, WGS 84

CONTRACTOR : RUBICON BORE
MACHINE : ROCK GIANT
DRILLED BY : S. MORELE
PROFILED BY : J.MEINTJES

INCLINATION : 90 DEGREES
DIAM : 165mm
DATE : 2015/11/05
DATE : 2015/11/09

ELEVATION : 1466 m AMSL
X-COORD : 2946941
Y-COORD : -89265

TYPE SET BY : J.MEINTJES
SETUP FILE : SETUP.SET

DATE : 01/12/15 12:43
TEXT : ..C:\DOTFILES\201512~1.TXT

HOLE No: 3925/01

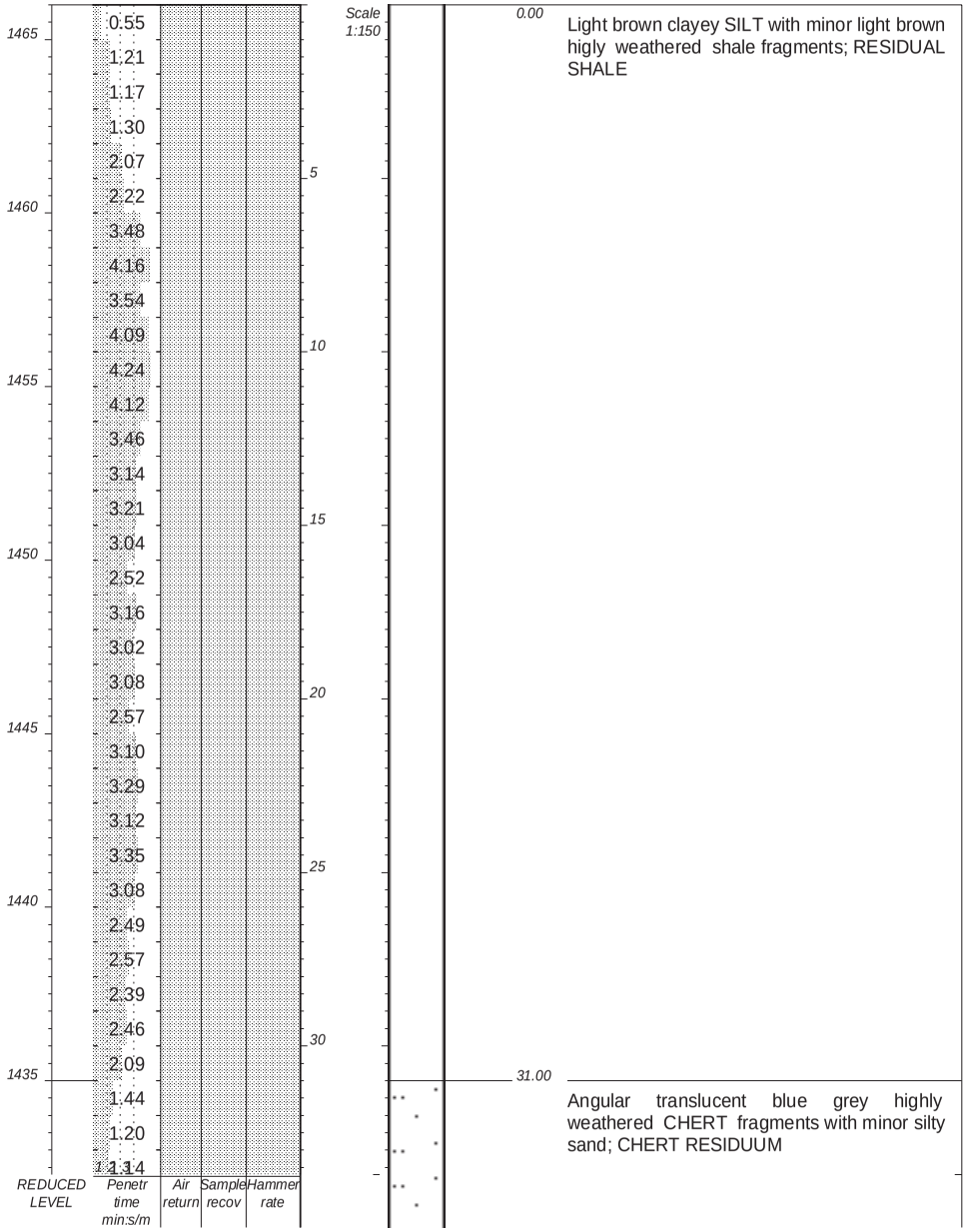
D055 DBB

dot.PLOT 5006 J&W

SCHULDEN PROPERTIES
UNITAS PARK EXTENSION 17

HOLE No: 3925/11
Sheet 1 of 2

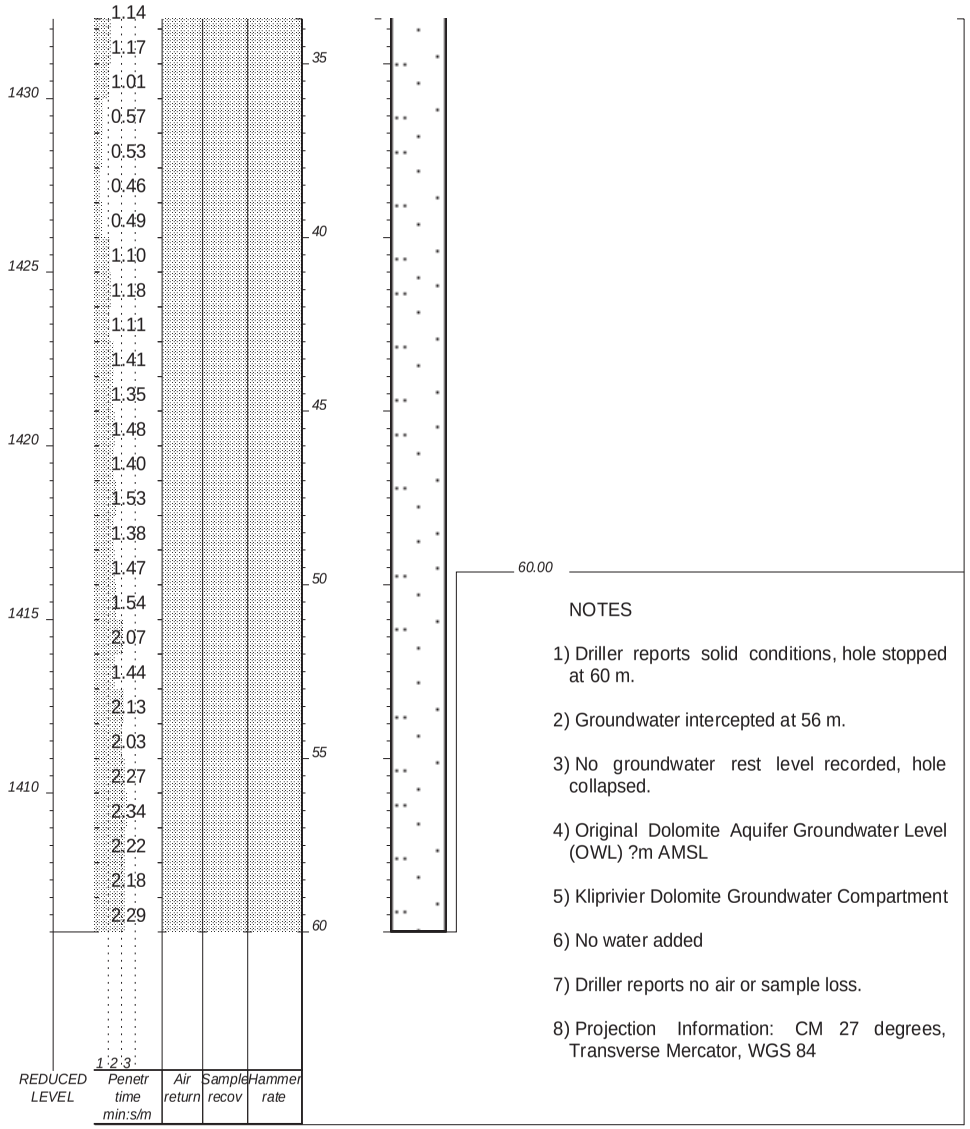
JOB NUMBER: VGI3925



SCHULDEN PROPERTIES
UNITAS PARK EXTENSION 17

HOLE No: 3925/11
Sheet 2 of 2

JOB NUMBER: VGI3925



NOTES

1) Driller reports solid conditions, hole stopped at 60 m.

2) Groundwater intercepted at 56 m.

3) No groundwater rest level recorded, hole collapsed.

4) Original Dolomite Aquifer Groundwater Level (OWL) ?m AMSL

5) Kliprivier Dolomite Groundwater Compartment

6) No water added

7) Driller reports no air or sample loss.

8) Projection Information: CM 27 degrees, Transverse Mercator, WGS 84

CONTRACTOR : RUBICON BORE
MACHINE : ROCK GIANT
DRILLED BY : S. MORELE
PROFILED BY : J.MEINTJES

INCLINATION : 90 DEGREES
DIAM : 165mm
DATE : 2015/11/10
DATE : 2015/11/11

ELEVATION : 1466 m AMSL
X-COORD : 2947262
Y-COORD : -89762

HOLE No: 3925/11

TYPE SET BY : J.MEINTJES
SETUP FILE : SETUP.SET

DATE : 01/12/15 12:44
TEXT : ..C:\DOTFILES\201512~1.TXT

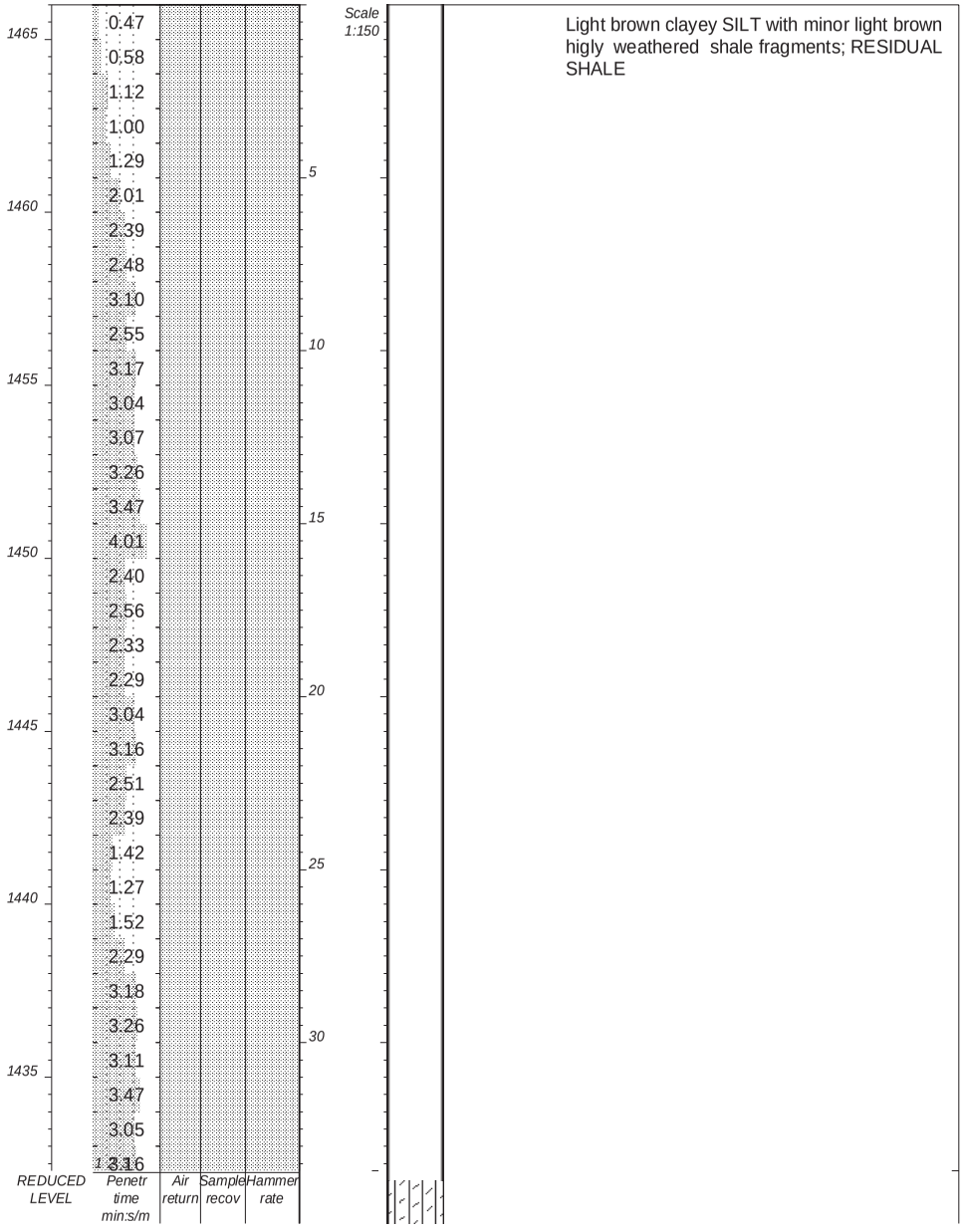
D055 DBB

dot.PLOT 5006 J&W

SCHULDEN PROPERTIES
UNITAS PARK EXTENSION 17

HOLE No: 3925/12
Sheet 1 of 2

JOB NUMBER: VGI3925

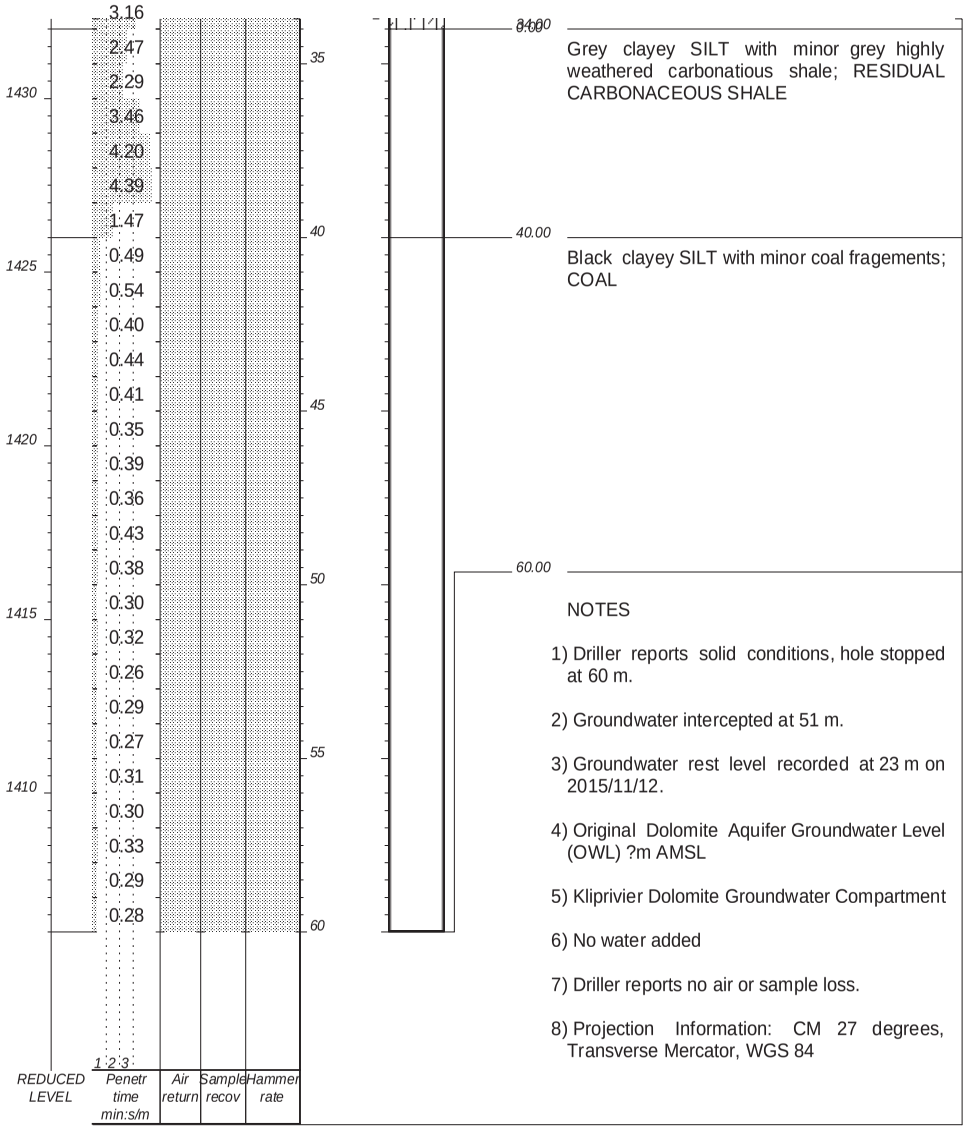


Light brown clayey SILT with minor light brown higly weathered shale fragments; RESIDUAL SHALE

SCHULDEN PROPERTIES
UNITAS PARK EXTENSION 17

HOLE No: 3925/12
Sheet 2 of 2

JOB NUMBER: VGI3925



Grey clayey SILT with minor grey highly weathered carbonatious shale; RESIDUAL CARBONACEOUS SHALE

Black clayey SILT with minor coal fragements; COAL

NOTES

1) Driller reports solid conditions, hole stopped at 60 m.

2) Groundwater intercepted at 51 m.

3) Groundwater rest level recorded at 23 m on 2015/11/12.

4) Original Dolomite Aquifer Groundwater Level (OWL) ?m AMSL

5) Kliprivier Dolomite Groundwater Compartment

6) No water added

7) Driller reports no air or sample loss.

8) Projection Information: CM 27 degrees, Transverse Mercator, WGS 84

CONTRACTOR : RUBICON BORE
MACHINE : ROCK GIANT
DRILLED BY : S. MORELE
PROFILED BY : J.MEINTJES

INCLINATION : 90 DEGREES
DIAM : 165mm
DATE : 2015/11/11
DATE : 2015/11/11

ELEVATION : 1466 m AMSL
X-COORD : 2947153
Y-COORD : -89788

TYPE SET BY : J.MEINTJES
SETUP FILE : SETUP.SET

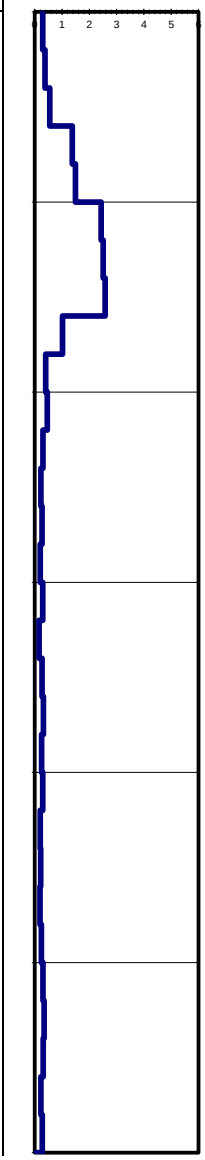
DATE : 01/12/15 12:44
TEXT : ..C:\DOTFILES\201512~1.TXT

HOLE No: 3925/12

GeoStable SA cc

Percussion borehole log

Project no:	GS0510	BH NO:	**GS03**
Project name:	**Unitaspark X21**	Client:	Schulden Properties (Pty) Ltd
Date drilled:	24/07/2018	Drill contractor:	JK Drilling
Date profiled:	24/07/2018	Driller:	Patrick
Coordinates (Lo 29 & WGS 84):	Y= E 27°54'01,9"	X=	S 26°37'58,3"



Penetr rate	CAVATY	V SOFT	SOFT	FAIR H	SOLID	Very irregular	Irregular	Regular	Air loss	Depth m	Chip size mm	Symbol	Groundwater	DESCRIPTION
0,29		1,0						X	NONE	1		:|\:|\:|\:|\o		
0,38		1,0						X	NONE	2		:|\:|\:|\:|\:		
0,55		1,0						X	NONE	3	<10	:|o:|\:|\:|\		Reddish brown to brown sandy clayey SILT with traces of yellow brown and light brown weathered shale GRAVEL. R**ESIDUAL SHALE with traces of chert and ferricrete.**
1,38			1,0				X		NONE	4		:|\:|\:|\:|\:		4,0
1,49			1,0					X	NONE	5		||\:||\:|\		
2,43				1,0			X		NONE	6		||\:||\:|\		
2,51				1,0				X	NONE	7	<10	||\:||\:|\		Yellow brown sandy clayey SILT with traces of yellow brown and light brown highly weathered shale GRAVEL. **RESIDUAL SHALE,STIFF CLAY**
2,58				1,0				X	NONE	8		||\:||\:|\		
1,02			1,0				X		NONE	9		||\:||\:|\		9,0
0,40		1,0					X		NONE	10				
0,46		1,0						X	NONE	11				
0,30		1,0						X	NONE	12			▽	
0,23		1,0						X	NONE	13	<10			Grey silty SAND with traces of grey highly weathered sandstone GRAVEL. **RESIDUAL SANDSTONE with traces of shale.**
0,27		1,0						X	NONE	14				
0,20		1,0						X	NONE	15				
0,29		1,0						X	NONE	16				16,0
0,16		1,0						X	NONE	17				
0,27		1,0						X	NONE	18	<10			Yellow brown sandy clayey SILT with minor yellow brown and light brown highly weathered shale GRAVEL. **RESIDUAL SHALE**
0,32		1,0						X	NONE	19				19,0
0,25		1,0						X	NONE	20				
0,29		1,0						X	NONE	21				
0,20		1,0						X	NONE	22				
0,22		1,0						X	NONE	23				
0,19		1,0						X	NONE	24				Grey moderately weathered sandstone GRAVEL with abundant grey silty SAND. S**ANDSTONE with traces of carbonaceous shale and diamictite below 27m.**
0,24		1,0						X	NONE	25				
0,30		1,0						X	NONE	26				
0,34		1,0						X	NONE	27				
0,31		1,0						X	NONE	28				
0,23		1,0						X	NONE	29				
0,28		1,0						X	NONE	30				30,0

continue ...

Notes:

1. Groundwater strike at 31m. Groundwater rest level at 12m.

2. No air or sample losses encountered during drilling.

3. No water applied during drilling.

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Percussion borehole log

Project no:	GS0510	BH NO:	**GS03 continue**
Project name:	**Unitaspark X21**	Client:	Schulden Properties (Pty) Ltd
Date drilled:	24/07/2018	Drill contractor:	JK Drilling
Date profiled:	24/07/2018	Driller:	Patrick
Coordinates (Lo 29 & WGS 84):	Y= E 27°54'01,9"	X=	S 26°37'58,3"

Penetr rate	Penetration rate min:s/m	Formation: CAVATY	V SOFT	SOFT	FAIR H	SOLID	Hammer rate: Very irregular	Irregular	Regular	Air loss	Depth m	Chip size mm	Symbol	Groundwater	DESCRIPTION
0,42			1,0						X	NONE	31		ooΔooΔoo	∇	
0,48			1,0						X	NONE	32		ooΔooΔoo		
0,37			1,0						X	NONE	33		ooΔooΔoo		
0,40			1,0						X	NONE	34		ooΔooΔoo		
0,46			1,0						X	NONE	35		ooΔooΔoo		
0,50			1,0						X	NONE	36		ooΔooΔoo		
0,29			1,0						X	NONE	37		ooΔooΔoo		
0,36			1,0						X	NONE	38		ooΔooΔoo		
0,44			1,0						X	NONE	39		ooΔooΔoo		
0,49			1,0						X	NONE	40		ooΔooΔoo		
0,56			1,0						X	NONE	41		ooΔooΔoo		
0,47			1,0						X	NONE	42		ooΔooΔoo		
1,09				1,0				X		NONE	43		ooΔooΔoo		
1,03				1,0					X	NONE	44		ooΔooΔoo		
1,06				1,0					X	NONE	45	<15	ooΔooΔoo		Dark grey and translucent, slightly weathered to unweathered diamictite GRAVEL. **DIAMICTITE**
1,19				1,0					X	NONE	46		ooΔooΔoo		
0,35			1,0					X		NONE	47		ooΔooΔoo		
0,31			1,0						X	NONE	48		ooΔooΔoo		
0,47			1,0						X	NONE	49		ooΔooΔoo		
0,43			1,0						X	NONE	50		ooΔooΔoo		
0,50			1,0						X	NONE	51		ooΔooΔoo		
0,48			1,0						X	NONE	52		ooΔooΔoo		
0,57			1,0						X	NONE	53		ooΔooΔoo		
1,18				1,0				X		NONE	54		ooΔooΔoo		
1,23				1,0					X	NONE	55		ooΔooΔoo		
1,26				1,0					X	NONE	56		ooΔooΔoo		
1,22				1,0					X	NONE	57		ooΔooΔoo		
1,30				1,0					X	NONE	58		ooΔooΔoo		
1,28				1,0					X	NONE	59		ooΔooΔoo		
1,38				1,0					X	NONE	60		ooΔooΔoo		60,0
															End of hole

Notes:

1. Groundwater strike at 31m. Groundwater rest level at 12m.
2. No air or sample losses encountered during drilling.
3. No water applied during drilling.

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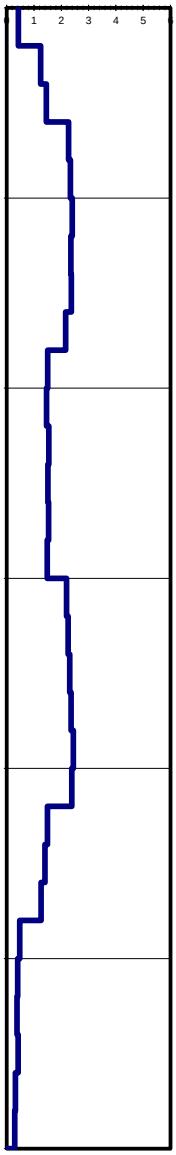
Percussion borehole log

Project no:	GS0510	BH NO:	**GS04**
Project name:	**Unitaspark X21**	Client:	Schulden Properties (Pty) Ltd
Date drilled:	24/07/2018	Drill contractor:	JK Drilling
Date profiled:	24/07/2018	Driller:	Patrick
Coordinates (Lo 29 & WGS 84):	Y= E 27°54'09,4"	X=	S 26°37'54,6"



Penetr rate	CAVATY	V SOFT	SOFT	FAIR H	SOLID	Very irregular	Irregular	Regular	Air loss	Depth m	Chip size mm	Symbol	Groundwater	DESCRIPTION
0,43		1,0						X	NONE	1		:|:|\o:|:|\		
1,24			1,0				X		NONE	2		:|:|:|:|\		
1,45			1,0					X	NONE	3	<10	:|:|\o:|:|\		Reddish brown to brown sandy clayey SILT with traces of yellow brown and light brown highly weathered shale GRAVEL. **RESIDUAL SHALE** with traces of chert and ferricrete.
2,27				1,0			X		NONE	4		:|:|:|:|\		
2,33				1,0				X	NONE	5		:|:|\o:|:|\		
2,40				1,0				X	NONE	6		:|:|:|:|\		6,0
2,35				1,0				X	NONE	7		\\:|\\:|\\:|\\		
2,37				1,0				X	NONE	8		\\:|\\:|\\:|\\		
2,16				1,0				X	NONE	9		\\:|\\:|\\:|\\		
1,50			1,0				X		NONE	10		\\:|\\:|\\:|\\		
1,46			1,0					X	NONE	11		\\:|\\:|\\:|\\		
1,54			1,0					X	NONE	12	<10	\\:|\\:|\\:|\\	∇	Yellow brown sandy clayey SILT with traces of yellow brown and light brown highly weathered shale GRAVEL. **RESIDUAL SHALE and stiff clay.**
1,51			1,0					X	NONE	13		\\:|\\:|\\:|\\		
1,53			1,0					X	NONE	14		\\:|\\:|\\:|\\		
1,48			1,0					X	NONE	15		\\:|\\:|\\:|\\		
2,19				1,0			X		NONE	16		\\:|\\:|\\:|\\		
2,25				1,0				X	NONE	17		\\:|\\:|\\:|\\		
2,31				1,0				X	NONE	18		\\:|\\:|\\:|\\		18,0
2,36				1,0				X	NONE	19	<10			Brown sandy clayey SILT with traces of yellow brown and light brown highly weathered shale GRAVEL. **RESIDUAL SHALE** and stiff clay.
2,44				1,0				X	NONE	20				20,0
2,38				1,0				X	NONE	21				
1,49			1,0				X		NONE	22				
1,40			1,0					X	NONE	23				
1,26			1,0					X	NONE	24				
0,48		1,0					X		NONE	25	<15			Black moderate to slightly weathered corbonaceous shale GRAVEL with minor to abundant black sandy SILT. **CARBONACEOUS SHALE**.
0,40		1,0						X	NONE	26				
0,38		1,0						X	NONE	27				
0,42		1,0						X	NONE	28				
0,32		1,0						X	NONE	29				
0,29		1,0						X	NONE	30				30,0

continue ...

Notes:

1. Groundwater strike at 47m. Groundwater rest level at 16m.

2. No air or sample losses encountered during drilling.

3. No water applied during drilling.

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Percussion borehole log

Project no:	GS0510	BH NO:	**GS04 continue**
Project name:	**Unitaspark X21**	Client:	Schulden Properties (Pty) Ltd
Date drilled:	24/07/2018	Drill contractor:	JK Drilling
Date profiled:	24/07/2018	Driller:	Patrick
Coordinates (Lo 29 & WGS 84):	Y= E 27°54'09,4"	X=	S 26°37'54,6"

Penetr rate	Penetration rate min:s/m	Formation: CAVATY	V SOFT	SOFT	FAIR H	SOLID	Hammer rate: Very irregular	Irregular	Regular	Air loss	Depth m	Chip size mm	Symbol	Groundwater	DESCRIPTION
0,29			1,0						X	NONE	31				
0,34			1,0						X	NONE	32				
0,37			1,0						X	NONE	33				
0,30			1,0						X	NONE	34				
0,41			1,0						X	NONE	35				
0,38			1,0						X	NONE	36	<15			
0,19			1,0						X	NONE	37				Grey moderately weathered sandstone GRAVEL with abundant grey sitly SAND. **SANDSTONE with traces of carbonaceous shale and diamictite below 40m.**
0,25			1,0						X	NONE	38				
0,19			1,0						X	NONE	39				
0,17			1,0						X	NONE	40				
0,21			1,0						X	NONE	41				
0,29			1,0						X	NONE	42				
0,41			1,0						X	NONE	43				
0,46			1,0						X	NONE	44				44,0
0,40			1,0						X	NONE	45		oo∆oo∆oo		
0,35			1,0						X	NONE	46		oo∆oo∆oo		
0,44			1,0						X	NONE	47		oo∆oo∆oo	▽	
0,27			1,0						X	NONE	48		oo∆oo∆oo		
0,20			1,0						X	NONE	49		oo∆oo∆oo		
0,26			1,0						X	NONE	50		oo∆oo∆oo		
0,32			1,0						X	NONE	51		oo∆oo∆oo		
0,49			1,0						X	NONE	52	<15	oo∆oo∆oo		Dark grey and translucent grey, slightly weathered to unweathered dimaictite GRAVEL. **DIAMICTITE**
0,55			1,0						X	NONE	53		oo∆oo∆oo		
1,12				1,0				X		NONE	54		oo∆oo∆oo		
1,08				1,0					X	NONE	55		oo∆oo∆oo		
1,14				1,0					X	NONE	56		oo∆oo∆oo		
1,18				1,0					X	NONE	57		oo∆oo∆oo		
1,26				1,0					X	NONE	58		oo∆oo∆oo		
1,22				1,0					X	NONE	59		oo∆oo∆oo		
1,27				1,0					X	NONE	60		oo∆oo∆oo		60,0
															End of hole

Notes:

1. Groundwater strike at 47m. Groundwater rest level at 16m.

2. No air or sample losses encountered during drilling.

3. No water applied during drilling.

Logged by Andre Fourie

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 3832
SHEET : 2 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946243
Y = -090239

COLLAR ELEV : 1473m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 29.02.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
1.33		**KEY REFERENCE** — **Casing** / **Air Loss** / Static water level
1.37		**DESCRIPTION**
1.42		19-57m: Yellow brown mottled grey CLAYEY SILT; KAROO.
1.41		
1.36	45	
1.48		
1.33		
1.19		
1.14		
1.08	50	
1.21		
1.28		
1.30		
1.25		
1.13	55	
1.16		
1.09		
1.29		57-60m : Dark brown blotched yellow brown CLAYEY SILT; KAROO.
1.26		
1.35	60	
	65	
	70	
	75	
	80	

PROFILED BY DB/DB ON 29.04.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 32m
3. AIR LOSSES : Nil

LENONG

Consulting Engineering Geologists
Tel . (011) 469-0854

REF NO. 1RR74

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 3948
SHEET : 1 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946656
Y = -89652

COLLAR ELEV : 1471m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 12.06.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated

KEY REFERENCE

Casing
Air Loss
Static water level

PENETRATION (MIN,SEC/METRE)	DESCRIPTION
1.19	0-2m: Orange brown CLAYEY SILTY SAND with minor angular white highly weathered CHERT; COLLUVIUM.
1.02	
0.51	2-7m: Yellow brown blotched grey CLAYEY SILT; KAROO.
0.48	
0.48	
0.54	
0.56	
0.59	7-22m: Angular dark red brown and grey highly weathered and FERRUGINISED CHERT and SHALE with minor dark red brown SILTY SAND; FERRUGINISED inter-layered CHERT and SHALE.
1.12	
0.54	
0.51	
1.17	
1.19	
1.16	
1.09	
1.12	
1.10	
1.12	
0.59	
1.03	
1.00	
0.56	
0.58	22-30m: Angular grey khaki highly weathered soft rock SHALE with minor yellow brown CLAYEY SILT; KAROO.
1.14	
1.11	
1.09	
1.03	
0.56	
0.58	
1.10	30-60m: Angular dark grey brown and yellow brown highly weathered CHERT with traces of yellow brown SILTY SAND; CHERT RESIDUUM.
1.31	
1.24	
1.17	
1.40	
1.38	
1.42	
1.53	
2.17	
1.56	
2.04	

PROFILED BY DB/BB ON 12.06.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 31m
3. AIR LOSSES : Nil

LENONG

REF NO IR874

FIG NO.

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Tel : (011) 469-0854

PERCUSSION DRILLING REPORT

BOREHOLE NO : 3948
SHEET : 2 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946656
Y = -89652

COLLAR ELEV : 1471m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 12.06.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY
REFERENCE

Casing
Air Loss
Static water level

PENETRATION (MIN,SEC/METRE)		DESCRIPTION
2.11		30-60m: Angular dark grey brown and yellow brown highly weathered CHERT with traces of yellow brown SILTY SAND; CHERT RESIDUUM.
2.09		
2.30		
2.23		
2.31	45	
2.19		
2.02		
1.42		
1.36		
1.31	50	
1.40		
1.38		
1.44		
1.53		
1.56	55	
1.49		
1.51		
1.28		
1.20		
1.32	60	
	65	
	70	
	75	
	80	

PROFILED BY DB/JB ON 12.06.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 31m
3. AIR LOSSES : Nil

LENONG

REF NO. 18874

FIG NO

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Consulting Engineering Geologists
Tel : (011) 469-0854

PERCUSSION DRILLING REPORT

BOREHOLE NO : 4037
SHEET : 1 OF 2

LOCALITY : LENONG

CO-ORDINATES : X – 2946408
Y = -090119

COLLAR ELEV : 1472m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 29.04.08

The "Geological Column" is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
0.45		Casing Air Loss Static water level
1.32		0-3m : Reddish orange CLAYEY SILTY SAND with abundant sub-round FERRICRETE NODULES; NODULAR FERRICRETE.
1.20		
1.31		3-6m : Reddish orange CLAYEY SILT; KAROO.
1.23	5	
1.08		
0.51		6-13m : Yellow brown mottled grey CLAYEY SILT; KAROO.
0.56		
0.49		
1.12	10	
1.03		
1.05		
0.57		
0.53		13-16m : Angular dark red brown highly weathered soft rock SHALE.
1.12	15	
1.33		
1.29		16-30m: orange brown blotched and mottled grey and dark brown CLAYEY SILT; KAROO
1.21		
1.24		
1.40	20	
1.36		
1.11		
1.04		
0.51		
1.33	25	
1.10		
1.20		
1.41		
1.29		
1.36	30	
0.50		30-38m: Dark brown CLAYEY SILT with abundant angular dark brown and grey highly and medium weathered CHERT; CHERT AND DOLOMITE RESIDUUM.
0.43		
1.38		
1.20		
1.33	35	
1.52		
1.38		
1.17		
3.51		38-44m : Dark brown CLAYEY SILT (WAD) with abundant angular dark grey medium weathered CHERT.
4.11	40	

PROFILED BY DB/RB ON 29.04.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 32m
3. AIR LOSSES : Nil

LENONG

REF NO. IR824

FIG NO.

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 4037
SHEET : 2 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946408
Y = -090119

COLLAR ELEV : 1472m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 29.04.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated

PENETRATION (MIN SEC/METRE)		KEY REFERENCE: Casing; Air Loss; Static water level DESCRIPTION
4.15		38-44m :Angular grey medium weathered hard rock DOLOMITE; [samples contaminated and appear to be not representative]. DOLOMITE BEDROCK.
4.16		
4.05		
4.22		
	45	
	50	
	55	
	60	
	65	
	70	
	75	
	80	

PROFILED BY DB/BB ON 29.04.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25.4m³/min to a 165mm button bit
2. DEPTH OWL : 32m
3. AIR LOSSES : Nil

LENONG

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REF NO. IR874

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO . 4325
SHEET : 1 OF 1

LOCALITY : LENONG

CO-ORDINATES : X – 29466232
Y –090644

COLLAR ELEV : 1471m AMSL
OWL : 1440m AMSL

WGS84, Lo....27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 30.04.08

The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY
REFERENCE

Casing
Air Loss
Static water level

PENETRATION (MIN,SEC/METRE)		DESCRIPTION
1.07 1.52		0-2m : Reddish orange brown CLAYEY SILTY SAND with Traces of sub-round FERRICRETE NODULES; AEOLIAN.
2.14 2.02 1.56 1.48 1.51 1.50 1.33 1.29	5 10	2-10m : Yellow brown mottled grey and orange SANDY CLAYEY SILT; KAROO.
1.41 1.32 1.38 1.46 1.29 1.33 1.27 1.38 1.14 1.09 1.20 1.31 1.25 1.23 1.16 1.05 1.02 1.19 0.54 1.00	15 20 25 30	10-30m : Angular light grey completely weathered very soft rock SHALE and translucent medium weathered CHERT; KAROO.
1.06 1.29 1.14		30-33m : Dark brown SANDY CLAYEY SILT WAD with traces of grey mottled yellow CLAYEY SILT; DOLOMITE RESIDUUM transition.
2.38 3.49 4.00 4.16 4.03 3.51 4.14	35 40	33-34m : Angular blue grey blotched grey slightly weathered Hard rock DOLOMITE with minor light grey CLAYEY SILT and traces of angular dark grey medium weathered CHERT. DOLOMITE BEDROCK. 34-40m : Angular blue grey slightly weathered hard rock DOLOMITE. DOLOMITE BEDROCK.

PROFILED BY DB/BB ON 30.04.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL 31m
3. AIR LOSSES Nil

LENONG

REF NO. IR874

FIG NO.

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 4443
SHEET : 1 OF 1

LOCALITY : LENONG

CO-ORDINATES : X = -2946647
Y = 90027

COLLAR ELEV : 1469m AMSL
OWL : 1440m AMSL

WGS84, Lo....27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 27.02.08

The "Geological Column" is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE	Casing Air Loss Static water level
		DESCRIPTION	
1.14		0-1m : Orange brown CLAYEY SILT; RESIDUAL DIABASE.	
1.29		1-2m . Orange blotched dark brown CLAYEY SILT; RESIDUAL DIABASE.	
1.06		2-12m : Dark brown CLAYEY SILT (WAD) with traces of angular grey white and brown highly weathered CHERT; CHERT AND DOLOMITE RESIDUUM.	
1.32			
1.48	5		
1.51			
1.42			
1.59			
2.16			
1.02	10		
1.14			
1.08			
1.53		12-13m : Angular grey and brown highly weathered and leached DOLOMITE; DOLOMITE BEDROCK.	
2.51			
3.19	15	13-19m : Angular blue grey and grey slightly weathered hard rock DOLOMITE; DOLOMITE BEDROCK.	
3.30			
3.14			
3.11			
3.07			
	20		
	25		
	30		
	35		
	40		

PROFILED BY DB/BB ON 27.02.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m^3/min to a 165mm button bit
2. DEPTH OWL -32m
3. AIR LOSSES Nil

LENONG

REF NO 1R874

Consulting Engineering Geologists
Tel : (011) 469 0854

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 4655
SHEET : 1 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946939
Y = -089616

COLLAR ELEV : 1467m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 13.06.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE

Casing
Air Loss
Static water level

PENETRATION (MIN,SEC/METRE)		DESCRIPTION
1.07		0-1m : Orange brown CLAYEY SILTY SAND; HILLWASH.
1.11		1-3m : As above with traces of angular and sub-angular reddish brown highly weathered QUARTZITE and grey and white highly weathered CHERT; COLLUVIUM / KAROO.
0.56		
0.52		
0.53	5	3-6m : Yellow brown blotched off white and grey CLAYEY SILT; KAROO.
0.48		
0.46		6-21m : Angular light grey blotched pale red medium weathered **soft rock** SHALE with traces of angular **dark grey unweathered** CHERT; KAROO.
0.52		
1.10		
0.59	10	
1.02		
1.06		
1.01		
1.14		
1.21	15	
1.09		
0.56		
0.51		
1.00		
1.03	20	
0.58		
1.13		21-24m : Angular grey stained red brown highly weathered soft rock SHALE, KAROO.
1.29		
1.24		
1.30	25	24-52m : Angular dusky red speckled off white blotched dark grey completely weathered very soft rock SHALE with abundant dusky red CLAYEY SILT; KAROO.
1.25		
1.39		
1.20		
1.09		
1.05	30	
1.11		
1.06		
0.58		
0.59		
1.14	35	
1.12		
1.08		
1.20		
1.13		
1.14	40	

PROFILED BY DH/BB ON 13.06.08

1. COMPRESSOR DELIVERY & PRESSURE HITTY PE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 27m
3. AIR LOSSES : Nil

LENONG

REF NO IR874

FIG NO.

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 4655
SHEET : 2 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946939
Y = -089616

COLLAR ELEV . 1467m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 13/06/08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE
Casing
Air Loss
Static water level

PENETRATION (MIN,SEC/METRE)

1.09
1.21
1.20
1.13
1.16
1.17
1.08
1.26
1.21
1.26
1.19
1.30
1.22
1.28
1.35
1.31
1.24
1.29
1.36
1.34

45
50
55
60
65
70
75
80

DESCRIPTION

24-52m : Angular dusky red speckled off white blotched dark grey completely weathered very soft rock SHALE with abundant dusky red CLAYEY SILT; KAROO.

PROFILED BY DB/RB ON 13/06/08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 27m
3. AIR LOSSES : Nil

LENONG

REF NO. LRB74

FIG NO

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 4732
SHEET : 1 OF 2

LOCALITY :

CO-ORDINATES : X = 2946489
Y = -090528

COLLAR ELEV : 1470m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 30.04.08

The "Geological Column" is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
1.13		0-2m : Reddish orange brown mottled yellow and black CLAYEY SILTY SAND with traces of FERRICRETE NODULES; slightly ferruginised AEOLIAN.
1.41		
1.28		
1.59		
3.44	5	2-60m : Yellow brown mottled grey SANDY CLAYEY SILT, KAROO.
4.18		
6.51		
5.19		
5.52		
6.06	10	
6.29		
6.43		
6.59		
7.42		
5.25	15	
6.39		
6.18		
5.54		
5.38		
4.19	20	
5.25		
4.52		
5.17		
4.41		
3.32	25	
3.56		
4.10		
4.38		
3.49		
3.52	30	
4.04		
2.40		
2.19		
2.21		
2.45	35	
1.52		
1.43		
2.18		
2.06		
2.45	40	

Casing
Air Loss
Static water level

PROFILED BY DB/BB ON 30.04.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL - 31m
3. AIR LOSSES : Nil

LENONG

REF NO IRB74

FIG NO.

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 4732
SHEET : 2 OF 2

LOCALITY :

CO-ORDINATES : X – 2946489
Y = -090528

COLLAR ELEV : 1470m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 30.04.08

The "Geological Column" is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
2.29		2-60m . Yellow brown mottled grey SANDY CLAYEY SILT. KAROO.
2.52		
2.47		
2.20		
2.18	45	
2.32		
2.40		
2.51		
3.11		
3.29	50	
3.04		
2.48		
2.31		
2.31		
2.26	55	
2.48		
3.13		
2.19		
3.20		
3.41	60	
	65	
	70	
	75	
	80	

Casing
Air Loss
Static water level

PROFILED BY DB/DD ON 30.04.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL . 31m
3. AIR LOSSES - Nil

LENONG

REF NO. 2R874

FIG NO

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 4750
SHEET : 1 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946921
Y = -89847

COLLAR ELEV : 1468m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHANN ROTHA

DATE COMPLETED : 13.06.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY
REFERENCE

Casing
Air Loss
Static water level

PENETRATION (MIN,SEC/METRE)		DESCRIPTION
1.59		0-1m : Dark orange brown CLAYEY SILTY SAND, HILLWASH
3.56		
5.29		1-5m : Orange brown mottled yellow brown and black CLAYEY SILTY SAND; FERRUGINISED KAROO.
5.51		
5.56	5	
5.19		5-20m : Yellow brown CLAYEY SILT; KAROO.
5.04		
5.26		
5.43		
5.17	10	
5.20		
4.41		
5.50		
4.58		
4.16	15	
3.49		
4.10		
4.06		
4.32		
4.07	20	
3.36		20-44m : Dark brown to black CLAYEY SILT; DWYKA TILLITE
4.14		
4.02		
3.36		
3.40	25	
3.11		
2.58		
2.41		
3.16		
3.03	30	
4.14		
2.06		
1.39		
1.28		
1.09	35	
1.17		
1.32		
1.29		
1.21		
1.33	40	

PROFILED BY DB/BB ON 13.06.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25.4m³/min to a 165mm button bit
2. DEPTH OWL : 28m
3. AIR LOSSES : Nil

LENONG

R.O.T. NO. 18874

FIG NO.

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 4750
SHEET : 2 OF 2

LOCALITY : LENONG

CO-ORDINATES : X – 2946921
Y = -89847

COLLAR ELEV : 1468m AMSL
OWL : 1440m AMSL

WG584, Lo 27°E

CONTRACTOR : JDHAN BOTHA

DATE COMPLETED : 13.06.08

The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE	Casing Air Loss Static water level DESCRIPTION
1.45			20-44m - Dark brown to black CLAYEY SILT; DWYKA TILLITE
1.39			
1.56			
1.33			
	45		
	50		
	55		
	60		
	65		
	70		
	75		
	80		

PROFILED BY DB/HR ON 13.06.08

1 COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit

2 DEPTH OWL : 28m

3. AIR LOSSES : Nil

LENONG

REF NO IR874

FIG NO.

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 3044
SHEET : 1 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946271
Y = -089563

COLLAR ELEV : 1476m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 28.02.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
2.02		0-3m : Reddish orange brown SANDY CLAYEY SILT with minor angular and sub-angular grey QUARTZITE AND CHERT; KAROO.
2.13		
2.34		
2.09		3-29m : Reddish orange CLAYEY SILT; RESIDUAL DIABASE.
3.12	5	
2.41		
2.08		
1.32		
1.45		
2.00	10	
1.36		
1.40		
1.52		
1.34		
1.45	15	
1.42		
1.51		
1.56		
1.40		
1.08	20	
1.21		
1.34		
1.29		
1.22		
1.03	25	
0.58		
0.51		
1.10		
0.56		
0.49	30	29-30m : Angular dark grey stained reddish brown highly weathered hard rock SLATE AND CHERT with minor orange CLAYEY SILT; KAROO.
1.04		30-40m : Olive blotched orange CLAYEY SILT; RESIDUAL DIABASE.
1.11		
0.59		
0.51		
0.52	35	
0.58		
1.02		
1.03		
0.51		
0.54	40	

KEY REFERENCE
Casing
Air Loss
Static water level

PROFILED BY DB/BB ON 28.02.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 36m
3. AIR LOSSES : Nil

LENONG

REF NO IR874
FIG NO.

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 3044
SHEET : 2 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946271
Y = -089563

COLLAR ELEV : 1476m AMSL
OWL : 1440m AMSL

WG584, Lo 27°E

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 28.02.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
1.06		40-43m : Angular grey blotched dark grey and red brown highly weathered hard rock CHERT BAND.
1.12		
1.19		
1.14		43-45m : Angular light grey stained red brown completely weathered very soft rock SHALE.
1.00	45	
1.08		45-51m : Angular dark grey blotched dark reddish brown slightly and medium weathered hard rock CHERT BAND.
1.01		
1.06		
1.16		
1.32	50	
1.49		
3.51		51-57m : Angular dark grey unweathered hard rock DIABASE.
3.08		
3.31		
3.42	55	
3.19		
3.33		
	60	
	65	
	70	
	75	
	80	

Casing
Air Loss
Static water level

PROFILED BY DB/BB ON 28.02.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 36m
3. AIR LOSSES : Nil

LENONG

REF NO. [illegible]

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FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 3426
SHEET : 1 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2945995
Y = -090331

COLLAR ELEV : 1475m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 29.04.08

The "Geological Column" is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE	DESCRIPTION
1.02		Casing Air Loss Static water level	0-6m: Reddish mottled black CLAYEY SILTY SAND with traces of sub-round FERRICRETE: FERRICRETE.
1.17			
2.48			
3.00			
3.14	5		
3.11			
2.39			6-43m : Yellow brown mottled grey CLAYEY SILT, KAROO.
2.06			
2.51			
2.32	10		
2.17			
2.12			
2.18			
2.04			
2.36	15		
2.21			
1.38			
1.41			
1.29			
1.17	20		
1.42			
1.58			
1.37			
1.28			
1.21	25		
1.20			
1.07			
1.18			
1.13			
1.20	30		
1.05			
1.21			
1.40			
1.38			
1.07	35		
1.51			
2.04			
1.37			
1.22			
1.26	40		

PROFILED BY DB/BB ON 29.04.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm hutton bit
2. DEPTH OWL : 34m
3. AIR LOSSES : Nil

LENONG

REF NO IR874

FIG NO

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 3426
SHEET : 2 OF 2

LOCALITY : LENONG

CO-ORDINATES : X – 2945995
Y = -090331

COLLAR ELEV : 1475m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 29.04.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE: Casing / Air Loss / Static water level

PENETRATION (MIN,SEC/METRE)		DESCRIPTION
1.41		6-43m: Yellow brown mottled grey CLAYEY SILT; KAROO.
1.37		
1.49		
1.32		43-51m : Dusky red mottled yellow CLAYEY SILT; KAROO.
1.38	45	
1.49		
1.53		
1.42		
2.03		
2.06	50	
1.52		
2.14		51-55m : Dark dusky red brown CLAYEY SILT; KAROO.
1.56		
1.29		
1.32	55	
1.08		55-60m : Angular black completely weathered very soft rock carbonaceous SHALE; KAROO.
1.13		
0.57		
0.56		
1.00	60	
	65	
	70	
	75	
	80	

PROFILED BY DB/BB ON 29.04.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 34m
3. AIR LOSSES : Nil

LENONG

REF NO. IR874

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Tel : (011) 469-0854

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 3451
SHEET : 1 OF 2

LOCALITY : LENONG

CO-ORDINATES : X – 2946551
Y = -89432

COLLAR ELEV : 1471m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 12.06.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE: Casing / Air Loss / Static water level — DESCRIPTION
1.36		0-8m. Angular, sub-angular and sub-angular white, reddish
2.11		brown and grey highly weathered CHERT, QUARTZITE and
2.36		FERRUGINISED SHALE GRAVEL, with traces of reddish
2.08		brown mottled yellow brown SILTY SAND; FERRUGINISED
2.21	5	KAROO
2.09		
2.15		
1.51		
1.32		8-10m: Reddish brown blotched orange CLAYEY SILTY
1.09	10	SAND with abundant angular grey and red brown highly
1.14		weathered CHERT GRAVEL; KAROO.
1.17		10-12m. Angular grey slightly weathered hard rock
1.44		QUARTZITE with traces of the above; KAROO.
1.52		12-20m: Reddish brown blotched orange CLAYEY SILT,
2.06	15	KAROO.
2.23		
2.09		
2.04		
1.52		
1.34	20	
1.16		20-41m: Yellow brown speckled black CLAYEY SILT,
1.29		KAROO.
1.08		
1.13		
1.29	25	
1.24		
1.08		
1.14		
1.19		
1.29	30	
1.32		
1.20		
1.06		
1.18		
1.19	35	
1.15		
1.26		
1.26		
1.33		
1.38	40	

PROFILED BY DB/BB ON 12.06.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 31m
3. AIR LOSSES : Nil

LENONG

REF NO IR874

FIG NO.

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 3451
SHEET : 2 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946551
Y = -89432

COLLAR ELEV : 1471m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 12.06.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE: Casing, Air Loss, Static water level

PENETRATION (MIN,SEC/METRE)				DESCRIPTION
1.40				20-43m: Yellow brown speckled black CLAYEY SILT; KAROO.
1.31				
1.38				
1.29				43-49m. As above but with traces of angular grey and red brown highly weathered QUARTZITE and yellow brown SANDSTONE and SHALE, also translucent CHERT; KAROO.
1.41		45		
1.42				
1.50				
1.36				
1.32				
1.45		50		49-50m: Yellow brown speckled black, CLAYEY SILT; KAROO
1.39				
1.45				50-53m. As above but with traces of angular grey and red brown highly weathered QUARTZITE and yellow brown SANDSTONE and SHALE, also translucent CHERT; KAROO.
1.29				
1.38				
1.41		55		53-60m: Yellow brown speckled black CLAYEY SILT; KAROO.
1.50				
1.43				
1.58				
1.46				
1.42		60		
		65		
		70		
		75		
		80		

PROFILED BY DB/BB ON 12.06.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 31m
3. AIR LOSSES Nil

LENONG

REF NO. IR874

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FIG NO.

PERCUSSION DRILLING REPORT | **BOREHOLE NO : 3456**
SHEET : 1 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946662
Y = -89253

COLLAR ELEV : 1469m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 12.06.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE — Casing / Air Loss / Static water level

PENETRATION (MIN,SEC/METRE)				DESCRIPTION
1.30				0-9m: Orange brown CLAYEY SILT with abundant angular sub-angular and sub-round grey, white and red brown highly weathered CHERT and QUARTZITE GRAVEL; FERRUGINISED KAROO.
1.26				
1.21				
1.09				
1.14		5		
1.31				
1.00				
0.51				
0.48				
1.12		10		9-18m: Reddish orange CLAYEY SILTY SAND with minor angular orange mottled black FERRUGINISED SHALE and CHERT GRAVEL; FERRUGINISED KAROO.
0.58				
0.59				
1.17				
1.34				
1.34		15		
1.41				
1.38				
1.42				
1.30				18-47m. Angular dark grey medium weathered CHERT with traces of translucent CHERT and angular reddish brown mottled orange and black FERRUGINISED SHALE; CHERT RESIDUUM.
1.31		20		
1.29				
1.41				
1.36				
1.25				
1.29		25		
1.34				
1.36				
1.21				
1.22				
1.32		30		
1.41				
1.47				
1.50				
1.38				
1.36		35		
1.52				
1.48				
1.59				
2.02				
1.53		40		

PROFILED BY DB/BB ON 12.06.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 29m
3. AIR LOSSES : Nil

LENONG

REF NO. IR847

FIG NO.

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 3456
SHEET : 2 OF 2

LOCALITY : LENONG

CO-ORDINATES : X – 2946662
Y = -89253

COLLAR ELEV : 1469m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 12.06.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
1.54		18-47m: Angular dark grey medium weathered CHERT with traces of translucent CHERT and angular reddish brown mottled orange and black FERRUGINISED SHALE; CHERT RESIDUUM.
2.03		
2.00		
1.56		
1.51	45	
1.58		
2.16		
2.09		47-51m: Angular dark grey unweathered hard rock CHERT with traces of angular light grey highly weathered soft rock SHALE; Interlayered CHERT and SHALE.
2.31		
2.24	50	
2.19		
3.41		51-57m: Angular dark grey occasionally blotched white unweathered hard rock CHERT; CHERT.
3.38		
4.10		
4.21	55	
4.07		
4.02		
	60	
	65	
	70	
	75	
	80	

Casing
Air Loss
Static water level

PROFILED BY DB/BB ON 12.06.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 29m
3. AIR LOSSES :

LENONG

REF NO. IR824

FIG NO.

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 3540
SHEET : 1 OF 1

LOCALITY : LENONG

CO-ORDINATES : X = 2946326
Y = -089862

COLLAR ELEV : 1474m AMSL
OWL : 1440m AMSL

WGS84, Lo...,27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 27.02.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE
Casing
Air Loss
Static water level

PENETRATION (MIN,SEC/METRE)	DESCRIPTION
1.04	0-1 m : Reddish orange brown CLAYEY SILTY fine SAND. AEOLIAN
0.51	
0.38	1-6 m Angular white brown and grey highly weathered CHERT and ferruginised concretions with abundant reddish brown CLAYEY SILTY SAND; KAROO.
0.46	
1.13	
1.21	
1.29	6-23 m : Reddish brown mottled orange CLAYEY SANDY SILT with traces of angular grey and translucent medium weathered CHERT; KAROO.
1.04	
1.13	
1.21	
1.06	
1.02	
1.01	
1.15	
1.31	
1.24	
1.06	
1.02	
1.11	
1.19	
1.03	
0.58	
0.52	
1.00	23-26 m . Angular dark grey medium weathered CHERT with traces of reddish brown CLAYEY SILT; CHERT RESIDUUM.
1.06	
1.32	
0.50	26-27 m : Angular dark grey medium weathered CHERT and minor dark brown CLAYEY SILT WAD; CHERT AND DOLOMITE RESIDUUM.
3.17	
3.40	27-33 m : Angular grey and blue grey slightly weathered hard DOLOMITE. DOLOMITE BEDROCK.
3.31	
3.29	
3.40	
3.31	

PROFILED BY DB/BB ON 27.02.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25.4m³/min to a 165mm button bit
2. DEPTH OWL 36m
3. AIR LOSSES Nil

LENONG

REF NO. IRB74

FIG NO.

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 3540
SHEET : 1 OF 1

LOCALITY : LENONG

CO-ORDINATES : X = 2946326
Y = -089862

COLLAR ELEV : 1474m AMSL
OWL : 1440m AMSL

WGS84, Lo....27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 27.02.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY / REFERENCE: Casing / Air Loss / Static water level — DESCRIPTION
1.04		0-1 m : Reddish orange brown CLAYEY SILTY fine SAND; AEOLIAN
0.51		
0.38		1-6 m . Angular white brown and grey highly weathered CHERT and ferruginised concretions with abundant reddish brown CLAYEY SILTY SAND; KAROO.
0.46		
1.13	5	
1.21		
1.29		6-23 m : Reddish brown mottled orange CLAYEY SANDY SILT with traces of angular grey and translucent medium weathered CHERT: KAROO.
1.04		
1.13		
1.31	10	
1.06		
1.02		
1.01		
1.15		
1.31	15	
1.24		
1.06		
1.02		
1.11		
1.19	20	
1.03		
0.58		
0.52		
1.00		23-26 m : Angular dark grey medium weathered CHERT with traces of reddish brown CLAYEY SILT; CHERT RESIDUUM
1.06	25	
1.32		
0.50		26-27 m : Angular dark grey medium weathered CHERT and minor dark brown CLAYEY SILT WAD; CHERT AND DOLOMITE RESIDUUM.
3.17		
3.40		
3.31	30	27-33 m . Angular grey and blue grey slightly weathered hard DOLOMITE. DOLOMITE BEDROCK.
3.29		
3.40		
3.31		
	35	
	40	

PROFILED BY DB/BB ON 27.02.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL 36m
3. AIR LOSSES Nil

LENONG

REF NO IRR74

FIG NO.

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 3621
SHEET : 1 OF 1

LOCALITY : LENONG

CO-ORDINATES X = 2945943
Y = -090569

COLLAR ELEV : 1474m AMSL
OWL : 1440m AMSL

WGS84, Lo....27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 29.04.08

The "Geological Column" is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE: Casing; Air Loss; Static water level

PENETRATION (MIN.SEC/METRE)	DESCRIPTION
0.56	0-2m ; Orange brown mottled yellow, reddish brown and black SANDY CLAYEY SILT with abundant ferruginised concretions: FERRICRETE.
1.04	
1.28	
1.32	2-17m: Orange brown SANDY CLAYEY SILT with traces of angular grey orange and white highly weathered CHERT; KAROO.
1.19	
1.08	
1.14	
1.31	
0.51	
0.58	
1.06	
1.12	
1.09	
1.15	
1.32	
1.29	
1.41	
2.29	17-21m: Dark brown CLAYEY SILT WAD with traces of the above; DOLOMITE RESIDUUM.
3.10	
2.41	
0.42	
2.14	21-22m: As above with traces of angular grey stained yellow highly weathered soft rock DOLOMITE
5.16	
5.29	22-28m: Angular dark blue grey stained yellow and light brown highly weathered hard rock DOLOMITE. DOLOMITE BEDROCK
4.48	
5.11	
5.20	
5.28	

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40

PROFILED BY DB/BB ON 29.04.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 33m
3. AIR LOSSES : Nil

LENONG

REF NO. IR874

FIG NO

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 3832
SHEET : 1 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946243
Y = -090239

COLLAR ELEV : 1473m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 29.04.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE
Casing
Air Loss
Static water level

PENETRATION (MIN,SEC/METRE)		DESCRIPTION
1.40		0-4m : Reddish orange mottled yellow brown and black CLAYEY SILTY SAND and abundant sub-round FERRICRETE NODULES; FERRICRETE.
2.32		
2.19		
1.58		
2.20	5	4-19m : Orange brown mottled yellow brown CLAYEY SILT; KAROO.
2.41		
3.17		
3.03		
3.12		
2.45	10	
2.29		
1.36		
2.08		
2.31		
2.19	15	
2.40		
2.10		
1.58		
2.29		
1.53	20	19-57m : Yellow brown mottled grey CLAYEY SILT, KAROO.
2.21		
1.46		
1.38		
1.31		
1.40	25	
1.47		
1.32		
1.09		
1.06		
1.24	30	
1.21		
1.02		
0.51		
0.58		
0.56	35	
1.04		
1.29		
1.18		
1.16		
1.26	40	

PROFILED BY DB/BB ON 29.04.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 32m
3. AIR LOSSES : Nil

LENONG

REF NO 3R874

FIG NO.

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 2643
SHEET : 1 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946139
Y = -089470

COLLAR ELEV : 1477m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 28.02.08

The "Geological Column" is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
1.02		0-1m : Angular grey, orange and white medium and highly weathered CHERT with traces of QUARTZITE and abundant orange brown CLAYEY SILTY SAND, KAROO
0.53		
0.37		
0.33		
0.41	5	1-11m : Angular dark grey, grey medium weathered CHERT with abundant angular light grey completely weathered very soft rock SHALE and traces of medium weathered QUARTZITE with minor light grey CLAYEY SILT; KAROO.
0.40		
0.49		
0.42		
0.41		
0.44	10	
0.40		
0.37		11-19m : Reddish orange brown CLAYEY SILT with minor angular dusky red highly weathered QUARTZITE AND SHALE with traces of angular grey and dusky red medium hard rock QUARTZITE, KAROO
0.43		
0.45		
0.46	15	
0.42		
0.45		
0.51		
0.56		
0.49	20	19-27m : Orange brown CLAYEY SILT with minor angular grey red brown and orange highly weathered CHERT AND QUARTZITE, KAROO
1.02		
1.10		
0.58		
0.41		
0.46	25	
1.00		
1.03		
0.59		27-39m : Angular grey blotched dusky red highly weathered soft rock SHALE; KAROO.
0.52		
0.56	30	
0.59		
1.08		
1.14		
1.21		
1.06	35	
1.10		
1.02		
0.58		
0.56		
1.15	40	39-41m : As above with minor angular black highly weathered

PROFILED BY DR/HR ON 28.02.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25.4m³/min to a 165mm button bit
2. DEPTH OWL : 34m
3. AIR LOSSES : Nil

LENONG

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Tel (011) 469-0854

REF NO. IRR74

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 2643
SHEET : 2 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946139
Y = -089470

COLLAR ELEV : 1477m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 28.02.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE: Casing / Air Loss / Static water level — DESCRIPTION
1.03		soft rock SHALE; KAROO.
1.02		41-60m: Orange blotched olive CLAYEY SILT; RESIDUAL KAROO.
0.56		
1.00		
1.08	45	
1.15		
1.31		
1.39		
1.25		
1.34	50	
1.06		
0.51		
0.48		
0.42		
0.48	55	
0.49		
0.55		
0.51		
1.02		
0.51	60	
	65	
	70	
	75	
	80	

PROFILED BY DB/BB ON 28.02.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 34m
3. AIR LOSSES : Nil

LENONG

REF NO. IR874

FIG NO.

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 2648
SHEET : 1 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946250
Y = -089292

COLLAR ELEV : 1476m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 29.02.08

The "Geological Column" is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
1.21		0-1m : Sub-angular, sub-round and angular yellow, orange and reddish brown highly weathered CHERT, SHALE AND QUARTZITE GRAVEL with abundant orange brown CLAYEY SILT, KAROO
1.04		
0.51		
0.49		
0.52	5	1-31m : Angular grey, translucent and dark grey medium weathered CHERT AND QUARTZITE with traces of angular completely weathered SHALE and abundant grey brown CLAYEY SILT; KAROO.
0.56		
0.43		
0.40		
0.41		
0.49	10	
0.58		
0.42		
0.41		
0.46		
0.39	15	
0.44		
0.41		
0.40		
0.48		
0.42	20	
0.49		
0.53		
0.51		
1.00		
0.59	25	
1.11		
1.16		
1.02		
0.59		
0.52	30	
0.46		
0.41		31-46m : Angular grey, pale red and brown medium and highly weathered QUARTZITE with traces of CHERT as above and abundant light grey blotched orange brown CLAYEY SILT; KAROO.
1.08		
1.12		
1.36	35	
1.04		
1.13		
1.06		
1.21		
1.13	40	

Casing
Air Loss
Static water level

PROFILED BY DB/BB ON 29.02.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 34m
3. AIR LOSSES : Nil

LENONG

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REF NO. IR874
FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 2648
SHEET : 2 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946250
Y = -089292

COLLAR ELEV : 1476m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 29.02.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE: Casing; Air Loss; Static water level
1.10		DESCRIPTION
1.38		31–46m : Angular grey, pale red and brown medium and highly weathered QUARTZITE with traces of CHERT as above and abundant light grey blotched orange brown CLAYEY SILT; KAROO.
1.49		
1.26		
1.32	45	
1.41		
1.30		46–60m : Orange brown CLAYEY SILT with traces of angular dark brown highly weathered soft rock DIABASE.
1.06		
1.02		
1.31	50	
1.20		
1.34		
1.38		
1.27		
1.18	55	
1.11		
1.32		
1.29		
1.40		
1.26	60	
	65	
	70	
	75	
	80	

PROFILED BY DD/BD ON 29.02.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 34m
3. AIR LOSSES : Nil

LENONG

REF NO. LR674

FIG NO

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PERCUSSION DRILLING REPORT — **BOREHOLE NO : 2931** — **SHEET : 1 OF 2**

LOCALITY : LENONG

CO-ORDINATES : X = 2945967
Y = -089997

COLLAR ELEV : 1477m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 29.02.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY
REFERENCE

Casing
Air Loss
Static water level

PENETRATION (MIN.SEC/METRE)		DESCRIPTION
3.19		0-6m Reddish brown mottled orange and black SANDY CLAYEY SILT; FERRUGINISED HILLWASH
3.34		
3.20		
3.01		
2.48	5	
3.31		
3.29		6-28m : Orange mottled grey CLAYEY SILT; KAROO
3.02		
3.11		
3.16	10	
2.51		
2.29		
3.48		
4.14		
4.02	15	
3.50		
3.19		
3.32		
3.29		
3.14	20	
2.48		
2.56		
3.02		
3.11		
2.26	25	
2.51		
3.18		
2.39		
3.21		28-46m : Yellow brown mottled grey CLAYEY SILT; KAROO.
2.14	30	
2.31		
2.09		
2.56		
3.11		
3.28	35	
3.03		
3.16		
2.45		
2.29		
3.10	40	

PROFILED BY DB/BB ON 29.02.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 36m
3. AIR LOSSES : Nil

LENONG

REF NO. 1R874

FIG NO.

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 2931
SHEET : 2 OF 2

LOCALITY : ROODTKOP

CO-ORDINATES : X = 2945967
Y = -089997

COLLAR ELEV : 1477m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 29.02.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY
REFERENCE

Casing
Air Loss
Static water level

PENETRATION (MIN,SEC/METRE)		DESCRIPTION
2.50		28-46m : Yellow brown mottled grey CLAYEY SILT; KAROO.
2.41		
3.10		
2.46		
2.52	45	
3.00		
3.16		46-60m : Pale dusky red blotched grey CLAYEY SILT; KAROO.
2.49		
2.24		
2.10	50	
1.40		
1.06		
1.13		
1.29		
1.04	55	
.056		
0.51		
0.59		
1.02		
1.09	60	
	65	
	70	
	75	
	80	

PROFILED BY DH/BB ON 29.02.08

1. COMPRESSOR DELIVERY & PRESSURE DTC TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL . 34m
3. AIR LOSSES Nil

LENONG

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REF NO. IR874

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 2938
SHEET : 1 OF 2

LOCALITY : LENONG

CO-ORDINATES : X – 29466115
Y – -089743

COLLAR ELEV : 1477m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 28.02.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE
Casing
Air Loss
Static water level

PENETRATION (MIN,SEC/METRE)	DESCRIPTION
1.06	0-2m : Orange brown SANDY CLAYEY SILT with minor angular and sub-angular brown, grey and red brown highly weathered CHERT, SHALE AND QUARTZITE, KAROO.
1.13	
1.29	
1.22	2-15m : Angular dark grey, grey and red brown medium and completely weathered SHALE and abundant orange brown highly weathered CHERT AND QUARTZITE with traces of CLAYEY SILT; KAROO.
1.21	
1.04	
0.58	
0.59	
0.51	
0.56	
1.13	
1.19	
1.22	
1.31	
1.04	
1.25	15-34m : Angular dusky red completely weathered medium hard rock QUARTZITE with traces of dry dark grey slightly weathered CHERT and minor pale red CLAYEY SILT; KAROO.
1.30	
1.29	
1.20	
1.30	
1.14	
1.09	
1.26	
1.22	
1.28	
1.34	
1.33	
1.22	
1.36	
1.44	
1.25	
1.20	
1.13	
0.59	
0.51	34-41m : Angular light grey stained orange completely weathered very soft rock SHALE; KAROO
1.00	
1.26	
1.29	
1.17	
1.24	

PROFILED BY DB/BH ON 28.02.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25.4m³/min to a 165mm button bit
2 DEPTH OWL : 38m
3. AIR LOSSES : Nil

LENONG

REF NO. 38874

FIG NO.

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PERCUSSION DRILLING REPORT

BOREHOLE NO : 2938
SHEET : 2 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946115
Y = -089743

COLLAR ELEV : 1477m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 28.02.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)		KEY REFERENCE / DESCRIPTION
1.20		34-41m : Angular light grey stained orange completely weathered very soft rock SHALE.
1.41		
1.56		
1.48		
1.29	45	41-44m : Angular grey and dark grey completely weathered SHALE and medium weathered CHERT with minor orange brown CLAYEY SILT; KAROO.
1.52		44-51m : Angular light grey stained orange completely Weathered very soft rock SHALE
1.38		
1.44		
1.56		
1.45	50	
1.48		
1.32		51-60m : Angular grey and dark grey completely weathered SHALE and medium weathered CHERT with minor orange brown CLAYEY SILT; KAROO.
1.52		
1.37		
1.41	55	
1.52		
2.06		
2.49		
2.23		
2.17	60	
	65	
	70	
	75	
	80	

Casing
Air Loss
Static water level

PROFILED BY DB/BB ON 28.02.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 38m
3. AIR LOSSES : Nil

LENONG

REF NO. 08874

FIG NO

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APPENDIX C
Water Precautionary Measures

WATER PRECAUTIONARY MEASURES ON DOLOMITE:

1. General measures to be implemented on all dolomite sites (minimum requirements – NHBRC Standards)

1.1 Wet-services of individual and entire development -

a. All wet-services should be of good quality in order to ensure low maintenance.

b. Piping materials selected should also be appropriate to local subsurface conditions. If clay pipes are utilized in areas of shallow dolomite, a higher standard of pipe bedding is recommended e.g. stabilized bedding or over excavation and recompaction with an approved material (minimum specification to be G7 material) in layers of 150mm thickness, compacted to 93% mod AASHTO. Some soils may have low pH values, which will render the use of ferrous material for underground services unsuitable. Chapter II in "A Technical Guide to Good House Construction" NBRI of the CSIR (July 1984) should be consulted concerning the potential corrosion of pipes.

c. The NHBRC[1] makes the following recommendations:
Water-piping materials shall be one or more of the following:
- High-impact PVC pipes with vitualic joints
- Other flexible (as defined in SABS 0102, Part 1) water pipes with flexible, self anchoring connections.

Pipes having diameter of less than 75mm.
- HDPE type IV
- Polypropylene

Pipes should be flexible, while joints should be minimised.

d. Water pipes entering buildings should either be fitted with flexible couplings or kinked with a Z to allow opportunity for relative movement. A flexible connection at the junction with all outlet pipes should be used, which included WC pan connections.

e. Pressure-release systems tend to leak after a couple of years. This leaking water must flow directly into the storm or sewerage water system.

f. Water reticulation to houses should be kept at a minimum depth of 500mm up to the structure and above ground where possible along the structure.

g. As many services as possible should be placed within a single trench.

h. Encasement of pipes in concrete or soilcrete should be avoided. Preferably place pipes in sleeves. If this cannot be achieved, care must be taken to ensure that differential movement can still be accommodated without the pipe breaking.

[1] National Home Builders Registration Council

i. All storm-water, sewerage and water pipes and channels must be watertight. All laid wet services should be tested for leakage on installation using the air test (see NBRI Info Sheet X/BOU 2-34) for water pipes, and the water test for sewerage pipes.

j. Placement of wet-services below the footprint of structures must be avoided. No plumbing and drainage pipes should be placed under floor slabs, as far as practicable. Where this situation is unavoidable, reasons must be cited and the pipes must be placed in a sleeve to permit monitoring.

k. Where practical, pipes running parallel to structure should be kept at a distance of at least 5m from the structure.

l. Each stand should have a rodding eye or some similar access to the sewer connection in addition to the inspection eye.

m. Each stand / unit should have a water meter at a suitable location so that testing of the stand / unit specific water supply is possible. Water leakage testing must be undertaken regularly, as set out in the risk management system.

n. The roots of trees planted in close proximity to the line of water-bearing services often causes leaks in or malfunctioning of the services. Care should therefore be taken to avoid the unfortunate positioning of trees and other plants.

o. Residents should be informed of where services traverse their garden so that accidental puncturing of pipes can be avoided.

1.2 Entire Development

a. The design of wet-services should be governed by the need to create low maintenance systems. Wherever possible, keep services above ground to facilitate detection of leaks, maintenance and repair.

b. The stability of the centre line of all bulk water services should be considered.

c. Piping used in mains and communication pipes should be flexible, while joints should be minimised and, where required, self anchoring type (ie not reliant on thrust blocks for their anchorage at fittings, except at valves and end caps).

d. The relevant provision of SABS 1200 DB, L, LB, LC, LD and LE shall be observed in the installation of all underground services.

e. Water mains shall be laid only in road reserves.

f. Provision for future connections shall be made in order to minimize the cutting into pipes to provide such connections.

g. Water pipe entries into the building shall be in accordance with those of the JSD's code of practice[2].

h. The use of pre-manufactured, unjointed manholes is preferred. The manhole should be placed on a properly prepared foundation.

i. Use flexible couplings on either side of manholes.

j. Water-borne sewerage reticulation must be installed. French drains are unacceptable.

k. A detailed sanitation and water reticulation plan should be drawn up for the development according to the local geological setting and engineering geological characteristics. The plan must be incorporated into the services management system of the local authority.

1.3 Storm-water drainage

a. No accumulation of surface water is to be permitted and the entire development must be properly drained.

b. A minimum gradient of 1:150 should be maintained along stormwater systems.

c. Brick and precast concrete walls must be so designed as to provide drainage ports at ground level permitting passage of maximum probable quantities of water.

d. When courtyards are designed the free flow of surface water should be ensured. When gutter downpipes are to be found in such a courtyard, a lined canal should permit passage of water into a drain or onto the lawn, away from the structure. The courtyard should preferably be paved and no garden beds should be created at gutter discharge pointes. Lawns must be graded in such a way to facilitate drainage.

e. In order to deal with rainwater run-off from the roofs of structures the following is recommended:

- If guttering is required by the local authority, then the down pipes should be discharged into a lined or precast furrow. This furrow should remove the water from the structure. The stormwater should be drained, without ponding, off the property and into the municipal stormwater system..
- If no gutting is to be utilized, then it is recommended that a sealed surface with a width of 1,5m be cast along those walls of the structure where water will be discharged from the roof. Roof water will cascade off this sloping roof onto the apron into a lined or precast furrow. The storm-water should be drained, without ponding, off the property and into the municipal storm-water system.
- The ground immediately against the buildings shall be shaped to fall in excess of 75mm over the first 1,5m beyond the perimeter of the building, from where it shall drain freely away from housing units. Apron slabs, where provided shall have the same fall.

[2] JSD Code of Practice reference

f. All ponds, watercourses and road surfaces shall be rendered impervious.

g. No trees shall be planted within 1,5 times their eventual height from the line of storm-water services.

h. The storm-water drainage system shall incorporate measures to ensure water tightness of conduits and other compartments. Whenever possible, storm-water should be channeled in lined, surface canals.

i. Concrete non-pressure pipes should be of the spigot-and-socket type with rubber ring seals. Joints in box culverts, channels, etc. should be sealed.

j. Storm-water drainage conduits shall be constructed at gradients that will not permit the deposition of silt , or sand, of the type present in the catchment area.

1.4 Trenchings

a. Trenches and excavation works should be opened and closed as rapidly as possible. Avoid leaving trenches open over weekends and holidays. A berm should be created to divert surface water away from the trenches while they are open. All trenches and excavation works must be properly backfilled and compacted according to specifications given in subclause 5.2.4 of SABS 1200 DA, but specifically to ground surface to prevent them acting as French drains. Once service / cables are installed and backfilling is completed, it must be ensured that ground surface is graded to match the slope of the surrounding area. No rocks in the top layer.

b. Berms should be constructed on the up-slope side of trenches to prevent the inflow of water during storms.

c. The fall of trenches shall be away from buildings. Wherever practical, service trenches shall not be excavated along the length of housing units within the first 3m beyond the perimeter of such units.

d. No ponding of surface water is to be permitted over, in, or in the vicinity of trenches and excavations.

1.5 Roads

a. Ensure that roadways are, in fact, placed below the site level so as to facilitate drainage. If the road network is the sole stormwater system, in a township, care must be taken that the roads are surfaced.

b. Ponding of surface water on, or next to roads that are not tarred, should be avoided.

c. Roadways which have a gradient of less than 1:80 shall be surfaced / sealed.

d. The velocity of the 1-in-20 year storm-water, flowing along unsurfaced roadways, shall not exceed 1,5m /s.

1.6 Swimming Pools

The following minimum requirements must exist:

Construction, maintenance and responsibilities for pools:

A) Construction

i) The design, construction and use of the swimming pool should at all times be to the satisfaction of the local city engineer, who should be aware of the requirements of swimming pools in dolomitic areas.

ii) The swimming pool must be designed as an *independent unit, which will not give way or distort.* The sides or floor of the pool should not crack in the event of any ground movement underneath or nearby the swimming pool.

iii) The swimming pool may be constructed from concrete, metal or any other suitable material on condition that the design conforms with conditions (Ai) above.

iv) All water pipes, pumps and connections should be installed either in the open, on the surface, or in service canals where these may be inspected or repaired without access problems.

v) **The swimming pool should be built so as to prevent any rain water into or towards the pool.**

B) Maintenance and responsibilities

i) All back wash must be discharged *directly* into main storm-water line.

ii) Any abnormal loss of water from the pool as well as any noticeable ground movements (cracks forming in the ground or in the pool) must be reported by the stand owner to the Home Owners Association or Body Corporate and the local council.

iii) It is important to note that the responsibility of checking pipes to and from the pool, the handling of run-off water from the pool as well as the repairing of cracks in the pool and replacing of leaking pipes lies solely with the stand owner. Negligence could result in the instability.

2. Additional precautionary measures for residential affordable, residential group housing (single and double story) and gentleman's estates.

a. Place bulk services in road reserves or servitudes with a minimum width of 5m. Servitudes may be utilized as parks or "bridle paths". If these services are placed mid-block, a building line restriction of a minimum width of 5 m must be imposed. Place water and sewer connections of every two units along their common property boundary. Shared sewer connections should be implemented if this arrangement leads to a reduction in the meterage of service and minimises

the disturbance of the environment. Property and unit entrances should be placed at points furthest from the trenches of these water and sewer connections.

b. It is recommended that structures be placed on earth mattresses, which serve to ensure load distribution and to prevent water ingress. A continuous mattress can be considered for high density development, where it is emplaced in strips for block lengths and with widths exceeding the house footprint by at least 2 m. This exercise must be completed prior to the installation of services.

c. Water and sewer connections to households should be placed within the mattress of enhanced earth. The mattress will retard the flow of water from a leaking service but material will eventually be mobilized sufficiently for structural damage to occur. It is thus evident that testing of water-borne services on a regular basis is very important. Consideration should be given to the placement of sewer lines in inspectable canals as these are not so easy to test. If the mattress is penetrated, wet-services must be placed in sleeves for 5 m beyond the structure so that the leaking services immediately beyond the mattress cannot result in instability in close vicinity to the foundation.

d. Roadways must be sealed and be constructed below the level of stands.

e. Property and unit entrances should be placed at points away from the trenches of water and sewer connections.

f. Each stand should either have a rodding eye or some similar access to the sewer connection in addition to the inspection eyes so that sensible monitoring may be possible.

3. Additional precautionary measures for High-rise, Light Industrial and Light Commercial sites

a. It is recommended that structures be placed in stiffened rafts on earth mattresses, which serves to ensure load distribution and to prevent water ingress. The mattresses must be emplaced prior to the installation of services.

b. The principal water-bearing services must be placed either in the mattress or sleeves for a distance of at least 5m beyond the periphery of the building.

c. The surfaces around buildings should be sealed and sloped so that no surface run-off water is allowed to pond against buildings.

d. Downpipes bearing accumulated roof water can be discharged either onto the sealed surfaces to drain away from the structure, or into lined furrows and into stormwater systems.

e. Roadways should be sealed.

f. Portions should be identified at which “plugs” can be installed to stop flow in sewer and water lines at short notice in the event of rupture or sinkhole formation underneath the service. The Local Authority must ensure that contingency plans are in place to deal with such emergencies.

g. No swimming pools should be permitted in this zone.

h. Lined channels are preferred to pipes for stormwater systems in these zones.

i. Structures must be correctly and safely founded.

j. A monitoring programme must be embarked upon by either the owner of the property/buildings or the appropriate Local Council or Metropolitan Substructure to regularly check for any leaks in services, unauthorized structures which could lead to concentration of water and, where necessary, monitor the groundwater level (refer to risk management systems).

k. With respect to commercial, industrial or high rise structures, the principal water-bearing services should preferably be placed above ground or in sleeves when within 5 m of the structure.

4. Precautionary measures for sites unsuitable for development

a. No buildings should be allowed in this zone.

b. The entire site must be properly sealed.

c. No water-borne services must be allowed in this area. Ablution blocks should be avoided.

d. Surface water run-off management is critical in these areas.

APPENDIX D
Monitoring

RISK MANAGEMENT PLAN:

1. Management at Township/Development Level

1.1 Monitoring

Monitoring comprises three parts:

a. *Infrastructure monitoring:* This entails the inspection of water-bearing services, buildings, roads, etc.
b. *Ground surface monitoring:* This entails the inspection of the ground surface as it is disturbed and affected by man's activities.
c. *Groundwater monitoring:* This entails the measuring and recording of the groundwater level.

Monitoring practices will differ from site to site but also possibly from zone to zone within a site. Some zones that have more stringent precautionary measures imposed on them may need to be monitored on a more frequent basis. This could be monthly, quarterly or yearly.

A. Infrastructure Monitoring

Seasonal interval basis

1. Visual checks for debris in open storm-water channels at the start of the rainy season and after heavy storms.
2. Visual checks for water flowing out of storm-water manholes at the start of the rainy season and after heavy storms.
3. Examine buildings for cracks at the start of the rainy season.

On a short-interval basis (weekly/monthly)

1. Visual checks for outside dripping taps and pressure valves.
2. Visual checks for damp areas.
3. Visual checks for debris in storm-water channels.
4. Visual checks for water flowing out of sewer and storm-water manholes.
5. Examine buildings for cracks.
6. Visual check for over-wetting of gardens.
7. Visual check for blocked drainage ports in garden walls.

On an intermediate-interval basis (4 or 6 monthly/yearly)

In many cases, visual inspections may not be sufficient. It may be necessary to undertake regular air and water tests on wet-services. Consideration should be given to the design of the infrastructure so that these tests may be possible.

1. Close all taps in the buildings or stopcocks controlling water supply to buildings, if fitted, for one hour and monitor the water meter OR monitor the meter late at night. A slow increase in the water meter reading or continued operation of the meter will indicate that there is a leakage between the meter and the taps/stopcocks.
2. Open all manholes on the property and observe if waste water/storm-water flows normally.

On a long-interval basis (yearly)

1. Wet-services to be inspected by camera (in pipes with a diameter greater than 100mm).

B. Ground Surface Monitoring

Ground surface monitoring may be undertaken visually on a regular basis. This should be done by inspecting paved areas after rainstorms (ponding water often indicates an area of differential settlement). Inspectors should look out for ground cracks and cracks in lined and unlined channels.

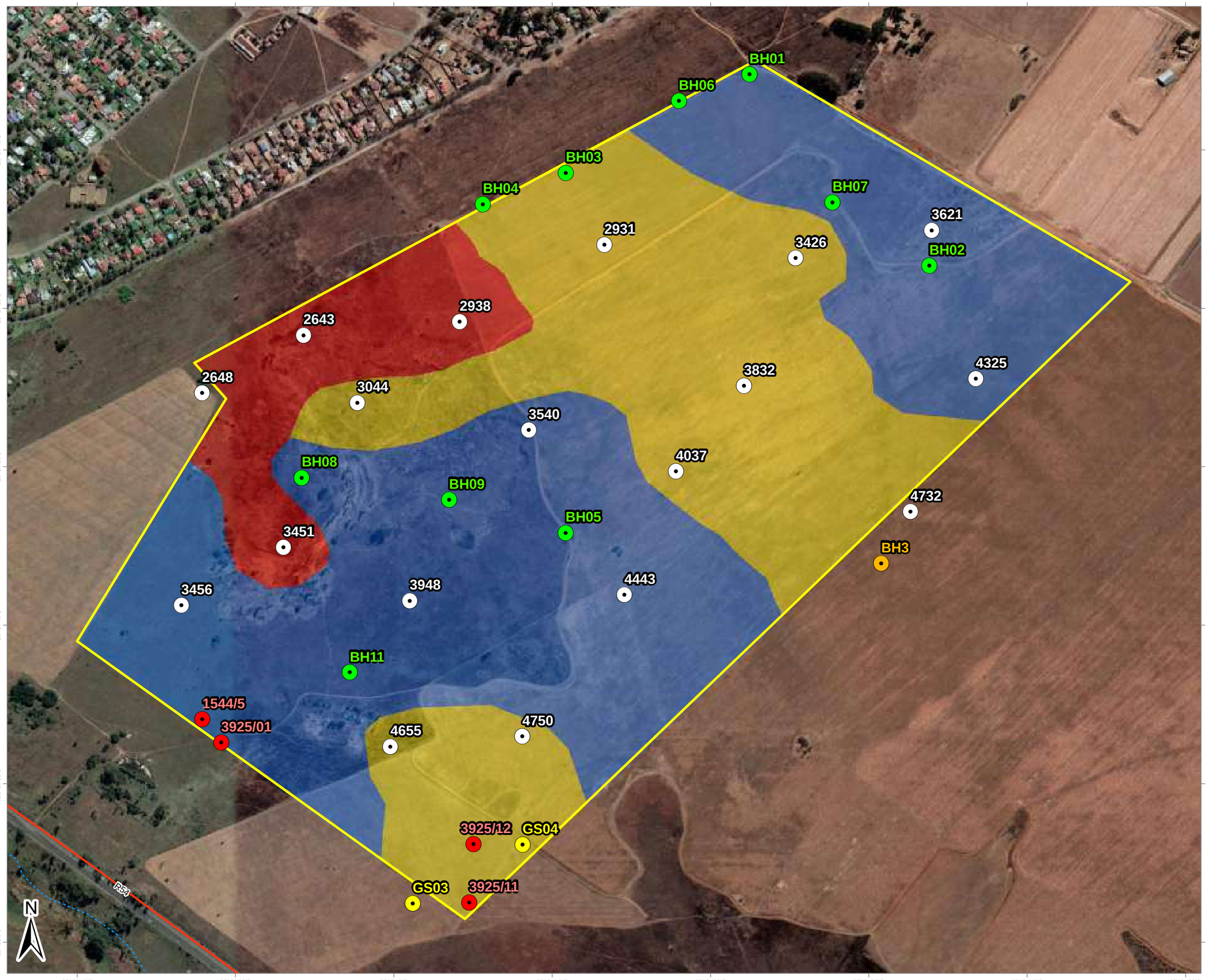
In many instances visual inspections may not be sufficient. It may be necessary to undertake precision ground surface levelling, particularly in areas that have been rehabilitated after an event. Such levelling must be undertaken by a registered land surveyor, recorded and stored in the database and appropriate actions taken when excessive settlement continues.

C. Groundwater- level Monitoring

In certain townships a recommendation will be made to fit one or more borehole(s) with the necessary equipment to measure the groundwater level. The time when the inspection is made as well as the name of the inspector must be recorded. The actual measurements should ultimately be reported to the DWAF.

FIGURES

UNITAS PARK EXT 16: DOLOMITE ZONATION MAP



LEGEND

- Project Boreholes
- GeoStable 2018 Boreholes
- Intraconsult 2008 Boreholes
- Luxton 1976 Boreholes
- VGI 2015 Boreholes

Rivers and Streams

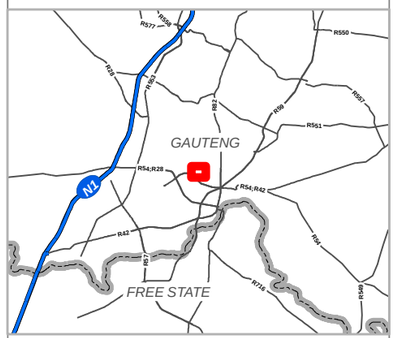
- Non-Perennial

Road Network

- Main Road
- Site Boundary

Dolomite Zone

- Zone A
- Zone B
- Zone C



Data Sources:
Google Earth™ mapping service: 2021
Imagery Date: 05/07/2019 and 07/22/2019

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SCALE: 1:7 000

FIGURE NO.:	-	MAP NUMBER:	19-0916.047-01
DRAWN BY:	N NAIDOO GIS TECHNICIAN	REVIEWED BY:	D FRANKLIN ENGINEERING GEOLOGIST
DATUM: PROJECTION:	WGS84 GEOGRAPHIC	DATE:	04 FEBRUARY 2021
PROJECT: CLIENT:	UNITAS PARK EXT 16 PHUMAF		

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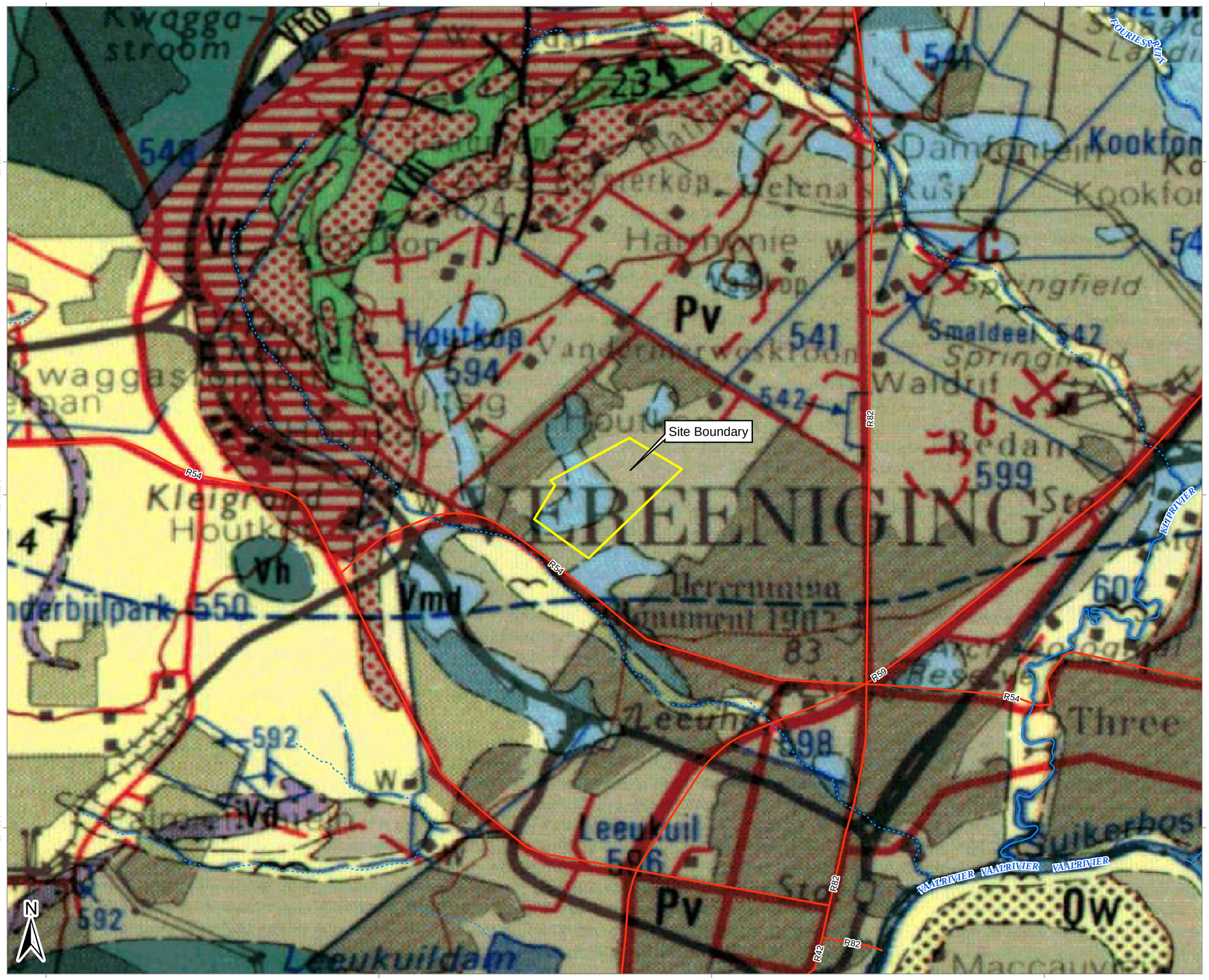
UNITAS PARK EXT 16: GEOLOGY



LEGEND

Rivers and Streams

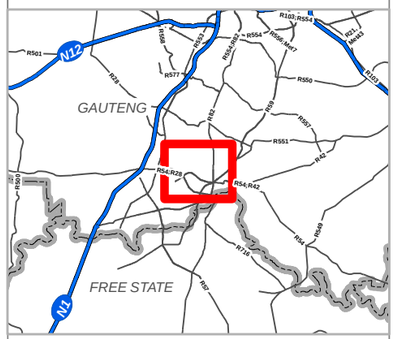
- Non-Perennial
- Perennial

Road Network

- Main Road
- Site Boundary

Lithology

- Alluvium
- Qs — Soil cover
- Qw — Aeolian sand
- Pv — Sandstone, shale, coal
- Vd — Diabase
- Vd — Quartzite and shale, ferruginous in places
- Vh — Andesite, agglomerate, tuff
- Vhc — Quartzite, conglomerate
- Vf — Ferruginous shale, hornfels
- Vf — Ferruginous quartzite
- Vmd — Dolomite, chert and remnants of chert breccia of the Rooihoogte Formation



Data Sources:
Council for Geoscience
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0 1 2 Kilometers

SCALE: 1:50 000

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DATUM: PROJECTION:	WGS84 GEOGRAPHIC	DATE:	04 FEBRUARY 2021
PROJECT:	UNITAS PARK EXT 16		
CLIENT:	PHUMAF		

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ANNEXURE G

ENVIRONMENTAL SCREENING REPORT

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Environmental Screening Report
Unitas Park ext 16

Revision 1

November 2019

Phumaf Engineering Solutions

GCS Project Number: 19.0921

Client Reference: 034RFP/7001/2019

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Document Reviewer - Applicant	Adam Gunn		November 2019
Unit Manager	Adam Gunn		November 2019

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CONTENTS PAGE

1 BACKGROUND AND INTRODUCTION 1
1.1 BACKGROUND 1
1.2 BRIEF PROJECT DESCRIPTION 1
2 DETAILS OF THE EAP 3
3 LEGISLATIVE BACKGROUND 4
3.1 THE CONSTITUTION OF THE REPUBLIC OF SOUTH AFRICA 4
3.2 NATIONAL ENVIRONMENTAL MANAGEMENT ACT (ACT NO. 107 OF 1998) 5
3.2.1 NEMA Principles 5
3.2.2 NEMA 2014 Environmental Impact Assessment (EIA) Regulations GN R982 5
3.3 NATIONAL WATER ACT, (ACT 36 OF 1998, AS AMENDED) 5
3.4 THE NATIONAL HERITAGE RESOURCES ACT, (ACT NO. 25 OF 1999) 6
3.5 LISTED AND SPECIFIED ACTIVITIES 6
3.5.1 NEMA 6
3.5.2 Water Uses NWA 7
4 BASELINE ENVIRONMENTAL DESCRIPTION 8
4.1 BIOPHYSICAL ENVIRONMENT 8
4.2 SOCIO-ECONOMIC ENVIRONMENT 8
5 RECOMMENDATIONS AND WAY FORWARD 14
5.1 ENVIRONMENTAL IMPACT ASSESSMENT 14
5.2 WATER USE LICENSE APPLICATION 14
5.3 ADDITIONAL RECOMMENDATIONS 15
5.4 CONCLUSION 15

LIST OF FIGURES

Figure 1-1: Unitas Park ext 16 Locality Map 1
Figure 1-2: Unitas Park Regional Locality 2
Figure 4-1: Unitas Park ext 16 Sensitivity Map 9

LIST OF TABLES

Table 2.1. Name and Address of Environmental Assessment Practitioner 3
Table 3.1: Applicable Legislation and Guidelines. 4
Table 4.1: Preliminary Impacts Identified. 10

1 BACKGROUND AND INTRODUCTION

1.1 Background

The Gauteng Rapid Land Release Programme aims to fast track the release of serviced stands from state-owned land to qualifying beneficiaries. Phumaf Holdings was appointed to assist the Department of Human Settlements with all pre-planning, planning work, design and construction management to enable the release of the identified stands.

GCS Water and Environment has been contracted by Phumaf Holdings to undertake the environmental authorization processes required for the stands in order for compliance to the National Environmental Management Act NEMA (Act 107 of 1998, as amended). This Report provides details of an Environmental Screening exercise undertaken in order to confirm the required authorization process, and to identify risks associated with the process.

1.2 Brief Project Description

Unitas Park ext 16 is located within Unitas Park, to the north east of the R54 (Houtkop Road). The R82 is runs north-south approximately 2.3km to the east of the site. The N1 is about 11km to the north west of the site. Sebokeng lies to the north west of the site, with Vereeniging to the south. The R59 is runs from Vereeniging to Meyerton in the north west of the site. The site is currently vacant, with immediate adjacent land portions also being vacant. There is evidence of a wetland or some surface water on the site, as well as to the south east of the site. A drainage line appears to run from the site towards Houtkop Road to the south west, where the surface water drains under the road and continues to flow into a National Freshwater Ecosystem Protection Area (NFEPA). The buffer of the NFEPA includes a portion of the south west of the site.

The site is approximately 149 hectares in extent. Refer to the maps below for the location and regional locality map, indicating the surrounding residential allotment townships. Unitas Park is within the 2010 urban edge.

Figure 1-1: Unitas Park ext 16 Locality Map

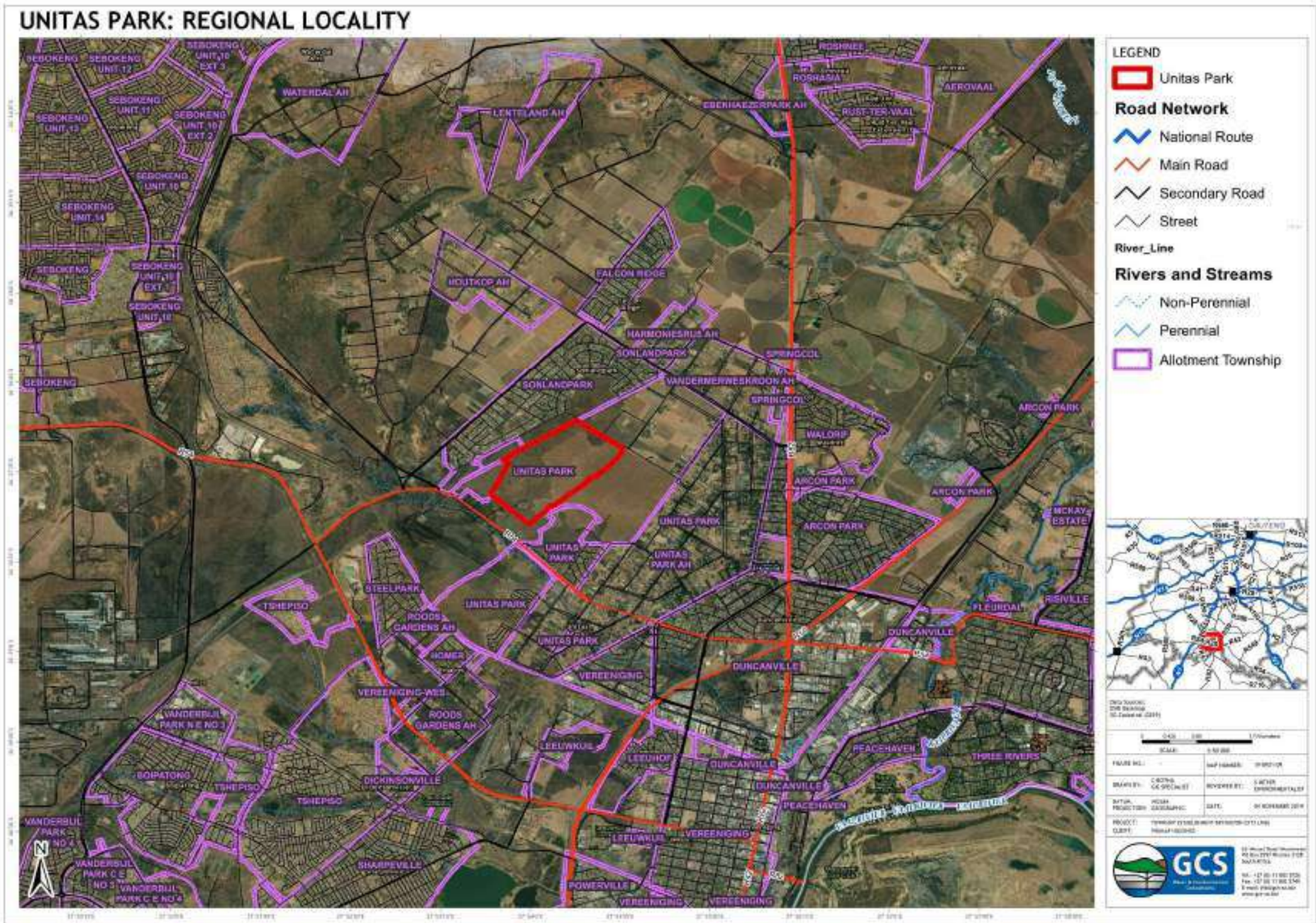

Figure 1-2: Unitas Park Regional Locality

2 DETAILS OF THE EAP

GCS Water and Environment (Pty) Ltd (GCS) have been appointed as the independent Environmental Assessment Practitioners (EAP) to undertake the environmental screening for this site. Sharon Meyer is the dedicated Project Manager and Environmental Assessment Practitioner (EAP). She is a Professional Natural Scientist (*Pr. Sci. Nat*.) with the South African Council for Natural Scientific Professionals (SACNASP). Ms Meyer has submitted her application for registration with the Environmental Assessment Practitioners Association of South Africa (EAPASA).

The contact details of the EAP are provided in Table 2.1.

Table 2.1. Name and Address of Environmental Assessment Practitioner.

ITEM	COMPANY CONTACT DETAILS
Company Name:	GCS Water and Environment (Pty) Ltd
Company Representative:	Sharon Meyer
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3 LEGISLATIVE BACKGROUND

The policy and legislative context applicable to the potential development of Unitas Park ext 16 is summarized in **Table 3.1,** and detailed thereafter. Note that this screening process addresses only the first four Acts listed in the table below. The Spatial Planning and Land Use Management Act (SPLUMA) is a land use management process which is part of a separate process.

Table 3.1: Applicable Legislation and Guidelines.

APPLICABLE LEGISLATION AND GUIDELINES USED TO COMPILE THE REPORT	REFERENCE WHERE APPLIED
The Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996)	Purpose of the process
National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA)	Throughout document
National Water Act, 1998 (Act No 36 of 1998) (NWA)	Throughout document
The National Heritage Resources Act, (Act No. 25 of 1999) (NHRA)	This will be addressed as a Notice of Intent to Develop to SAHRA
Spatial Planning and Land Use Management Act, 2013 (Act No. 16 of 2013) (SPLUMA)	Not part of this document, will be applied for separately.

Below is a description of how these laws are relevant to the project and what needs to be done to comply with the laws.

3.1 The Constitution of the Republic of South Africa

The Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996) is the supreme law and all other acts must comply with it and are subservient to it. The Constitution sets out the rights and obligations for every person in South Africa and aims to address past social injustices. With respect to the environment, Section 24 of the constitution states that:

"Everyone has the right:

a) To an environment that is not harmful to their health or well-being;
b) To have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that:
   i. Prevent pollution and ecological degradation;
   ii. Promote conservation; and
   iii. Secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development".

All developers are thus duty-bound to constitutional, legislative, and other measures to prevent pollution and ecological degradation, promote conservation and to develop in a sustainable manner as far as is reasonably possible. The constitutional environmental right elevates the importance of environmental protection and conservation and emphasises the significance that South Africans attach to an environment that is not harmful to their health or well-being.

3.2 National Environmental Management Act (Act No. 107 of 1998)

3.2.1 NEMA Principles

The NEMA provides the environmental legislation framework and establishes an integrated environmental management system for South Africa. It aims to prevent pollution and degradation of South Africa's natural resources while promoting sustainable economic and social development.

These principles serve as guiding principles for a project and they are binding, enforceable and justiciable.

3.2.2 NEMA 2014 Environmental Impact Assessment (EIA) Regulations GN R982

The Department of Environmental Affairs (DEA) has developed a list of activities which are likely to have an impact on the environment. The list of activities was published in 2014 (GN 982) and were separated into three listing notices (GN R983, GN R984 and GN R985) and were amended by the Department in 2017 and again in 2018. The amended list of activities is referred to as GN R983, GN R984 and GN R985.

Any activity which is listed under these notices requires an environmental assessment to be conducted and approved before the activity can proceed. Activities falling under Listing Notice 1 (GN R983) or Listing Notice 3 (GN R985) require a Basic Assessment (BA) to be conducted while any activity falling under Listing Notice 2 (GN R984) requires a full Scoping and Environmental Impact Reporting (S&EIR) process to be conducted.

3.3 National Water Act, (Act 36 of 1998, as amended)

The National Water Act NWA, is founded on the principle that the National Government has overall responsibility for and authority over water resource management, including the equitable allocation and beneficial use of water in the public interest. A person can only be entitled to use water if the use is permissible under the Act. Water Use is defined broadly and must be licensed unless it is listed in Schedule 1 as an existing water use or is permissible under general authorization.

3.4 The National Heritage Resources Act, (Act No. 25 of 1999)

The National Heritage Resources Act, (Act No. 25 of 1999) (NHRA) requires Heritage Resources Impact Assessments for various categories of development stipulated in Section 38 of the Act. It also provides for the grading of heritage resources and the implementation of a three-tier level of responsibilities and functions for heritage resources to be undertaken by the national and Provincial Authorities, depending on the grade of the heritage resource. The Act defines cultural significance, archaeological and paleontological sites and materials (Section 35), historical sites and structures (Section 34), and graves and burial sites (Section 36) that fall under its jurisdiction. Archaeological sites and material are generally those resources older than a hundred years, including gravestones and grave dressing. Procedures for managing graves and burial grounds are set out in Section 36 of the NHRA. Graves older than 100 years are legislated as archaeological sites and must be dealt with accordingly. Section 38 of the NHRA makes provision for application by developers for permits before any heritage resource may be damaged or destroyed.

This Act is only applicable if any heritage resources such as sites of cultural significance, archaeological and paleontological sites and materials; historical sites and structures; and/or graves and burial sites are within the proposed development area.

3.5 Listed and specified activities

3.5.1 NEMA

Due to the fact that the site is larger than 20 hectares and is located within the urban edge, some of the following activities according to the National Environmental Management Act NEMA (Act 107 of 1998, as amended) and EIA Regulations 2014 may be triggered:

- Listing Notice 1. Activity 9 – *The development of infrastructure*
- Listing Notice 1. Activity 10 – *The development and related operation of infrastructure exceeding 1000 metres in length for the bulk transportation of sewage, effluent, wastewater.*
- Listing Notice 1. Activity 11 – *The development of facilities or infrastructure for the transmission and distribution of electricity inside urban areas with a capacity of 275 kilovolts or more.*
- Listing Notice 1. Activity 24 – *the development of a road with a reserve wider than 13,5 meters, or where no reserve exists, where the road is wider than 8 meters.*
- Listing Notice 1. Activity 28 – *residential, mixed, retail, commercial, industrial or institutional development where the land extent is more than 5 hectares within an urban area.*

- Listing Notice 2. Activity 15 – *The clearance of 20 hectares or more of indigenous vegetation.*
- Listing Notice 3. Activity 4 – *The development of a road wider than 4 meters with a reserve less than 13.5 meters within a Protected Area.*
- Listing Notice 3. Activity 12 – *The clearance o 300 square metres or more of indigenous vegetation in any endangered ecosystem.*
- Listing Notice 3. Activity 14 – *The development of infrastructure or structures with a physical footprint of 10 square metres or more in a Protected Area or sensitive areas as identified within an environmental management framework.*
- Listing Notice 3. Activity 15 – *The transformation of land bigger than 1000 square metres in size to residential, commercial, retail, industrial or institutional used where such land was zoned open space, conservation or had an equivalent zoning, on or after 01 August 2010.*

Therefore, this site requires an Environmental Impact Assessment in terms of NEMA and the EIA Regulations (2014) in order to authorise development for purposes of residential, mixed, retail, commercial, industrial or institutional use.

3.5.2 Water Uses NWA

The following water uses are triggered due to the development site falling within the 500m buffer of both the NFEPA and the watercourse:

- Section 21 (c) – *Impeding or diverting the flow of water in a watercourse*;
- Section 21 (d) – *engaging in a stream flow reduction activity*; and
- Section 21 (i) – *altering the bed, banks, course or characteristics of a watercourse*;

Note that land use zoning should be confirmed.

4 BASELINE ENVIRONMENTAL DESCRIPTION

4.1 Biophysical Environment

The site is not located within a sensitive area as delineated by the Gauteng Conservation Plan. However, to the north west there is a Critical Biodiversity Area associated with a tributary of the Rietspruit. This tributary has been identified as a National Freshwater Ecosystem Priority Area (NFEPA) and is of high conservation value. See Figure 4-1 below. The south western portion of Unitas Park ext 16 is located within the 500m buffer of the NFEPA as well as within the 500m buffer of the watercourse (Rietspruit). From site investigation it is likely that there is surface water on site, even if this is temporary or ephemeral.

4.2 Socio-economic Environment

According to the Sedibeng Growth and Development Strategy 2 (Sedibeng District Municipality, 2012), the Unitas Park population is of low-Living Standards Measurement with a low access to services. This places the community as vulnerable to impact. The community also has a high unemployment rate. These factors must be considered when proposing development within Unitas Park. The community is not positioned to address impacts to their human health, living conditions or environment. Therefore, it is important that the developer communicate with neighbouring community members in order to minimize negative impacts of the development. This will be focused within the construction phase of the project.

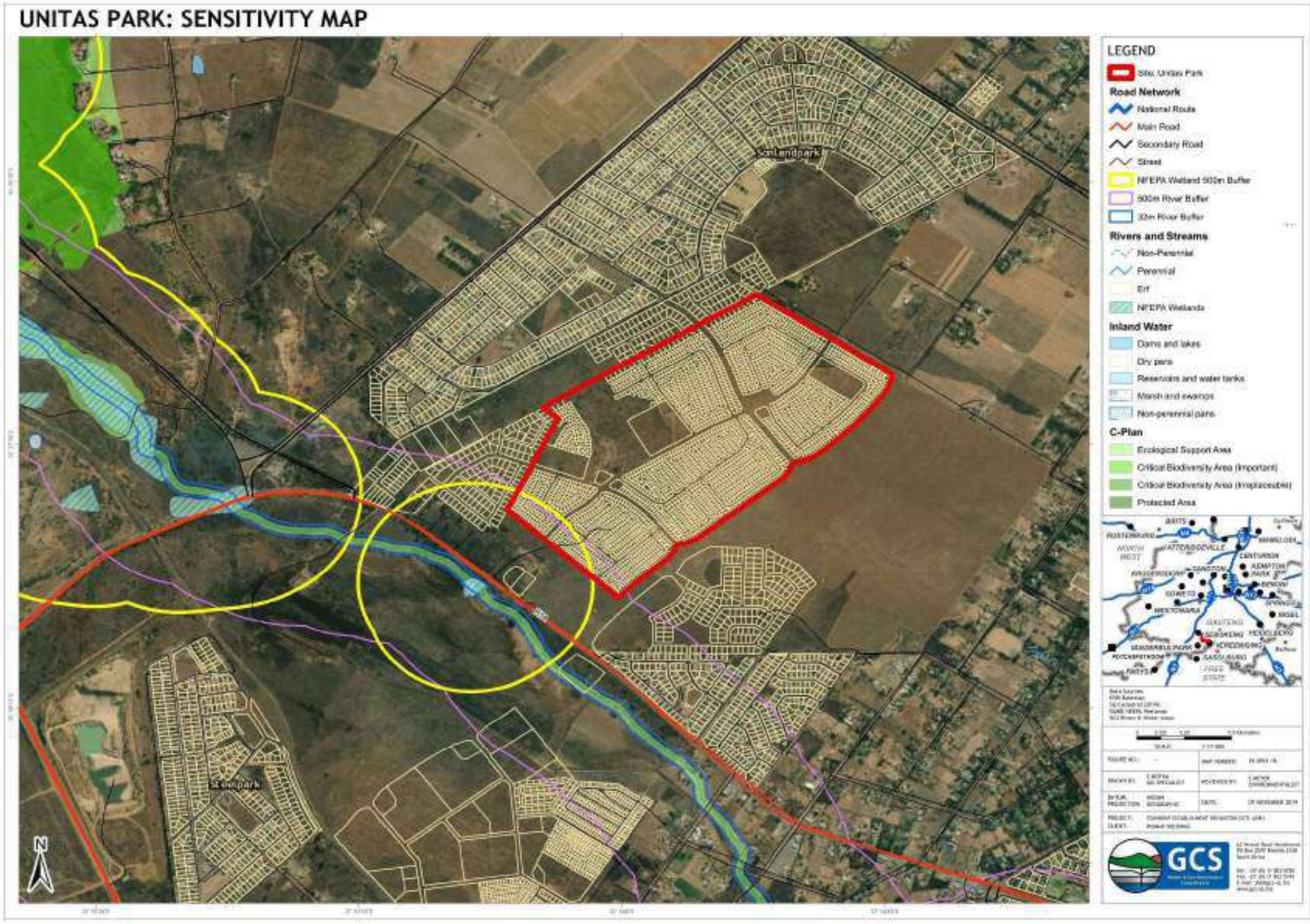


Figure 4-1: Unitas Park ext 16 Sensitivity Map

Table 4.1: Preliminary Impacts Identified.

POTENTIAL ENVIRONMENTAL IMPACT	IDENTIFIED ACTIVITY	RECOMMENDED MITIGATION MEASURES	ACTION PLAN
GEOLOGY			
Altering of geological strata	Foundations	Little to no impact and therefore no mitigation necessary	Compile and implement an Environmental Management Plan.
TOPOGRAPHY AND DRAINAGE			
Alteration of natural topography	Residential development	Stormwater drainage is an important consideration. This will impact on the quality and quantity of surface water reaching the Rietspruit tributary.	Undertake ecological and wetland screening. Implement a stormwater management plan during construction. Compile and implement an Environmental Management Plan. Water Use License will be required under Section 21 (c), (d) and (i).
SOILS, LAND USE AND LAND CAPABILITY			
Loss of soil resource, land use and land capability	Residential development	This site and most of the surrounding area is vacant. It is important to understand the land capability, and this should be carried out as a desktop study to inform the EIA.	Desktop Land capability study.
Contamination of soil resources	Residential development	Impact to the critical biodiversity area and watercourse to south west of the site. This needs to be managed, especially during construction.	Compile and Implement an Environmental Management Plan. Undertake wetland and ecological assessment.

POTENTIAL ENVIRONMENTAL IMPACT	IDENTIFIED ACTIVITY	RECOMMENDED MITIGATION MEASURES	ACTION PLAN
			Implement Environmental Awareness and Response Plan.
SURFACE WATER			
Change in Drainage patterns	Residential Development	Ensure drainage to the downstream tributary remains constant. Investigate the potential impact to the watercourse and the NFEPA.	Design for optimal drainage and compile and implement a Stormwater Management Plan. Implement Environmental Awareness and Response Plan. Ecological and wetland assessment.
Contamination of Surface Water resources	Residential Development	Keep clean and dirty water areas separate and don't allow for contaminated water or spills to enter the environment	Compile and Implement Stormwater Management Plan and Environmental Management Plan. Implement Environmental Awareness and Response Plan. Ecological and wetland assessment.
HYDROGEOLOGY			
Potential contamination of groundwater resources	Residential Development	Little to no impact expected	Compile and Implement Environmental Management Plan.

ECOLOGY			
Disruption of ecological connectivity	Residential Development	No land use changes or other disturbances of animals outside of the study area should be allowed. The NFEPA and wetland buffer will be impacted and need to be assessed.	Signs should be erected on site and access roads limiting the speed to no more than 40 km/hour. Compile and Implement Environmental Management Plan. Wetland and ecological assessment.
Loss and degradation of faunal habitat	Residential Development	Impacts should be limited	Prohibit habitat degradation or destruction outside of boundary fences. Compile and Implement Environmental Management Plan. Wetland and ecological assessment.
Loss of biodiversity	Residential Development	Biodiversity will be higher and more sensitive closer to the NFEPA and watercourse and this must be investigated.	Compile and Implement Environmental Management Plan. Wetland and ecological assessment.
Spreading of weeds and alien vegetation	Residential Development	Little to no impact expected. However, the NFEPA and watercourse will be impacted upon by any change in vegetation.	Compile and Implement Environmental Management Plan. Wetland and ecological assessment.
NOISE			
Noise nuisance	Construction phase	Workers should be equipped with appropriate gear to ameliorate the effects of noise levels. Construction activities will be limited to the hours of 07h00 to 18h00 weekdays.	Compile and Implement Environmental Management Plan.

AIR QUALITY			
Fugitive dust releases	Construction Phase	Manage dust during construction phase.	Compile and Implement Environmental Management Plan. Implement speed limits on roads. Implement dust suppression.
HERITAGE			
Possible damage to heritage artefacts	Residential development	Little to no impact expected.	Notice of Intent to Develop submitted to SAHRA Compile and Implement Environmental Management Plan. Implement Environmental Awareness and Response Plan.
SOCIO-ECONOMIC			
Increase in crime	Influx of job seekers	Manage the site access. Manage employee movement. Provide a grievance mechanism with adjacent landowners.	Compile and Implement Environmental Management Plan. Stakeholder Communication Strategy and Grievance Mechanism.
Noise and dust	Construction Phase	Addressed above.	Compile and Implement Environmental Management Plan.

5 RECOMMENDATIONS AND WAY FORWARD

Numerous NEMA listed activities are triggered (see Section 3.5) and therefore a full Environmental Impact Assessment (EIA) is required for authorisation. In addition, water uses are triggered through NWA and so a Water Use License Application (WULA) will need to be submitted with the Department of Water Affairs (See Section 3.5.2).

5.1 Environmental Impact Assessment

The EIA will be carried out in the following Phases:

- Project Initiation and pre-Application Meetings;
- Project Announcement and Draft Scoping Report;
- Specialist Investigation;
- Public Review and Meetings;
- Submit Final Scoping Report;
- Updated Specialist Reports;
- Draft Impact Assessment Report for public review;
- Final Impact Assessment Report submission;
- Follow up with Competent Authority.

5.2 Water Use License Application

The following phases will be carried out for the WULA:

- Project Initiation and Pre-Application Meeting;
- Wetland assessment and matrix;
- Confirm GA or WULA;
- Authority Site Visit;
- Complete forms and technical reports;
- Public Review of Submission; and
- Submission and Follow up.

5.3 Additional recommendations

From the findings of this environmental screening process, it is evident that potential environmental and social impacts may be of moderate to high consequence. Therefore, the required processes, EIA and WULA, have been triggered. Several supporting assessments, processes and reports are recommended, and should be carried out in tandem with the licensing and authorisation processes.

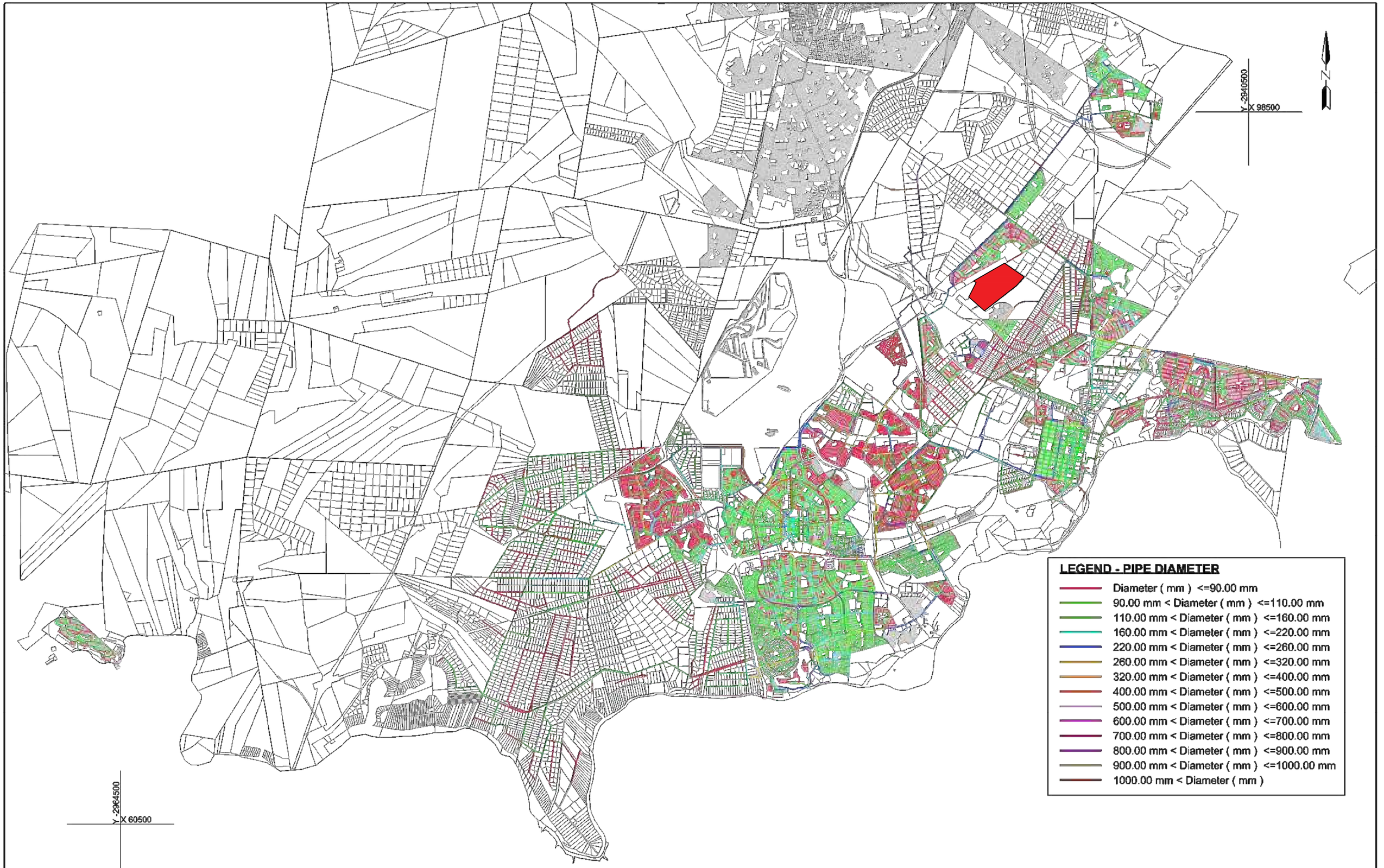
- Environmental Management Plan (EMP) is compiled and implemented during the construction phase.
- An ecological and wetland assessment is carried out to confirm the sensitivity of the wetland and watercourse, so as to input recommendations to the EMP.
- An Environmental Control Officer (ECO) is employed by the client during the construction phase to audit the site on a regular basis and ensure compliance of to the EMP.
- A Notice of Intent to Develop (NID) should be sent to the South African Heritage Resources Agency (SAHRA) to indicate the proposed development.

5.4 Conclusion

GCS will provide a quotation to undertake all of the assessments and reports required to support the EIA and WUL application processes. A meeting will be set up with the client in order to discuss the way forward, including timelines and deliverables.

ANNEXURE H

GLS WATER MASTER PLAN LAYOUT



LEGEND - PIPE DIAMETER

- Diameter (mm) <=90.00 mm
- 90.00 mm < Diameter (mm) <=110.00 mm
- 110.00 mm < Diameter (mm) <=160.00 mm
- 160.00 mm < Diameter (mm) <=220.00 mm
- 220.00 mm < Diameter (mm) <=260.00 mm
- 260.00 mm < Diameter (mm) <=320.00 mm
- 320.00 mm < Diameter (mm) <=400.00 mm
- 400.00 mm < Diameter (mm) <=500.00 mm
- 500.00 mm < Diameter (mm) <=600.00 mm
- 600.00 mm < Diameter (mm) <=700.00 mm
- 700.00 mm < Diameter (mm) <=800.00 mm
- 800.00 mm < Diameter (mm) <=900.00 mm
- 900.00 mm < Diameter (mm) <=1000.00 mm
- 1000.00 mm < Diameter (mm)

ILIFA Africa Engineers (Pty) Ltd

PRETORIA:	012- 362 1473
HARRISMITH:	058- 622 1297
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VANDERBIJLPARK:	016- 981 0581
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RICHARDSBAY:	035- 753 1083
GEORGE:	044- 871 0043
DUNDEE:	034- 212 1206
SECUNDA:	017- 634 8886

ASSOCIATED OFFICES:
BETHLEHEM; BRITS; MTUBATUBA; NELSPRUIT; PHALABORWA.

15 Roseberry Street,
PO Box 1184,
Sasolburg, 1947.

Amendments

	SHORT DESCRIPTION OF REVISION DONE	BY	DATE
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-

All dimensions to be checked on site before any work is put in hand. Copyright reserved.

EMFULENI LM

EMFULENI MASTER PLAN
WATER LAYOUT-SOUTH-PIPES

BASE PIPE LAYOUT

Scale	1:30 000	FOR INFORMATION	
Date	18-02-2013	Drawing Number	Rev
Drawn	MC	S12/012/315	R-a
Designed	C.P CLAASSENS	Checked	P.V CLAASSENS
Plot ini	black	Approved	C.P CLAASSENS
File Name	S12-012-315-R-a-EMP-WLAYOUT-6-BASE PIPE LAYOUT.dgn		

ANNEXURE I

PROPOSED WATER RETICULATION LAYOUT

Coordinate List

WG27

Unitas Park Water

Node	YLo	XLo
Const:		
W1	-90 267.785	2 945 631.766
W2	-90 248.016	2 945 643.174
W3	-90 202.035	2 945 669.707
W4	-90 156.051	2 945 696.241
W5	-90 382.203	2 945 708.031
W6	-90 437.755	2 945 720.291
W7	-90 110.071	2 945 722.774
W8	-90 008.436	2 945 756.599
W9	-90 308.530	2 945 763.554
W10	-90 474.564	2 945 769.597
W11	-90 336.758	2 945 776.211
W12	-90 329.024	2 945 777.214
W13	-90 518.063	2 945 798.590
W14	-90 381.277	2 945 804.979
W15	-90 373.125	2 945 806.610
W16	-90 393.758	2 945 813.299
W17	-90 367.578	2 945 814.931
W18	-90 395.389	2 945 821.451
W19	-90 369.210	2 945 823.084
W20	-90 429.538	2 945 837.149
W21	-90 421.386	2 945 838.780
W22	-90 616.905	2 945 841.035
W23	-89 899.379	2 945 844.684
W24	-90 353.569	2 945 846.549
W25	-90 346.403	2 945 850.151
W26	-90 472.959	2 945 866.093
W27	-90 300.927	2 945 866.432
W28	-90 464.803	2 945 867.720
W29	-90 308.819	2 945 869.044
W30	-89 828.356	2 945 885.924
W31	-90 253.573	2 945 890.236
W32	-90 261.466	2 945 892.848
W33	-90 244.638	2 945 894.728
W34	-90 242.026	2 945 902.620
W35	-90 268.211	2 945 906.227
W36	-90 206.219	2 945 914.040
W37	-90 265.590	2 945 914.144
W38	-89 778.199	2 945 915.049
W39	-90 214.112	2 945 916.652
W40	-90 197.285	2 945 918.532
W41	-90 194.673	2 945 926.424
W42	-89 712.261	2 945 928.467
W43	-90 220.849	2 945 930.054
W44	-90 429.511	2 945 931.117
W45	-90 421.887	2 945 931.719
W46	-90 718.129	2 945 931.937
W47	-90 218.237	2 945 937.947
W48	-90 436.252	2 945 939.608
W49	-90 408.845	2 945 939.693
W50	-90 407.630	2 945 947.238
W51	-90 436.911	2 945 947.954
W52	-90 111.512	2 945 961.649
W53	-90 119.405	2 945 964.261
W54	-89 811.665	2 945 973.187
W55	-90 783.567	2 945 975.552
W56	-90 082.921	2 945 976.021
W57	-90 688.734	2 945 976.038
W58	-90 126.142	2 945 977.663
W59	-90 080.309	2 945 983.914
W60	-90 123.530	2 945 985.556
W61	-90 774.619	2 945 988.977
W62	-90 306.929	2 945 996.138
W63	-90 314.775	2 945 998.561
W64	-89 753.506	2 945 999.987
W65	-89 761.534	2 946 002.140
W66	-90 832.634	2 946 008.256
W67	-90 503.544	2 946 011.115
W68	-90 495.919	2 946 011.718
W69	-90 762.457	2 946 017.966
W70	-90 755.009	2 946 020.211
W71	-90 823.984	2 946 021.233
W72	-89 989.108	2 946 023.181
W73	-90 488.337	2 946 024.977
W74	-89 997.001	2 946 025.793
W75	-90 655.553	2 946 025.820
W76	-90 518.334	2 946 027.730
W77	-89 980.096	2 946 027.904
W78	-90 487.624	2 946 033.318
W79	-90 649.131	2 946 035.456
W80	-89 977.566	2 946 035.550
W81	-89 527.618	2 946 036.663
W82	-90 518.654	2 946 037.628
W83	-90 877.634	2 946 038.250
W84	-90 003.738	2 946 039.195
W85	-90 883.302	2 946 042.027
W86	-90 271.739	2 946 044.378
W87	-90 001.126	2 946 047.087
W88	-90 868.691	2 946 051.668
W89	-89 785.469	2 946 055.412
W90	-89 926.306	2 946 056.084
W91	-90 746.349	2 946 056.359
W92	-89 934.297	2 946 058.230
W93	-89 917.649	2 946 061.084
W94	-90 741.346	2 946 062.378
W95	-89 915.490	2 946 069.121
W96	-89 941.421	2 946 070.606
W97	-90 610.701	2 946 071.314
W98	-89 939.107	2 946 078.323
W99	-90 728.016	2 946 078.413
W100	-90 719.737	2 946 079.176
W101	-89 876.080	2 946 085.091
W102	-90 174.391	2 946 086.734
W103	-90 796.484	2 946 086.780
W104	-89 884.106	2 946 087.247
W105	-90 182.284	2 946 089.346
W106	-90 186.775	2 946 098.280
W107	-90 145.801	2 946 101.106
W108	-90 184.163	2 946 106.173
W109	-90 572.019	2 946 107.102
W110	-90 645.835	2 946 108.968
W111	-90 143.189	2 946 108.999
W112	-90 842.297	2 946 114.578
W113	-89 820.948	2 946 116.933
W114	-89 828.977	2 946 119.086
W115	-89 965.621	2 946 124.383
W116	-90 312.320	2 946 125.105
W117	-90 679.715	2 946 136.517
W118	-90 671.753	2 946 136.745

Pipe Data List

Node	–	Node	Length	Dia.	MATERIAL	CLASS
Unitas Park Water			(m)	(mm)		
W1	–	W2	22.82	75	PE100 HDPE	PN10
W1	–	W5	137.51	75	PE100 HDPE	PN10
W2	–	W3	53.09	75	PE100 HDPE	PN10
W2	–	W9	134.73	75	PE100 HDPE	PN10
W3	–	W4	53.09	75	PE100 HDPE	PN10
W3	–	W27	220.18	75	PE100 HDPE	PN10
W4	–	W7	53.09	75	PE100 HDPE	PN10
W4	–	W31	217.13	75	PE100 HDPE	PN10
W5	–	W11	81.94	75	PE100 HDPE	PN10
W6	–	W14	101.79	75	PE100 HDPE	PN10
W7	–	W36	214.07	75	PE100 HDPE	PN10
W8	–	W52	229.50	250	PE100 HDPE	PN10
W9	–	W12	24.63	75	PE100 HDPE	PN10
W10	–	W13	52.28	75	PE100 HDPE	PN10
W10	–	W20	81.18	75	PE100 HDPE	PN10
W11	–	W12	7.80	75	PE100 HDPE	PN10
W12	–	W15	53.00	75	PE100 HDPE	PN10
W13	–	W26	81.19	75	PE100 HDPE	PN10
W14	–	W15	8.31	75	PE100 HDPE	PN10
W14	–	W16	15.00	75	PE100 HDPE	PN10
W15	–	W17	10.00	75	PE100 HDPE	PN10
W16	–	W18	8.31	75	PE100 HDPE	PN10
W17	–	W19	8.31	75	PE100 HDPE	PN10
W18	–	W21	31.24	75	PE100 HDPE	PN10
W19	–	W24	28.20	75	PE100 HDPE	PN10
W20	–	W21	8.31	75	PE100 HDPE	PN10
W21	–	W28	52.18	75	PE100 HDPE	PN10
W22	–	W67	204.40	200	PE100 HDPE	PN10
W23	–	W30	82.13	75	PE100 HDPE	PN10
W23	–	W72	199.78	75	PE100 HDPE	PN10
W24	–	W25	8.02	75	PE100 HDPE	PN10
W25	–	W29	42.07	75	PE100 HDPE	PN10
W25	–	W45	111.14	110	PE100 HDPE	PN10
W26	–	W28	8.32	75	PE100 HDPE	PN10
W26	–	W44	78.20	75	PE100 HDPE	PN10
W27	–	W29	8.31	75	PE100 HDPE	PN10
W29	–	W32	53.00	75	PE100 HDPE	PN10
W30	–	W38	58.00	75	PE100 HDPE	PN10
W30	–	W90	196.34	75	PE100 HDPE	PN10
W31	–	W32	8.31	75	PE100 HDPE	PN10
W31	–	W33	10.00	75	PE100 HDPE	PN10
W32	–	W35	14.98	75	PE100 HDPE	PN10
W33	–	W34	8.31	75	PE100 HDPE	PN10
W34	–	W39	31.24	75	PE100 HDPE	PN10
W35	–	W37	8.34	75	PE100 HDPE	PN10
W36	–	W39	8.31	160	PE100 HDPE	PN10
W36	–	W40	10.00	160	PE100 HDPE	PN10
W37	–	W62	91.83	75	PE100 HDPE	PN10
W38	–	W54	67.08	75	PE100 HDPE	PN10
W39	–	W43	15.00	160	PE100 HDPE	PN10
W40	–	W41	8.31	160	PE100 HDPE	PN10
W41	–	W53	84.24	160	PE100 HDPE	PN10
W42	–	W64	82.56	75	PE100 HDPE	PN10
W42	–	W81	214.01	75	PE100 HDPE	PN10
W43	–	W47	8.31	160	PE100 HDPE	PN10
W44	–	W45	7.65	110	PE100 HDPE	PN10
W44	–	W48	10.84	110	PE100 HDPE	PN10
W45	–	W49	15.29	75	PE100 HDPE	PN10
W46	–	W55	78.64	75	PE100 HDPE	PN10
W46	–	W57	53.00	75	PE100 HDPE	PN10
W47	–	W86	119.12	160	PE100 HDPE	PN10
W48	–	W51	8.37	110	PE100 HDPE	PN10
W49	–	W50	7.64	75	PE100 HDPE	PN10
W50	–	W63	106.09	75	PE100 HDPE	PN10
W51	–	W68	86.88	110	PE100 HDPE	PN10
W52	–	W53	8.31	250	PE100 HDPE	PN10
W52	–	W56	32.00	160	PE100 HDPE	PN10
W53	–	W58	15.00	250	PE100 HDPE	PN10
W54	–	W65	57.89	75	PE100 HDPE	PN10
W54	–	W101	129.12	75	PE100 HDPE	PN10
W55	–	W61	16.13	75	PE100 HDPE	PN10
W55	–	W66	58.97	75	PE100 HDPE	PN10
W56	–	W59	8.31	160	PE100 HDPE	PN10
W57	–	W70	79.65	75	PE100 HDPE	PN10
W57	–	W75	59.83	75	PE100 HDPE	PN10
W58	–	W60	8.31	250	PE100 HDPE	PN10
W59	–	W74	93.24	160	PE100 HDPE	PN10
W60	–	W102	113.24	250	PE100 HDPE	PN10
W61	–	W69	31.44	75	PE100 HDPE	PN10
W62	–	W63	8.21	75	PE100 HDPE	PN10
W64	–	W65	8.31	75	PE100 HDPE	PN10
W64	–	W89	63.98	75	PE100 HDPE	PN10
W66	–	W71	15.60	75	PE100 HDPE	PN10
W66	–	W83	54.08	75	PE100 HDPE	PN10
W67	–	W68	7.65	200	PE100 HDPE	PN10
W67	–	W76	22.24	110	PE100 HDPE	PN10
W68	–	W73	15.27	200	PE100 HDPE	PN10
W69	–	W70	7.78	75	PE100 HDPE	PN10
W69	–	W91	41.64	75	PE100 HDPE	PN10
W71	–	W103	71.08	75	PE100 HDPE	PN10
W72	–	W74	8.31	160	PE100 HDPE	PN10
W72	–	W77	10.17	75	PE100 HDPE	PN10
W73	–	W78	8.37	200	PE100 HDPE	PN10
W74	–	W84	15.00	160	PE100 HDPE	PN10
W75	–	W79	11.58	75	PE100 HDPE	PN10
W75	–	W100	83.46	75	PE100 HDPE	PN10
W76	–	W82	9.90	110	PE100 HDPE	PN10
W77	–	W80	8.05	75	PE100 HDPE	PN10
W78	–	W122	189.11	200	PE100 HDPE	PN10
W79	–	W97	52.56	75	PE100 HDPE	PN10
W80	–	W92	48.85	75	PE100 HDPE	PN10
W81	–	W129	145.16	75	PE100 HDPE	PN10
W82	–	W109	87.60	110	PE100 HDPE	PN10
W83	–	W85	6.81	75	PE100 HDPE	PN10
W83	–	W88	16.13	75	PE100 HDPE	PN10
W84	–	W87	8.31	160	PE100 HDPE	PN10
W86	–	W105	100.12	160	PE100 HDPE	PN10
W86	–	W116	90.35	160	PE100 HDPE	PN10
W87	–	W121	113.24	160	PE100 HDPE	PN10
W88	–	W112	68.22	75	PE100 HDPE	PN10
W89	–	W113	71.02	75	PE100 HDPE	PN10
W89	–	W129	213.92	75	PE100 HDPE	PN10
W90	–	W92	8.27	75	PE100 HDPE	PN10
W90	–	W93	10.00	75	PE100 HDPE	PN10
W91	–	W94	7.83	75	PE100 HDPE	PN10
W92	–	W96	14.28	75	PE100 HDPE	PN10
W93	–	W95	8.32	75	PE100 HDPE	PN10
W94	–	W99	20.85	75	PE100 HDPE	PN10
W95	–	W104	36.24	75	PE100 HDPE	PN10
W96	–	W98	8.06	75	PE100 HDPE	PN10

Coordinate List

WG27

Unitas Park Water

Node	YLo	XLo
Const:		
W119	-90 528.060	2 946 145.472
W120	-90 329.247	2 946 147.207
W121	-90 051.987	2 946 148.265
W122	-90 337.488	2 946 148.300
W123	-90 059.094	2 946 151.279
W124	-90 321.520	2 946 153.125
W125	-89 915.381	2 946 153.365
W126	-89 845.247	2 946 159.068
W127	-90 620.544	2 946 159.551
W128	-90 319.457	2 946 161.780
W129	-89 600.208	2 946 162.374
W130	-90 350.944	2 946 165.174
W131	-90 021.301	2 946 170.591
W132	-90 349.772	2 946 174.008
W133	-90 012.844	2 946 175.662
W134	-90 645.561	2 946 177.601
W135	-90 637.599	2 946 177.829
W136	-90 486.900	2 946 179.025
W137	-89 997.268	2 946 179.362
W138	-90 005.142	2 946 181.098
W139	-89 859.560	2 946 183.886
W140	-90 627.284	2 946 187.454
W141	-90 655.693	2 946 188.459
W142	-90 225.929	2 946 189.258
W143	-89 866.470	2 946 194.410
W144	-90 247.341	2 946 196.542
W145	-90 626.953	2 946 197.023
W146	-90 655.951	2 946 197.498
W147	-90 196.208	2 946 202.379
W148	-90 444.968	2 946 211.140
W149	-89 949.677	2 946 212.945
W150	-89 957.550	2 946 214.680
W151	-90 595.789	2 946 218.061
W152	-90 604.097	2 946 218.349
W153	-90 685.448	2 946 220.350
W154	-90 259.424	2 946 220.482
W155	-90 677.486	2 946 220.578
W156	-90 189.229	2 946 222.886
W157	-90 692.141	2 946 227.523
W158	-90 666.787	2 946 231.743
W159	-90 256.138	2 946 234.258
W160	-90 692.400	2 946 236.561
W161	-90 666.521	2 946 239.430
W162	-89 902.906	2 946 246.045
W163	-89 911.099	2 946 247.459
W164	-90 557.050	2 946 254.207
W165	-90 565.358	2 946 254.495
W166	-90 118.744	2 946 256.841
W167	-90 721.897	2 946 259.413
W168	-90 713.935	2 946 259.641
W169	-89 659.991	2 946 265.905
W170	-90 702.678	2 946 278.181
W171	-90 430.781	2 946 279.783
W172	-90 510.867	2 946 297.186
W173	-90 518.887	2 946 297.855
W174	-90 501.862	2 946 311.578
W175	-89 466.603	2 946 318.418
W176	-89 956.721	2 946 322.308
W177	-89 973.703	2 946 326.711
W178	-89 943.396	2 946 328.727
W179	-90 468.371	2 946 328.864
W180	-90 476.655	2 946 330.052
W181	-90 332.742	2 946 334.316
W182	-90 355.034	2 946 337.318
W183	-90 561.366	2 946 337.546
W184	-90 180.101	2 946 339.235
W185	-89 939.668	2 946 343.106
W186	-89 988.076	2 946 347.079
W187	-90 549.258	2 946 348.844
W188	-90 364.340	2 946 349.473
W189	-90 480.301	2 946 353.297
W190	-90 307.064	2 946 353.438
W191	-90 537.138	2 946 357.562
W192	-89 984.347	2 946 361.459
W193	-90 527.059	2 946 364.949
W194	-90 361.388	2 946 371.732
W195	-90 303.985	2 946 375.503
W196	-90 130.062	2 946 376.498
W197	-90 499.033	2 946 378.047
W198	-90 507.309	2 946 379.278
W199	-90 583.591	2 946 389.298
W200	-90 014.230	2 946 403.806
W201	-90 084.034	2 946 410.775
W202	-90 238.156	2 946 417.194
W203	-90 246.382	2 946 418.398
W204	-90 531.185	2 946 420.435
W205	-90 539.441	2 946 421.656
W206	-89 775.986	2 946 421.956
W207	-89 479.719	2 946 428.501
W208	-89 755.735	2 946 431.712
W209	-89 966.840	2 946 437.246
W210	-90 038.093	2 946 437.624
W211	-90 046.236	2 946 438.922
W212	-89 923.536	2 946 467.804
W213	-90 280.386	2 946 473.903
W214	-89 807.257	2 946 486.870
W215	-90 452.319	2 946 490.469
W216	-89 627.587	2 946 493.444
W217	-89 204.887	2 946 493.826
W218	-90 146.163	2 946 494.206
W219	-89 880.232	2 946 498.361
W220	-90 226.557	2 946 506.077
W221	-90 234.798	2 946 507.315
W222	-89 196.848	2 946 516.533
W223	-90 315.090	2 946 520.506
W224	-90 097.831	2 946 522.281
W225	-90 106.030	2 946 523.620
W226	-89 836.063	2 946 527.693
W227	-90 202.876	2 946 530.711
W228	-90 085.761	2 946 531.127
W229	-90 111.740	2 946 531.712
W230	-90 084.405	2 946 539.432
W231	-90 110.376	2 946 540.059
W232	-90 051.043	2 946 556.573
W233	-89 384.460	2 946 557.426
W234	-90 059.200	2 946 557.905
W235	-89 987.705	2 946 558.740
W236	-89 789.526	2 946 562.342
W237	-90 346.684	2 946 562.932

Pipe Data List

Node	–	Node	Length	Dia.	MATERIAL	CLASS
Unitas Park Water			(m)	(mm)		
W97	–	W109	52.70	75	PE100 HDPE	PN10
W97	–	W110	51.50	75	PE100 HDPE	PN10
W98	–	W115	53.15	75	PE100 HDPE	PN10
W99	–	W100	8.31	75	PE100 HDPE	PN10
W99	–	W117	75.56	75	PE100 HDPE	PN10
W101	–	W104	8.31	75	PE100 HDPE	PN10
W102	–	W105	8.31	250	PE100 HDPE	PN10
W102	–	W107	32.00	160	PE100 HDPE	PN10
W103	–	W153	173.69	75	PE100 HDPE	PN10
W104	–	W114	63.66	75	PE100 HDPE	PN10
W105	–	W106	10.00	250	PE100 HDPE	PN10
W106	–	W108	8.31	250	PE100 HDPE	PN10
W107	–	W111	8.31	160	PE100 HDPE	PN10
W108	–	W142	92.99	250	PE100 HDPE	PN10
W109	–	W127	71.45	110	PE100 HDPE	PN10
W110	–	W118	37.99	75	PE100 HDPE	PN10
W111	–	W123	94.13	160	PE100 HDPE	PN10
W112	–	W167	188.34	75	PE100 HDPE	PN10
W113	–	W114	8.31	75	PE100 HDPE	PN10
W113	–	W126	48.64	75	PE100 HDPE	PN10
W115	–	W125	58.00	75	PE100 HDPE	PN10
W115	–	W137	63.44	75	PE100 HDPE	PN10
W116	–	W120	27.84	160	PE100 HDPE	PN10
W117	–	W118	7.97	75	PE100 HDPE	PN10
W117	–	W134	53.43	75	PE100 HDPE	PN10
W119	–	W136	53.10	75	PE100 HDPE	PN10
W119	–	W151	99.28	75	PE100 HDPE	PN10
W120	–	W122	8.31	200	PE100 HDPE	PN10
W120	–	W124	9.73	200	PE100 HDPE	PN10
W121	–	W123	7.72	160	PE100 HDPE	PN10
W122	–	W130	21.58	75	PE100 HDPE	PN10
W123	–	W131	42.44	160	PE100 HDPE	PN10
W124	–	W128	8.90	200	PE100 HDPE	PN10
W125	–	W149	68.75	75	PE100 HDPE	PN10
W126	–	W139	28.65	75	PE100 HDPE	PN10
W126	–	W169	213.85	75	PE100 HDPE	PN10
W127	–	W135	25.00	110	PE100 HDPE	PN10
W128	–	W144	80.06	200	PE100 HDPE	PN10
W129	–	W169	119.55	75	PE100 HDPE	PN10
W130	–	W132	8.91	75	PE100 HDPE	PN10
W131	–	W133	9.86	160	PE100 HDPE	PN10
W132	–	W171	133.23	160	PE100 HDPE	PN10
W133	–	W138	9.43	160	PE100 HDPE	PN10
W134	–	W135	7.97	110	PE100 HDPE	PN10
W134	–	W141	14.85	110	PE100 HDPE	PN10
W135	–	W140	14.11	75	PE100 HDPE	PN10
W136	–	W148	52.82	75	PE100 HDPE	PN10
W136	–	W164	102.83	75	PE100 HDPE	PN10
W137	–	W138	8.06	75	PE100 HDPE	PN10
W138	–	W150	58.25	160	PE100 HDPE	PN10
W139	–	W143	12.59	75	PE100 HDPE	PN10
W140	–	W145	9.57	75	PE100 HDPE	PN10
W141	–	W146	9.04	110	PE100 HDPE	PN10
W142	–	W144	22.62	200	PE100 HDPE	PN10
W142	–	W147	32.49	200	PE100 HDPE	PN10
W143	–	W162	63.20	75	PE100 HDPE	PN10
W144	–	W154	26.82	200	PE100 HDPE	PN10
W145	–	W152	31.26	75	PE100 HDPE	PN10
W146	–	W155	31.57	110	PE100 HDPE	PN10
W147	–	W156	21.66	200	PE100 HDPE	PN10
W148	–	W172	108.38	75	PE100 HDPE	PN10
W149	–	W150	8.06	75	PE100 HDPE	PN10
W150	–	W163	56.85	160	PE100 HDPE	PN10
W151	–	W152	8.31	75	PE100 HDPE	PN10
W152	–	W165	52.98	75	PE100 HDPE	PN10
W153	–	W155	7.97	110	PE100 HDPE	PN10
W153	–	W157	9.81	110	PE100 HDPE	PN10
W154	–	W159	14.16	200	PE100 HDPE	PN10
W155	–	W158	15.46	75	PE100 HDPE	PN10
W156	–	W166	28.24	200	PE100 HDPE	PN10
W157	–	W160	9.04	110	PE100 HDPE	PN10
W158	–	W161	7.69	75	PE100 HDPE	PN10
W159	–	W181	126.02	200	PE100 HDPE	PN10
W160	–	W168	31.57	110	PE100 HDPE	PN10
W161	–	W183	143.82	75	PE100 HDPE	PN10
W162	–	W163	8.31	160	PE100 HDPE	PN10
W162	–	W176	93.34	160	PE100 HDPE	PN10
W164	–	W165	8.31	75	PE100 HDPE	PN10
W165	–	W173	63.56	75	PE100 HDPE	PN10
W166	–	W177	160.99	200	PE100 HDPE	PN10
W166	–	W184	102.73	160	PE100 HDPE	PN10
W167	–	W168	7.97	110	PE100 HDPE	PN10
W167	–	W170	26.86	75	PE100 HDPE	PN10
W169	–	W208	191.46	75	PE100 HDPE	PN10
W170	–	W199	162.88	75	PE100 HDPE	PN10
W171	–	W179	61.82	75	PE100 HDPE	PN10
W171	–	W182	95.12	160	PE100 HDPE	PN10
W172	–	W173	8.05	75	PE100 HDPE	PN10
W173	–	W174	21.87	75	PE100 HDPE	PN10
W174	–	W180	31.25	75	PE100 HDPE	PN10
W175	–	W207	110.86	110	PE100 HDPE	PN10
W176	–	W177	17.54	200	PE100 HDPE	PN10
W176	–	W178	14.79	200	PE100 HDPE	PN10
W177	–	W186	24.93	160	PE100 HDPE	PN10
W178	–	W185	14.86	200	PE100 HDPE	PN10
W179	–	W180	8.37	75	PE100 HDPE	PN10
W179	–	W189	27.19	75	PE100 HDPE	PN10
W181	–	W182	22.49	200	PE100 HDPE	PN10
W181	–	W190	32.02	160	PE100 HDPE	PN10
W182	–	W188	15.31	200	PE100 HDPE	PN10
W183	–	W187	16.56	75	PE100 HDPE	PN10
W184	–	W196	62.39	160	PE100 HDPE	PN10
W184	–	W202	97.20	160	PE100 HDPE	PN10
W185	–	W206	181.68	200	PE100 HDPE	PN10
W186	–	W192	14.86	160	PE100 HDPE	PN10
W187	–	W191	14.93	75	PE100 HDPE	PN10
W188	–	W194	22.45	200	PE100 HDPE	PN10
W189	–	W197	31.04	75	PE100 HDPE	PN10
W190	–	W195	22.28	160	PE100 HDPE	PN10
W191	–	W193	12.50	75	PE100 HDPE	PN10
W192	–	W200	51.83	160	PE100 HDPE	PN10
W193	–	W198	24.40	75	PE100 HDPE	PN10
W194	–	W215	149.56	200	PE100 HDPE	PN10
W195	–	W203	71.82	160	PE100 HDPE	PN10
W196	–	W201	57.39	160	PE100 HDPE	PN10
W196	–	W220	161.56	75	PE100 HDPE	PN10
W197	–	W198	8.37	75	PE100 HDPE	PN10
W197	–	W204	53.20	75	PE100 HDPE	PN10
W199	–	W205	54.74	75	PE100 HDPE	PN10

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS

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DISCIPLINE

CIVIL ENGINEERING

PROJECT TITLE

UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE

WATER SETTING OUT DATA

SHEET 1 OF 2

REF. NO. –

DESIGNER R. MABOHO

SCALE 1:1000

DRAWING F. MAZIBUKO

DATE 03/2021

CHECKED S. MNGUNI

TYPE NUMBER

DRAWING NUMBER 7001/W/A001

A1

100mm ON ORIGINAL DRAWING

Coordinate List

WG27

Unitas Park Water

Node	YLo	XLo
Const:		
W238	-90 041.650	2 946 570.768
W239	-90 134.160	2 946 573.764
W240	-90 142.317	2 946 575.096
W241	-89 438.795	2 946 576.670
W242	-89 941.012	2 946 584.494
W243	-89 949.204	2 946 585.908
W244	-90 008.288	2 946 587.909
W245	-90 016.446	2 946 589.241
W246	-89 932.735	2 946 590.872
W247	-90 120.734	2 946 590.915
W248	-89 746.214	2 946 592.888
W249	-89 954.864	2 946 594.691
W250	-89 538.811	2 946 596.687
W251	-90 022.181	2 946 597.436
W252	-89 931.427	2 946 598.452
W253	-89 953.556	2 946 602.271
W254	-89 513.994	2 946 603.293
W255	-89 563.884	2 946 605.577
W256	-90 020.834	2 946 605.688
W257	-90 090.720	2 946 612.913
W258	-89 897.708	2 946 615.052
W259	-89 905.900	2 946 616.465
W260	-89 498.134	2 946 621.710
W261	-89 568.329	2 946 622.530
W262	-89 911.666	2 946 624.636
W263	-89 883.409	2 946 625.141
W264	-89 882.596	2 946 629.850
W265	-89 910.252	2 946 632.829
W266	-89 598.267	2 946 633.130
W267	-89 683.137	2 946 637.373
W268	-89 502.616	2 946 638.789
W269	-90 044.617	2 946 639.392
W270	-90 052.774	2 946 640.724
W271	-89 848.877	2 946 646.449
W272	-89 857.069	2 946 647.863
W273	-89 840.706	2 946 652.215
W274	-90 035.224	2 946 653.587
W275	-90 121.531	2 946 654.952
W276	-90 129.748	2 946 656.219
W277	-89 865.718	2 946 660.119
W278	-89 839.292	2 946 660.407
W279	-90 113.466	2 946 660.864
W280	-90 135.565	2 946 664.898
W281	-89 864.304	2 946 668.312
W282	-90 112.199	2 946 669.080
W283	-90 001.862	2 946 670.728
W284	-90 010.020	2 946 672.060
W285	-90 134.393	2 946 672.501
W286	-89 805.573	2 946 677.007
W287	-89 648.194	2 946 677.223
W288	-89 813.765	2 946 678.420
W289	-89 338.915	2 946 685.867
W290	-90 152.862	2 946 697.700
W291	-90 161.079	2 946 698.966
W292	-89 959.107	2 946 702.064
W293	-89 967.265	2 946 703.396
W294	-89 762.744	2 946 707.678
W295	-89 771.618	2 946 708.162
W296	-89 756.042	2 946 715.362
W297	-89 434.625	2 946 716.750
W298	-89 783.587	2 946 718.074
W299	-89 756.526	2 946 722.780
W300	-89 756.160	2 946 723.864
W301	-89 783.170	2 946 725.717
W302	-89 082.507	2 946 734.660
W303	-89 615.286	2 946 734.880
W304	-89 408.575	2 946 746.619
W305	-89 736.031	2 946 746.944
W306	-89 727.751	2 946 747.484
W307	-89 992.553	2 946 749.461
W308	-90 000.711	2 946 750.793
W309	-89 399.789	2 946 756.694
W310	-89 747.264	2 946 756.865
W311	-89 713.299	2 946 764.054
W312	-89 747.807	2 946 765.196
W313	-89 584.093	2 946 770.199
W314	-89 713.842	2 946 772.386
W315	-89 584.608	2 946 778.497
W316	-89 945.765	2 946 783.753
W317	-89 953.922	2 946 785.085
W318	-89 693.307	2 946 795.932
W319	-89 685.027	2 946 796.472
W320	-89 360.858	2 946 801.332
W321	-89 535.000	2 946 805.395
W322	-89 878.230	2 946 809.668
W323	-89 801.864	2 946 812.936
W324	-89 889.485	2 946 825.025
W325	-89 897.348	2 946 826.550
W326	-89 658.470	2 946 835.876
W327	-89 650.191	2 946 836.416
W328	-89 326.023	2 946 841.276
W329	-89 643.627	2 946 843.943
W330	-89 838.861	2 946 845.610
W331	-89 669.746	2 946 846.438
W332	-89 644.170	2 946 852.274
W333	-89 670.262	2 946 853.995
W334	-89 920.815	2 946 867.773
W335	-89 929.032	2 946 869.039
W336	-89 773.183	2 946 872.552
W337	-89 623.634	2 946 875.820
W338	-89 615.354	2 946 876.360
W339	-89 698.278	2 946 878.475
W340	-89 291.993	2 946 880.295
W341	-89 548.951	2 946 888.426
W342	-89 272.461	2 946 902.412
W343	-89 808.887	2 946 904.084
W344	-89 733.188	2 946 908.978
W345	-89 741.058	2 946 909.006
W346	-89 809.402	2 946 912.382
W347	-89 588.798	2 946 915.765
W348	-89 580.518	2 946 916.304
W349	-89 892.387	2 946 918.641
W350	-89 727.753	2 946 925.314
W351	-89 514.698	2 946 927.700
W352	-89 506.404	2 946 928.266
W353	-89 522.277	2 946 934.893
W354	-89 499.831	2 946 935.803
W355	-89 522.801	2 946 942.567
W356	-89 500.398	2 946 944.097
W357	-89 550.778	2 946 966.966
W358	-89 479.863	2 946 967.643
W359	-89 471.568	2 946 968.210
W360	-89 670.319	2 946 991.169
W361	-89 594.585	2 946 997.371
W362	-89 586.291	2 946 997.938
W363	-89 445.023	2 947 007.591

Pipe Data List

Node	–	Node	Length (m)	Dia. (mm)	MATERIAL	CLASS
Unitas Park Water						
W200	–	W209	58.00	75	PE100 HDPE	PN10
W200	–	W210	41.39	160	PE100 HDPE	PN10
W201	–	W211	47.13	160	PE100 HDPE	PN10
W201	–	W218	104.02	75	PE100 HDPE	PN10
W202	–	W203	8.31	160	PE100 HDPE	PN10
W202	–	W213	70.70	75	PE100 HDPE	PN10
W204	–	W205	8.35	75	PE100 HDPE	PN10
W206	–	W208	22.48	200	PE100 HDPE	PN10
W206	–	W214	72.05	160	PE100 HDPE	PN10
W207	–	W241	153.72	110	PE100 HDPE	PN10
W208	–	W216	142.24	200	PE100 HDPE	PN10
W209	–	W212	53.00	75	PE100 HDPE	PN10
W209	–	W232	146.04	75	PE100 HDPE	PN10
W210	–	W211	8.25	160	PE100 HDPE	PN10
W210	–	W224	103.61	75	PE100 HDPE	PN10
W212	–	W219	53.00	75	PE100 HDPE	PN10
W212	–	W235	111.30	75	PE100 HDPE	PN10
W213	–	W221	56.52	75	PE100 HDPE	PN10
W213	–	W223	58.11	75	PE100 HDPE	PN10
W214	–	W226	49.96	160	PE100 HDPE	PN10
W216	–	W250	136.16	200	PE100 HDPE	PN10
W217	–	W222	24.09	160	PE100 HDPE	PN10
W217	–	W233	190.50	160	PE100 HDPE	PN10
W218	–	W225	49.76	75	PE100 HDPE	PN10
W219	–	W242	105.42	75	PE100 HDPE	PN10
W220	–	W221	8.33	75	PE100 HDPE	PN10
W221	–	W227	39.58	75	PE100 HDPE	PN10
W222	–	W302	246.28	160	PE100 HDPE	PN10
W223	–	W237	52.90	75	PE100 HDPE	PN10
W223	–	W276	229.72	75	PE100 HDPE	PN10
W224	–	W225	8.31	75	PE100 HDPE	PN10
W224	–	W228	14.96	75	PE100 HDPE	PN10
W225	–	W229	9.90	75	PE100 HDPE	PN10
W226	–	W258	106.92	160	PE100 HDPE	PN10
W227	–	W240	75.08	75	PE100 HDPE	PN10
W228	–	W230	8.42	75	PE100 HDPE	PN10
W229	–	W231	8.46	75	PE100 HDPE	PN10
W230	–	W234	31.25	75	PE100 HDPE	PN10
W231	–	W239	41.25	75	PE100 HDPE	PN10
W232	–	W234	8.27	75	PE100 HDPE	PN10
W233	–	W241	57.64	160	PE100 HDPE	PN10
W233	–	W289	136.28	110	PE100 HDPE	PN10
W234	–	W238	21.76	75	PE100 HDPE	PN10
W235	–	W243	47.12	110	PE100 HDPE	PN10
W235	–	W244	35.70	75	PE100 HDPE	PN10
W236	–	W248	53.00	75	PE100 HDPE	PN10
W236	–	W271	102.94	75	PE100 HDPE	PN10
W237	–	W291	230.12	75	PE100 HDPE	PN10
W238	–	W245	31.25	75	PE100 HDPE	PN10
W239	–	W240	8.27	75	PE100 HDPE	PN10
W240	–	W247	26.76	75	PE100 HDPE	PN10
W241	–	W254	79.77	160	PE100 HDPE	PN10
W242	–	W243	8.31	110	PE100 HDPE	PN10
W242	–	W246	10.45	110	PE100 HDPE	PN10
W243	–	W249	10.45	75	PE100 HDPE	PN10
W244	–	W245	8.27	75	PE100 HDPE	PN10
W245	–	W251	10.00	75	PE100 HDPE	PN10
W246	–	W252	7.69	110	PE100 HDPE	PN10
W247	–	W257	37.21	75	PE100 HDPE	PN10
W248	–	W267	77.19	75	PE100 HDPE	PN10
W248	–	W286	102.95	75	PE100 HDPE	PN10
W249	–	W253	7.69	75	PE100 HDPE	PN10
W250	–	W254	25.68	200	PE100 HDPE	PN10
W250	–	W255	26.60	160	PE100 HDPE	PN10
W251	–	W256	8.36	75	PE100 HDPE	PN10
W252	–	W259	31.24	110	PE100 HDPE	PN10
W253	–	W283	83.78	75	PE100 HDPE	PN10
W254	–	W260	24.30	200	PE100 HDPE	PN10
W255	–	W261	17.53	160	PE100 HDPE	PN10
W256	–	W269	41.25	75	PE100 HDPE	PN10
W257	–	W270	47.05	75	PE100 HDPE	PN10
W257	–	W275	52.12	75	PE100 HDPE	PN10
W258	–	W259	8.31	110	PE100 HDPE	PN10
W258	–	W263	17.50	110	PE100 HDPE	PN10
W259	–	W262	10.00	75	PE100 HDPE	PN10
W260	–	W268	17.66	200	PE100 HDPE	PN10
W261	–	W266	31.76	160	PE100 HDPE	PN10
W262	–	W265	8.31	75	PE100 HDPE	PN10
W263	–	W264	4.78	110	PE100 HDPE	PN10
W264	–	W272	31.24	110	PE100 HDPE	PN10
W265	–	W292	84.74	75	PE100 HDPE	PN10
W266	–	W287	66.61	160	PE100 HDPE	PN10
W267	–	W294	106.21	75	PE100 HDPE	PN10
W268	–	W297	103.44	200	PE100 HDPE	PN10
W269	–	W270	8.27	75	PE100 HDPE	PN10
W270	–	W274	21.76	75	PE100 HDPE	PN10
W271	–	W273	10.00	110	PE100 HDPE	PN10
W272	–	W277	15.00	75	PE100 HDPE	PN10
W273	–	W278	8.31	110	PE100 HDPE	PN10
W274	–	W284	31.25	75	PE100 HDPE	PN10
W275	–	W276	8.31	75	PE100 HDPE	PN10
W275	–	W279	10.00	75	PE100 HDPE	PN10
W276	–	W280	10.45	75	PE100 HDPE	PN10
W277	–	W281	8.31	75	PE100 HDPE	PN10
W278	–	W288	31.24	110	PE100 HDPE	PN10
W279	–	W282	8.31	75	PE100 HDPE	PN10
W280	–	W285	7.69	75	PE100 HDPE	PN10
W281	–	W316	141.29	75	PE100 HDPE	PN10
W282	–	W308	138.23	75	PE100 HDPE	PN10
W283	–	W284	8.27	75	PE100 HDPE	PN10
W284	–	W293	53.01	75	PE100 HDPE	PN10
W285	–	W290	31.24	75	PE100 HDPE	PN10
W286	–	W288	8.31	75	PE100 HDPE	PN10
W287	–	W306	106.14	160	PE100 HDPE	PN10
W287	–	W321	171.00	75	PE100 HDPE	PN10
W288	–	W295	51.58	110	PE100 HDPE	PN10
W289	–	W304	92.43	110	PE100 HDPE	PN10
W290	–	W291	8.31	75	PE100 HDPE	PN10
W291	–	W335	287.70	75	PE100 HDPE	PN10
W292	–	W293	8.27	75	PE100 HDPE	PN10
W292	–	W307	58.01	75	PE100 HDPE	PN10
W294	–	W295	8.89	110	PE100 HDPE	PN10
W294	–	W296	10.20	110	PE100 HDPE	PN10
W295	–	W298	15.54	75	PE100 HDPE	PN10
W296	–	W299	7.43	110	PE100 HDPE	PN10
W297	–	W304	39.63	200	PE100 HDPE	PN10
W297	–	W321	133.91	75	PE100 HDPE	PN10
W298	–	W301	7.65	75	PE100 HDPE	PN10
W300	–	W305	30.62	110	PE100 HDPE	PN10
W301	–	W322	126.82	75	PE100 HDPE	PN10
W302	–	W342	253.42	160	PE100 HDPE	PN10
W303	–	W313	47.12	75	PE100 HDPE	PN10
W303	–	W319	93.05	75	PE100 HDPE	PN10
W304	–	W309	13.37	200	PE100 HDPE	PN10
W305	–	W306	8.30	160	PE100 HDPE	PN10

Coordinate List

WG27

Unitas Park Water

Node	YLo	XLo
Const:		
W363	-89 445.023	2 947 007.591
W364	-89 436.744	2 947 008.131
W365	-89 713.258	2 947 021.247
W366	-89 704.960	2 947 021.762
W367	-89 699.613	2 947 038.215
W368	-89 484.750	2 947 042.675
W369	-89 476.470	2 947 043.215
W370	-89 619.479	2 947 049.463
W371	-89 524.476	2 947 077.760
W372	-89 516.197	2 947 078.299
W373	-89 663.074	2 947 080.112
W374	-89 654.795	2 947 080.651
W375	-89 564.203	2 947 112.844
W376	-89 555.923	2 947 113.384

Pipe Data List

Node	–	Node	Length (m)	Dia. (mm)	MATERIAL	CLASS
Unitas Park Water						
W305	–	W306	8.30	160	PE100 HDPE	PN10
W305	–	W310	14.99	160	PE100 HDPE	PN10
W306	–	W311	21.99	110	PE100 HDPE	PN10
W307	–	W308	8.27	75	PE100 HDPE	PN10
W308	–	W317	58.01	75	PE100 HDPE	PN10
W309	–	W320	59.23	200	PE100 HDPE	PN10
W309	–	W341	199.00	110	PE100 HDPE	PN10
W310	–	W312	8.35	160	PE100 HDPE	PN10
W311	–	W314	8.35	110	PE100 HDPE	PN10
W312	–	W323	72.12	160	PE100 HDPE	PN10
W313	–	W315	8.31	75	PE100 HDPE	PN10
W314	–	W318	31.24	110	PE100 HDPE	PN10
W315	–	W327	87.50	75	PE100 HDPE	PN10
W316	–	W317	8.27	75	PE100 HDPE	PN10
W317	–	W325	70.14	75	PE100 HDPE	PN10
W318	–	W319	8.30	75	PE100 HDPE	PN10
W318	–	W326	53.00	110	PE100 HDPE	PN10
W320	–	W328	53.00	200	PE100 HDPE	PN10
W320	–	W352	193.12	75	PE100 HDPE	PN10
W321	–	W338	107.21	75	PE100 HDPE	PN10
W322	–	W324	19.04	75	PE100 HDPE	PN10
W323	–	W330	49.36	160	PE100 HDPE	PN10
W324	–	W325	8.01	75	PE100 HDPE	PN10
W324	–	W334	53.00	75	PE100 HDPE	PN10
W326	–	W327	8.30	110	PE100 HDPE	PN10
W326	–	W331	15.45	75	PE100 HDPE	PN10
W327	–	W329	9.99	110	PE100 HDPE	PN10
W328	–	W340	51.77	200	PE100 HDPE	PN10
W328	–	W359	193.12	75	PE100 HDPE	PN10
W329	–	W332	8.35	110	PE100 HDPE	PN10
W330	–	W349	90.55	160	PE100 HDPE	PN10
W331	–	W333	7.57	75	PE100 HDPE	PN10
W332	–	W337	31.24	110	PE100 HDPE	PN10
W333	–	W339	37.20	75	PE100 HDPE	PN10
W334	–	W335	8.31	75	PE100 HDPE	PN10
W336	–	W343	47.63	75	PE100 HDPE	PN10
W336	–	W345	48.59	75	PE100 HDPE	PN10
W337	–	W338	8.30	75	PE100 HDPE	PN10
W337	–	W347	53.00	110	PE100 HDPE	PN10
W339	–	W344	46.36	75	PE100 HDPE	PN10
W339	–	W361	157.76	75	PE100 HDPE	PN10
W340	–	W342	29.51	200	PE100 HDPE	PN10
W340	–	W364	193.12	75	PE100 HDPE	PN10
W341	–	W348	42.12	110	PE100 HDPE	PN10
W341	–	W351	52.11	75	PE100 HDPE	PN10
W343	–	W346	8.31	75	PE100 HDPE	PN10
W344	–	W345	7.87	75	PE100 HDPE	PN10
W345	–	W350	21.05	75	PE100 HDPE	PN10
W346	–	W365	145.24	75	PE100 HDPE	PN10
W347	–	W348	8.30	110	PE100 HDPE	PN10
W350	–	W360	87.38	75	PE100 HDPE	PN10
W351	–	W352	8.31	75	PE100 HDPE	PN10
W351	–	W353	10.45	75	PE100 HDPE	PN10
W352	–	W354	10.00	75	PE100 HDPE	PN10
W353	–	W355	7.69	75	PE100 HDPE	PN10
W354	–	W356	8.31	75	PE100 HDPE	PN10
W355	–	W357	37.12	75	PE100 HDPE	PN10
W356	–	W358	31.24	75	PE100 HDPE	PN10
W357	–	W362	47.12	75	PE100 HDPE	PN10
W357	–	W368	100.46	75	PE100 HDPE	PN10
W358	–	W359	8.31	75	PE100 HDPE	PN10
W358	–	W363	53.01	75	PE100 HDPE	PN10
W360	–	W366	46.22	75	PE100 HDPE	PN10
W360	–	W370	77.35	75	PE100 HDPE	PN10
W361	–	W362	8.31	75	PE100 HDPE	PN10
W361	–	W371	106.67	75	PE100 HDPE	PN10
W363	–	W364	8.30	75	PE100 HDPE	PN10
W364	–	W369	53.00	75	PE100 HDPE	PN10
W365	–	W366	8.31	75	PE100 HDPE	PN10
W365	–	W367	21.77	75	PE100 HDPE	PN10
W367	–	W373	55.59	75	PE100 HDPE	PN10
W368	–	W369	8.30	75	PE100 HDPE	PN10
W369	–	W372	53.00	75	PE100 HDPE	PN10
W370	–	W374	47.12	75	PE100 HDPE	PN10
W370	–	W375	84.10	75	PE100 HDPE	PN10
W371	–	W372	8.30	75	PE100 HDPE	PN10
W372	–	W376	53.00	75	PE100 HDPE	PN10
W373	–	W374	8.30	75	PE100 HDPE	PN10
W375	–	W376	8.30	75	PE100 HDPE	PN10

PIPE MATERIAL LIST

Diameter (mm)	Class	Length (m)
PE100 HDPE		
250	PN10	493.99
200	PN10	2171.95
160	PN10	3614.49
110	PN10	1872.26
75	PN10	14918.36
Total length :		23071.06

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS

P.O. BOX 4049
RANDBURG 2125
FIRST FLOOR 24 PETER PLACE
LYME PARK BRYANSTON 2191
TEL (011)326-0741/90

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DISCIPLINE

CIVIL ENGINEERING

PROJECT TITLE

UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE

WATER SETTING OUT DATA

SHEET 2 OF 2

REF. NO. –

DESIGNER R. MABOHO

SCALE 1:1000

DRAWING F. MAZIBUKO

DATE 03/2021

CHECKED S. MNGUNI

TYPE NUMBER

DRAWING NUMBER 7001/W/A002

A1

100mm ON ORIGINAL DRAWING

LOCALITY PLAN
NTS

SEE DWG 7001/W/U002

SEE DWG 7001/W/U002

WATER RETICULATION LAYOUT
SCALE 1:1500

UNITAS PARK EXT.16 – P. BENCHMARKS WG–29				DESCRIPTION
BM1B	89603.38	2946872.99	1468.80	12mm Iron Peg in concrete
BM2B	89184.97	2946609.98	1470.33	12mm Iron Peg in concrete
BM3B	89396.12	2946070.32	1477.67	12mm Iron Peg in concrete
BM4B	90214.71	2945629.83	1478.42	12mm Iron Peg in concrete
BM5B	90982.23	2946053.61	1472.43	12mm Iron Peg in concrete
QU7	90424.23	2945692.86	1476.87	12mm Iron Peg in concrete

NOTES AND SPECIFICATIONS GENERAL

1. ALL MATERIAL AND WORKMANSHIP MUST COMPLY WITH THE REQUIREMENTS OF THE LATEST RELEVANT SABS REQUIREMENTS.
2. ALL DIMENSIONS ARE IN MILLIMETRES.(UNLESS OTHERWISE SPECIFIED).
3. DO NOT SCALE FROM THESE DRAWINGS.
4. ALL DIMENSIONS MUST BE CHECKED AND APPROVED ON SITE.
5. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, THIRD EDITION 2005 AND THE STANDARD COT DETAIL DRAWINGS.
6. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE STANDARD DRAWINGS.(IF APPLICABLE).
7. THIS DRAWING MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, SERIES 4.
8. THE SIGNATURE OR INITIALS ON THIS DRAWING, OF ANY DIRECTOR OF THE PUBLIC WORKS AND INFRASTRUCTURE DEVELOPMENT DEPARTMENT, IN NO WAY REMOVES ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT.
9. THE CONSULTANT REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARD DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE PUBLIC WORKS AND INFRASTRUCTURE DEVELOPMENT DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH.
10. FINAL POSITION OF SERVICES TO BE DETERMINED ON SITE.
11. THE CONTRACTOR SHALL WHERE NECESSARY DETERMINE THE EXACT LOCATION OF EXISTING SERVICES AND PROTECT THEM FROM DAMAGE THROUGHOUT THE DURATION OF THE WORKS.
12. THE CONTRACTOR SHALL REPORT ANY DISCREPANCIES TO THE ENGINEER WITH REGARDS TO STANDARD AND SPECIFICATION BEFORE ORDERING ANY MATERIAL.
13. ONLY STAFF FROM LOCAL AUTHORITY WILL HANDLE ON EXISTING SERVICES UNLESS PERMISSION GRANTED TO THE CONTRACTOR IN WRITING BY THE LOCAL AUTHORITY.
14. THE LOCAL AUTHORITY'S STAFF WILL BE NOTIFIED WELL IN ADVANCE TO ATTEND SITE INSPECTIONS AND MEETINGS.

LEGEND: SANITATION

- PROPOSED/NEW WATER PIPE
- 110 ø PE100 HDPE Class PN12.5 — PIPE DIAMETER, PIPE MATERIAL
- 234.50m — DISTANCE BETWEEN NODES
- W101 — NODE NUMBER
- NEW VALVE
- WATER HOUSE CONNECTION
- NEW END CAP
- EXISTING WATERPIPE
- BM 3 — BENCHMARK

NO.	DATE	AMENDMENT	APPROVED
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DISCIPLINE
CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
WATER RETICULATION LAYOUT
SHEET 1 OF 5

REF. NO. –
SCALE 1:1500
DATE 03/2021
TYPE NUMBER

DESIGNER R. MABOHO
DRAWING F. MAZIBUKO
CHECKED S. MNGUNI

DRAWING NUMBER
7001/W/U001

A1
100mm ON ORIGINAL DRAWING

LOCALITY PLAN
NTS

UNITAS PARK EXT.16 – P. BENCHMARKS WG–29				DESCRIPTION
BM1B	89603.38	2946872.99	1468.80	12mm Iron Peg in concrete
BM2B	89184.97	2946609.98	1470.33	12mm Iron Peg in concrete
BM3B	89396.12	2946070.32	1477.67	12mm Iron Peg in concrete
BM4B	90214.71	2945629.83	1478.42	12mm Iron Peg in concrete
BM5B	90982.23	2946053.61	1472.43	12mm Iron Peg in concrete
QU7	90424.23	2945692.86	1476.87	12mm Iron Peg in concrete

SEE DWG 7001/W/U001

SEE DWG 7001/W/U003

SEE DWG 7001/W/U002

SEE DWG 7001/W/U003

WATER RETICULATION LAYOUT
SCALE 1:1500

NOTES AND SPECIFICATIONS GENERAL

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14. THE LOCAL AUTHORITY'S STAFF WILL BE NOTIFIED WELL IN ADVANCE TO ATTEND SITE INSPECTIONS AND MEETINGS.

LEGEND: SANITATION

- PROPOSED/NEW WATER PIPE
- 110 ● PE100 HDPE Class PN12.5 — PIPE DIAMETER, PIPE MATERIAL
- 234.50m — DISTANCE BETWEEN NODES
- W101 — NODE NUMBER
- NEW VALVE
- WATER HOUSE CONNECTION
- NEW END CAP
- EXISTING WATERPIPE
- BM3 — BENCHMARK

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
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CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
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DISCIPLINE
CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
WATER RETICULATION LAYOUT
SHEET 3 OF 5

REF. NO. –	DESIGNER R. MABOHO
SCALE 1:1500	DRAWING F. MAZIBUKO
DATE 03/2021	CHECKED S. MNGUNI

TYPE NUMBER

DRAWING NUMBER
7001/W/U002

A1
100mm ON ORIGINAL DRAWING

LOCALITY PLAN
NTS

UNITAS PARK EXT.16 – P. BENCHMARKS WG-29				DESCRIPTION
BM1B	89603.38	2946872.99	1468.80	12mm Iron Peg in concrete
BM2B	89184.97	2946609.98	1470.33	12mm Iron Peg in concrete
BM3B	89396.12	2946070.32	1477.67	12mm Iron Peg in concrete
BM4B	90214.71	2945629.83	1478.42	12mm Iron Peg in concrete
BM5B	90982.23	2946053.61	1472.43	12mm Iron Peg in concrete
QU7	90424.23	2945692.86	1476.87	12mm Iron Peg in concrete

SEE DWG 7001/S/U004

SEE DWG 7001/S/U004

SEE DWG 7001/W/U002

SEE DWG 7001/W/U002

WATER RETICULATION LAYOUT

NOTES AND SPECIFICATIONS GENERAL

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14. THE LOCAL AUTHORITY'S STAFF WILL BE NOTIFIED WELL IN ADVANCE TO ATTEND SITE INSPECTIONS AND MEETINGS.

LEGEND: SANITATION

- PROPOSED/NEW WATER PIPE
- 110 ϕ PE100 HDPE Class PN12.5 — PIPE DIAMETER, PIPE MATERIAL
- 234.50m — DISTANCE BETWEEN NODES
- W101 — NODE NUMBER
- NEW VALVE
- WATER HOUSE CONNECTION
- NEW END CAP
- EXISTING WATERPIPE
- BM3 — BENCHMARK

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS

P.O. BOX 4049
RANDBURG-2125
FIRST FLOOR 24 PETER PLACE
LYME PARK BRYANSTON 2191
TEL (011)326-0741/90

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DISCIPLINE
CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
WATER RETICULATION LAYOUT
SHEET 3 OF 5

REF. NO.	–
SCALE	1:1500
DATE	03/2021
TYPE NUMBER	
DRAWING NUMBER	7001/W/U003
DESIGNER	R. MABOHO
DRAWING	F. MAZIBUKO
CHECKED	S. MNGUNI

A1
100mm ON ORIGINAL DRAWING

LOCALITY PLAN
NTS

UNITAS PARK EXT.16 – P. BENCHMARKS WG-29				DESCRIPTION
BM1B	89603.38	2946872.99	1468.80	12mm Iron Peg in concrete
BM2B	89184.97	2946609.98	1470.33	12mm Iron Peg in concrete
BM3B	89396.12	2946070.32	1477.67	12mm Iron Peg in concrete
BM4B	90214.71	2945629.83	1478.42	12mm Iron Peg in concrete
BM5B	90982.23	2946053.61	1472.43	12mm Iron Peg in concrete
QU7	90424.23	2945692.86	1476.87	12mm Iron Peg in concrete

SEE DWG 7001/W/U002

SEE DWG 7001/W/U003

WATER RETICULATION LAYOUT
SCALE 1:1500

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- WATER HOUSE CONNECTION
- NEW END CAP
- EXISTING WATERPIPE
- BM3 — BENCHMARK

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CLIENT:

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HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

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DISCIPLINE
CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
WATER RETICULATION LAYOUT
SHEET 4 OF 5

REF. NO. –	DESIGNER R. MABOHO
SCALE 1:1500	DRAWING F. MAZIBUKO
DATE 03/2021	CHECKED S. MNGUNI
TYPE NUMBER	

DRAWING NUMBER
7001/W/U004

A1
100mm ON ORIGINAL DRAWING

LOCALITY PLAN
NTS

NOTES AND SPECIFICATIONS GENERAL

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- BM 3 — BENCHMARK

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

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RANDBURG-2125
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LYME PARK BRYANSTON 2191
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DISCIPLINE
CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
WATER RETICULATION LAYOUT
SHEET 5 OF 5

REF. NO. –
SCALE 1:1500
DATE 03/2021
TYPE NUMBER

DESIGNER R. MABOHO
DRAWING F. MAZIBUKO
CHECKED S. MNGUNI

DRAWING NUMBER
7001/W/U005

A1
100mm ON ORIGINAL DRAWING

UNITAS PARK EXT.16 – P. BENCHMARKS WG-29				DESCRIPTION
BM1B	89603.38	2946872.99	1468.80	12mm Iron Peg in concrete
BM2B	89184.97	2946609.98	1470.33	12mm Iron Peg in concrete
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WATER RETICULATION LAYOUT
SCALE 1:1500

SEE DWG 7001/W/U003

ANNEXURE J

7001/W/U005 SHEET 5 OF 5

LOCALITY PLAN
NTS

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NO.	DATE	AMENDMENT	APPROVED
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REPUBLIC OF SOUTH AFRICA

ENGINEER:

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CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
WATER RETICULATION LAYOUT
SHEET 5 OF 5

REF. NO. –
SCALE 1:1500
DATE 03/2021
TYPE NUMBER

DESIGNER R. MABOHO
DRAWING F. MAZIBUKO
CHECKED S. MNGUNI

DRAWING NUMBER
7001/W/U005

A1
100mm ON ORIGINAL DRAWING

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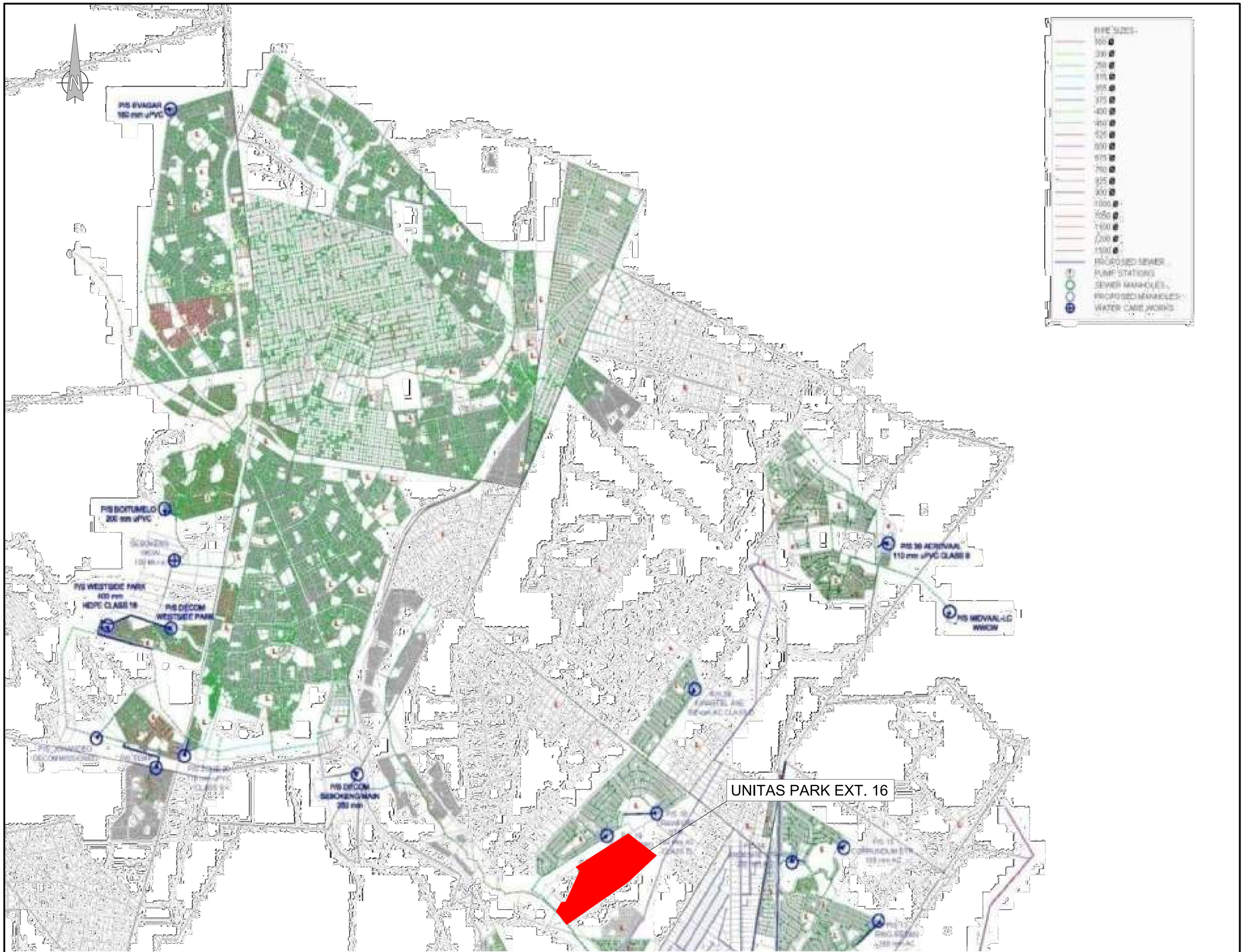
WATER RETICULATION LAYOUT
SCALE 1:1500

SEE DWG 7001/W/U003

ANNEXURE K

GLS SEWER MASTER PLAN LAYOUT



PIPE SIZES
160
200
250
315
355
375
400
450
525
600
675
750
825
900
1000
1050
1100
1200
1500
PROPOSED SEWER
PUMP STATIONS
SEWER MANHOLES
PROPOSED MANHOLES
WATER CARE WORKS

LEGED

DEMARCATED AREA

NO.	DATE	AMENDMENT	APPROVED
	03/2021	BULK INVESTIGATION	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

CIVIL, STRUCTURAL ENGINEERS &
PROJECT MANAGERS

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DISCIPLINE
CIVIL ENGINEERING

PROJECT TITLE
GAUTENG RAPID LAND RELEASE

WCS NO.

DRAWING TITLE
EMFULENI LOCAL MUNICIPALITY
FIGURE 7.2.2
NORTHERN DRAINAGE AREA
PUMP STATIONS SEWER PIPES MANHOLES

REF. NO.

DESIGNER R. MABOHO

SCALE NTS

DRAWING F. MAZIBUKO

DATE 03/2021

CHECKED S. MNGUNI

TYPE NUMBER

DRAWING NUMBER SMN/2012/03

A1
100mm ON ORIGINAL DRAWING

ANNEXURE L

PROPOSED SEWER RETICULATION LAYOUT

COORDINATE LIST

WG 27

Unitas Sewer Network 2

MH No.	YLo	XLo
Constant:		
MH1	−89467.598	2946318.317
MH2	−89477.390	2946389.588
MH3	−89480.772	2946428.446
MH4	−89467.328	2946477.122
MH5	−89453.867	2946525.855
MH6	−89441.146	2946571.914
MH7	−89438.464	2946573.900
MH8	−89371.513	2946550.188
MH9	−89363.169	2946573.754
MH10	−89370.175	2946590.232
MH11	−89355.288	2946632.215
MH12	−89335.991	2946686.633
MH13	−89370.519	2946716.747
MH14	−89405.048	2946746.860
MH15	−89360.054	2946798.451
MH16	−89315.061	2946850.041
MH17	−89270.067	2946901.632
MH18	−89328.517	2946953.253
MH19	−89386.967	2947004.875
MH20	−89445.416	2947056.497
MH21	−89503.866	2947108.119
MH22	−89562.315	2947159.742
MH23	−89581.193	2947175.560
MH24	−89252.396	2946508.000
MH25	−89298.942	2946524.485
MH26	−89345.487	2946540.970
MH27	−89452.524	2946692.423
MH28	−89080.486	2946734.209
MH29	−89127.881	2946776.065
MH30	−89175.277	2946817.920
MH31	−89222.672	2946859.776
MH32	−89440.247	2946765.075
MH33	−89492.341	2946811.081
MH34	−89544.436	2946857.088
MH35	−89596.530	2946903.095
MH36	−89606.406	2946919.157
MH37	−89622.896	2946933.720
MH38	−89588.746	2946972.878
MH39	−89602.311	2946984.709
MH40	−89613.420	2946991.750
MH41	−89629.906	2947006.318
MH42	−89588.259	2947054.071
MH43	−89546.612	2947101.825
MH44	−89560.682	2947114.251
MH45	−89568.160	2947123.546
MH46	−89582.826	2947136.499
MH47	−89629.726	2946720.283
MH48	−89665.382	2946751.773
MH49	−89701.039	2946783.262
MH50	−89666.203	2946823.207
MH51	−89631.366	2946863.151
MH52	−89604.266	2946768.507
MH53	−89635.234	2946795.857
MH54	−89606.909	2946725.481
MH55	−89578.114	2946758.086
MH56	−89549.319	2946790.691
MH57	−89590.343	2946826.921
MH58	−89666.906	2946883.258
MH59	−89401.494	2946809.571
MH60	−89445.070	2946847.574
MH61	−89488.646	2946885.578
MH62	−89532.222	2946923.582
MH63	−89706.632	2946918.342
MH64	−89668.269	2946962.330
MH65	−89366.410	2946849.298
MH66	−89406.803	2946884.525
MH67	−89447.196	2946919.753
MH68	−89487.589	2946954.981
MH69	−89452.754	2946994.923
MH70	−89458.556	2947008.049
MH71	−89475.136	2947022.509
MH72	−89467.102	2947031.606
MH73	−89493.080	2947054.548
MH74	−89506.453	2947066.359
MH75	−89532.806	2947089.632
MH76	−89331.662	2946888.650
MH77	−89372.026	2946924.074
MH78	−89412.390	2946959.499
MH79	−89519.221	2946971.961
MH80	−89558.845	2947006.953
MH81	−89625.834	2947087.761

PIPE DATA LIST

MH − MH	Distance (m)	Diam. (mm)
Unitas Sewer Network 2		
MH1 − MH2	71.940	160mm HDPE−PE100 Class PN10
MH2 − MH3	39.005	160mm HDPE−PE100 Class PN10
MH3 − MH4	50.498	160mm HDPE−PE100 Class PN10
MH4 − MH5	50.558	160mm HDPE−PE100 Class PN10
MH5 − MH6	47.783	160mm HDPE−PE100 Class PN10
MH6 − MH7	3.337	160mm HDPE−PE100 Class PN10
MH7 − MH8	71.026	160mm HDPE−PE100 Class PN10
MH8 − MH9	25.000	160mm HDPE−PE100 Class PN10
MH9 − MH10	17.905	160mm HDPE−PE100 Class PN10
MH10 − MH11	44.544	160mm HDPE−PE100 Class PN10
MH11 − MH12	57.739	160mm HDPE−PE100 Class PN10
MH12 − MH13	45.815	160mm HDPE−PE100 Class PN10
MH13 − MH14	45.815	160mm HDPE−PE100 Class PN10
MH14 − MH15	68.454	160mm HDPE−PE100 Class PN10
MH15 − MH16	68.454	160mm HDPE−PE100 Class PN10
MH16 − MH17	68.454	160mm HDPE−PE100 Class PN10
MH17 − MH18	77.982	160mm HDPE−PE100 Class PN10
MH18 − MH19	77.982	160mm HDPE−PE100 Class PN10
MH19 − MH20	77.982	160mm HDPE−PE100 Class PN10
MH20 − MH21	77.982	160mm HDPE−PE100 Class PN10
MH21 − MH22	77.982	160mm HDPE−PE100 Class PN10
MH22 − MH23	24.629	250mm HDPE−PE100 Class PN10
MH24 − MH25	49.378	160mm HDPE−PE100 Class PN10
MH25 − MH26	49.378	160mm HDPE−PE100 Class PN10
MH26 − MH9	37.248	160mm HDPE−PE100 Class PN10
MH27 − MH14	72.231	160mm HDPE−PE100 Class PN10
MH28 − MH29	63.232	160mm HDPE−PE100 Class PN10
MH29 − MH30	63.232	160mm HDPE−PE100 Class PN10
MH30 − MH31	63.232	160mm HDPE−PE100 Class PN10
MH31 − MH17	63.232	160mm HDPE−PE100 Class PN10
MH32 − MH33	69.501	160mm HDPE−PE100 Class PN10
MH33 − MH34	69.501	160mm HDPE−PE100 Class PN10
MH34 − MH35	69.501	160mm HDPE−PE100 Class PN10
MH35 − MH36	18.855	160mm HDPE−PE100 Class PN10
MH36 − MH37	22.000	160mm HDPE−PE100 Class PN10
MH37 − MH38	51.958	160mm HDPE−PE100 Class PN10
MH38 − MH39	18.000	200mm HDPE−PE100 Class PN10
MH39 − MH40	13.152	200mm HDPE−PE100 Class PN10
MH40 − MH41	22.001	200mm HDPE−PE100 Class PN10
MH41 − MH42	63.363	200mm HDPE−PE100 Class PN10
MH42 − MH43	63.363	200mm HDPE−PE100 Class PN10
MH43 − MH44	18.771	200mm HDPE−PE100 Class PN10
MH44 − MH45	11.930	200mm HDPE−PE100 Class PN10
MH45 − MH46	19.567	200mm HDPE−PE100 Class PN10
MH46 − MH22	30.999	200mm HDPE−PE100 Class PN10
MH47 − MH48	47.571	160mm HDPE−PE100 Class PN10
MH48 − MH49	47.571	160mm HDPE−PE100 Class PN10
MH49 − MH50	53.001	160mm HDPE−PE100 Class PN10
MH50 − MH51	53.001	160mm HDPE−PE100 Class PN10
MH51 − MH35	53.001	160mm HDPE−PE100 Class PN10
MH52 − MH53	41.317	160mm HDPE−PE100 Class PN10
MH53 − MH50	41.316	160mm HDPE−PE100 Class PN10
MH54 − MH55	43.500	160mm HDPE−PE100 Class PN10
MH55 − MH56	43.500	160mm HDPE−PE100 Class PN10
MH56 − MH57	54.732	160mm HDPE−PE100 Class PN10
MH57 − MH51	54.731	160mm HDPE−PE100 Class PN10
MH58 − MH37	66.957	160mm HDPE−PE100 Class PN10
MH59 − MH60	57.820	160mm HDPE−PE100 Class PN10
MH60 − MH61	57.820	160mm HDPE−PE100 Class PN10
MH61 − MH62	57.820	160mm HDPE−PE100 Class PN10
MH62 − MH38	75.000	160mm HDPE−PE100 Class PN10
MH63 − MH64	58.367	160mm HDPE−PE100 Class PN10
MH64 − MH41	58.367	160mm HDPE−PE100 Class PN10
MH65 − MH66	53.596	160mm HDPE−PE100 Class PN10
MH66 − MH67	53.596	160mm HDPE−PE100 Class PN10
MH67 − MH68	53.596	160mm HDPE−PE100 Class PN10
MH68 − MH69	52.998	160mm HDPE−PE100 Class PN10
MH69 − MH70	14.351	160mm HDPE−PE100 Class PN10
MH70 − MH71	22.000	160mm HDPE−PE100 Class PN10
MH71 − MH72	12.137	160mm HDPE−PE100 Class PN10
MH72 − MH73	34.658	160mm HDPE−PE100 Class PN10
MH73 − MH74	17.842	160mm HDPE−PE100 Class PN10
MH74 − MH75	35.159	160mm HDPE−PE100 Class PN10
MH75 − MH43	18.419	160mm HDPE−PE100 Class PN10
MH76 − MH77	53.704	160mm HDPE−PE100 Class PN10
MH77 − MH78	53.704	160mm HDPE−PE100 Class PN10
MH78 − MH69	53.704	160mm HDPE−PE100 Class PN10
MH79 − MH71	67.071	160mm HDPE−PE100 Class PN10
MH80 − MH74	79.208	160mm HDPE−PE100 Class PN10
MH81 − MH46	65.000	160mm HDPE−PE100 Class PN10

TOTAL LENGTHS OF PIPING

MH Centre to MH Centre

Diameter (mm)	Length (m)
250mm HDPE−PE100 Class PN10	24.63
200mm HDPE−PE100 Class PN10	261.15
160mm HDPE−PE100 Class PN10	3634.85
Total :	3920.63

COORDINATE LIST

WG 27

Unitas Sewer Network 1

MH No.	YLo	XLo
Constant:		
MH82	−90255.747	2945635.826
MH83	−90203.796	2945665.804
MH84	−90151.846	2945695.782
MH85	−90099.895	2945725.759
MH86	−90132.715	2945791.098
MH87	−90165.536	2945856.436
MH88	−90198.356	2945921.775
MH89	−90234.566	2945993.807
MH90	−90259.624	2946043.656
MH91	−90258.031	2946048.470
MH92	−90269.582	2946063.466
MH93	−90303.383	2946130.705
MH94	−90323.547	2946157.033
MH95	−90337.790	2946183.854
MH96	−90376.263	2946234.089
MH97	−90414.736	2946284.324
MH98	−90457.693	2946340.850
MH99	−90481.749	2946372.661
MH100	−90513.795	2946415.036
MH101	−90532.496	2946439.765
MH102	−90540.213	2946449.970
MH103	−90525.604	2946461.160
MH104	−90473.669	2946483.173
MH105	−90413.928	2946528.923
MH106	−90379.136	2946573.315
MH107	−90365.543	2946583.724
MH108	−90356.167	2946571.480
MH109	−90294.316	2946616.812
MH110	−90232.465	2946662.144
MH111	−90170.614	2946707.476
MH112	−90108.763	2946752.807
MH113	−90046.913	2946798.139
MH114	−89984.573	2946843.830
MH115	−89923.211	2946888.803
MH116	−89920.105	2946884.566
MH117	−89902.408	2946897.537
MH118	−89865.967	2946924.245
MH119	−89863.059	2946950.784
MH120	−89828.351	2946995.069
MH121	−89808.209	2947010.317
MH122	−89765.527	2947044.396
MH123	−89722.846	2947078.475
MH124	−89677.875	2947117.712
MH125	−89660.404	2947102.282
MH126	−89655.441	2947107.901
MH127	−90119.507	2945961.411
MH128	−90158.597	2945941.763
MH129	−90142.366	2945736.921
MH130	−90173.552	2945798.960
MH131	−90204.738	2945860.998
MH132	−90235.924	2945923.036
MH133	−90262.161	2945975.229
MH134	−90288.399	2946027.423
MH135	−90182.541	2946086.419
MH136	−90219.951	2946067.613
MH137	−90272.264	2945631.747
MH138	−90333.127	2945672.315
MH139	−90393.991	2945712.883
MH140	−90370.287	2945748.446
MH141	−90346.583	2945784.008
MH142	−90344.829	2945800.368
MH143	−90366.784	2945815.003
MH144	−90403.396	2945839.407
MH145	−90447.150	2945868.571
MH146	−90456.443	2945874.767
MH147	−90458.217	2945883.656
MH148	−90428.106	2945928.720
MH149	−90410.843	2945942.606
MH150	−90454.714	2945990.012
MH151	−90485.797	2946023.600
MH152	−90485.068	2946032.126
MH153	−90435.533	2946070.063
MH154	−90385.997	2946108.000
MH155	−90336.462	2946145.937
MH156	−90364.870	2945729.527
MH157	−90335.440	2945773.680
MH158	−90447.380	2945773.419
MH159	−90473.417	2945765.828
MH160	−90502.694	2945785.341

PIPE DATA LIST

MH − MH	Distance (m)	Diam. (mm)
Unitas Sewer Network 1		
MH82 − MH83	59.979	160mm HDPE−PE100 Class PN10
MH83 − MH84	59.979	160mm HDPE−PE100 Class PN10
MH84 − MH85	59.979	160mm HDPE−PE100 Class PN10
MH85 − MH86	73.118	160mm HDPE−PE100 Class PN10
MH86 − MH87	73.118	160mm HDPE−PE100 Class PN10
MH87 − MH88	73.118	160mm HDPE−PE100 Class PN10
MH88 − MH89	80.621	160mm HDPE−PE100 Class PN10
MH89 − MH90	55.793	160mm HDPE−PE100 Class PN10
MH90 − MH91	5.071	200mm HDPE−PE100 Class PN10
MH91 − MH92	18.929	250mm HDPE−PE100 Class PN10
MH92 − MH93	75.257	250mm HDPE−PE100 Class PN10
MH93 − MH94	33.163	250mm HDPE−PE100 Class PN10
MH94 − MH95	30.368	315mm HDPE−PE100 Class PN10
MH95 − MH96	63.275	315mm HDPE−PE100 Class PN10
MH96 − MH97	63.275	315mm HDPE−PE100 Class PN10
MH97 − MH98	70.997	315mm HDPE−PE100 Class PN10
MH98 − MH99	39.883	400mm HDPE−PE100 Class PN10
MH99 − MH100	53.128	400mm HDPE−PE100 Class PN10
MH100 − MH101	31.004	400mm HDPE−PE100 Class PN10
MH101 − MH102	12.795	450mm HDPE−PE100 Class PN10
MH102 − MH103	18.402	450mm HDPE−PE100 Class PN10
MH103 − MH104	56.408	450mm HDPE−PE100 Class PN10
MH104 − MH105	75.247	450mm HDPE−PE100 Class PN10
MH105 − MH106	56.401	450mm HDPE−PE100 Class PN10
MH106 − MH107	17.121	450mm HDPE−PE100 Class PN10
MH107 − MH108	15.422	450mm HDPE−PE100 Class PN10
MH108 − MH109	76.684	450mm HDPE−PE100 Class PN10
MH109 − MH110	76.684	450mm HDPE−PE100 Class PN10
MH110 − MH111	76.684	450mm HDPE−PE100 Class PN10
MH111 − MH112	76.684	450mm HDPE−PE100 Class PN10
MH112 − MH113	76.684	450mm HDPE−PE100 Class PN10
MH113 − MH114	77.291	450mm HDPE−PE100 Class PN10
MH114 − MH115	76.078	450mm HDPE−PE100 Class PN10
MH115 − MH116	5.254	450mm HDPE−PE100 Class PN10
MH116 − MH117	21.942	500mm HDPE−PE100 Class PN10
MH117 − MH118	45.181	500mm HDPE−PE100 Class PN10
MH118 − MH119	26.697	500mm HDPE−PE100 Class PN10
MH119 − MH120	56.266	500mm HDPE−PE100 Class PN10
MH120 − MH121	25.263	500mm HDPE−PE100 Class PN10
MH121 − MH122	54.618	500mm HDPE−PE100 Class PN10
MH122 − MH123	54.618	500mm HDPE−PE100 Class PN10
MH123 − MH124	59.682	500mm HDPE−PE100 Class PN10
MH124 − MH125	23.309	500mm HDPE−PE100 Class PN10
MH125 − MH126	7.497	500mm HDPE−PE100 Class PN10
MH127 − MH128	43.750	160mm HDPE−PE100 Class PN10
MH128 − MH88	44.500	160mm HDPE−PE100 Class PN10
MH129 − MH130	69.436	160mm HDPE−PE100 Class PN10
MH130 − MH131	69.436	160mm HDPE−PE100 Class PN10
MH131 − MH132	69.436	160mm HDPE−PE100 Class PN10
MH132 − MH133	58.417	160mm HDPE−PE100 Class PN10
MH133 − MH134	58.417	160mm HDPE−PE100 Class PN10
MH134 − MH90	33.038	160mm HDPE−PE100 Class PN10
MH135 − MH136	41.871	160mm HDPE−PE100 Class PN10
MH136 − MH91	42.621	160mm HDPE−PE100 Class PN10
MH137 − MH138	73.145	160mm HDPE−PE100 Class PN10
MH138 − MH139	73.145	160mm HDPE−PE100 Class PN10
MH139 − MH140	42.739	160mm HDPE−PE100 Class PN10
MH140 − MH141	42.738	160mm HDPE−PE100 Class PN10
MH141 − MH142	16.454	160mm HDPE−PE100 Class PN10
MH142 − MH143	26.386	160mm HDPE−PE100 Class PN10
MH143 − MH144	44.000	160mm HDPE−PE100 Class PN10
MH144 − MH145	52.583	160mm HDPE−PE100 Class PN10
MH145 − MH146	11.169	160mm HDPE−PE100 Class PN10
MH146 − MH147	9.065	160mm HDPE−PE100 Class PN10
MH147 − MH148	54.198	160mm HDPE−PE100 Class PN10
MH148 − MH149	22.154	160mm HDPE−PE100 Class PN10
MH149 − MH150	64.591	160mm HDPE−PE100 Class PN10
MH150 − MH151	45.764	160mm HDPE−PE100 Class PN10
MH151 − MH152	8.556	160mm HDPE−PE100 Class PN10
MH152 − MH153	62.394	200mm HDPE−PE100 Class PN10
MH153 − MH154	62.394	200mm HDPE−PE100 Class PN10
MH154 − MH155	62.394	250mm HDPE−PE100 Class PN10
MH155 − MH94	17.027	250mm HDPE−PE100 Class PN10
MH156 − MH157	53.062	160mm HDPE−PE100 Class PN10
MH157 − MH141	15.193	160mm HDPE−PE100 Class PN10
MH158 − MH144	79.303	160mm HDPE−PE100 Class PN10
MH159 − MH160	35.184	160mm HDPE−PE100 Class PN10
MH160 − MH161	50.031	160mm HDPE−PE100 Class PN10
MH161 − MH145	50.031	160mm HDPE−PE100 Class PN10
MH162 − MH160	19.566	160mm HDPE−PE100 Class PN10

TOTAL LENGTHS OF PIPING

MH Centre to MH Centre

Diameter (mm)	Length (m)
500mm HDPE−PE100 Class PN10	353.13
500mm HDPE−PE100 Class PN10	21.94
450mm HDPE−PE100 Class PN10	793.84
400mm HDPE−PE100 Class PN10	227.85
355mm HDPE−PE100 Class PN10	111.00
315mm HDPE−PE100 Class PN10	519.24
250mm HDPE−PE100 Class PN10	622.89
200mm HDPE−PE100 Class PN10	989.75
160mm HDPE−PE100 Class PN10	13196.12
Total :	16835.76

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

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DISCIPLINE

CIVIL ENGINEERING

PROJECT TITLE

UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE

COORDINATE LIST AND PIPE DATA LIST

SHEET 1 OF 3

REF. NO. –

SCALE 1:1500

DATE 03/2021

TYPE NUMBER

DESIGNER R. MABOHO

DRAWING F. MAZIBUKO

CHECKED S. MNGUNI

DRAWING NUMBER 7001/S/A001

A1

100mm ON ORIGINAL DRAWING

COORDINATE LIST

WG 27

Unitas Sewer Network 1

MH No.	YLo	XLo
Constant:		
MH162	−90518.975	2945796.193
MH163	−90233.950	2945683.100
MH164	−90241.588	2945698.294
MH165	−90274.372	2945763.512
MH166	−90293.015	2945800.597
MH167	−90322.547	2945859.345
MH168	−90326.118	2945857.550
MH169	−90328.316	2945861.921
MH170	−90346.626	2945873.213
MH171	−90378.735	2945907.910
MH172	−90264.860	2945671.114
MH173	−90271.152	2945683.631
MH174	−90294.307	2945686.669
MH175	−90327.307	2945722.605
MH176	−90292.242	2945754.529
MH177	−90189.720	2945713.117
MH178	−90218.211	2945769.794
MH179	−90246.365	2945825.802
MH180	−90275.193	2945883.149
MH181	−90339.969	2945850.587
MH182	−90314.780	2945995.701
MH183	−90362.484	2945969.335
MH184	−90582.385	2945887.767
MH185	−90549.946	2945935.887
MH186	−90517.507	2945984.006
MH187	−90227.604	2946186.631
MH188	−90247.853	2946193.520
MH189	−90285.362	2946175.439
MH190	−90727.836	2945935.402
MH191	−90780.200	2945970.304
MH192	−90831.940	2946004.789
MH193	−90885.521	2946040.502
MH194	−90883.474	2946043.573
MH195	−90868.150	2946080.096
MH196	−90851.373	2946120.085
MH197	−90809.731	2946170.178
MH198	−90768.089	2946220.271
MH199	−90726.447	2946270.364
MH200	−90681.064	2946312.709
MH201	−90635.682	2946355.054
MH202	−90590.299	2946397.399
MH203	−90706.620	2945944.696
MH204	−90676.916	2945989.262
MH205	−90647.212	2946033.827
MH206	−90609.792	2946068.743
MH207	−90572.372	2946103.658
MH208	−90574.937	2946107.007
MH209	−90621.653	2946157.075
MH210	−90638.657	2946175.298
MH211	−90640.505	2946179.774
MH212	−90612.869	2946206.271
MH213	−90574.340	2946242.695
MH214	−90549.401	2946265.987
MH215	−90532.446	2946281.784
MH216	−90517.991	2946295.272
MH217	−90501.794	2946308.528
MH218	−90486.949	2946319.408
MH219	−90635.526	2946142.613
MH220	−90687.460	2946021.941
MH221	−90738.761	2946061.577
MH222	−90713.527	2946091.931
MH223	−90694.370	2946114.977
MH224	−90665.533	2946149.665
MH225	−90646.985	2946070.967
MH226	−90657.614	2946082.271
MH227	−90667.710	2946092.585
MH228	−90680.568	2946103.415
MH229	−90602.392	2946195.042
MH230	−90520.964	2946185.483
MH231	−90477.402	2946217.789
MH232	−90504.924	2946249.786
MH233	−90526.898	2946141.902
MH234	−90486.030	2946175.283
MH235	−90433.710	2946215.353
MH236	−90417.037	2946228.122
MH237	−90451.993	2946273.765
MH238	−90720.490	2945972.568
MH239	−90766.052	2946002.936
MH240	−90802.640	2946019.522
MH241	−90780.235	2946074.521
MH242	−90743.019	2946119.849
MH243	−90705.828	2946164.184
MH244	−90669.112	2946207.939
MH245	−90656.444	2946220.746
MH246	−90623.503	2946251.482

PIPE DATA LIST

MH – MH Unitas Sewer Network 1	Distance (m)	Diam. (mm)
MH163 – MH164	17.005	160mm HDPE–PE100 Class PN10
MH164 – MH165	72.995	160mm HDPE–PE100 Class PN10
MH165 – MH166	41.507	160mm HDPE–PE100 Class PN10
MH166 – MH167	65.753	160mm HDPE–PE100 Class PN10
MH167 – MH168	3.997	160mm HDPE–PE100 Class PN10
MH168 – MH169	4.893	160mm HDPE–PE100 Class PN10
MH169 – MH170	21.513	160mm HDPE–PE100 Class PN10
MH170 – MH171	47.274	160mm HDPE–PE100 Class PN10
MH171 – MH149	47.273	160mm HDPE–PE100 Class PN10
MH172 – MH173	14.009	160mm HDPE–PE100 Class PN10
MH173 – MH164	33.001	160mm HDPE–PE100 Class PN10
MH174 – MH175	48.790	160mm HDPE–PE100 Class PN10
MH175 – MH176	47.421	160mm HDPE–PE100 Class PN10
MH176 – MH165	20.000	160mm HDPE–PE100 Class PN10
MH177 – MH178	63.436	160mm HDPE–PE100 Class PN10
MH178 – MH179	62.686	160mm HDPE–PE100 Class PN10
MH179 – MH180	64.186	160mm HDPE–PE100 Class PN10
MH180 – MH167	53.000	160mm HDPE–PE100 Class PN10
MH181 – MH168	15.503	160mm HDPE–PE100 Class PN10
MH182 – MH183	54.505	160mm HDPE–PE100 Class PN10
MH183 – MH149	55.255	160mm HDPE–PE100 Class PN10
MH184 – MH185	58.033	160mm HDPE–PE100 Class PN10
MH185 – MH186	58.033	160mm HDPE–PE100 Class PN10
MH186 – MH152	58.033	160mm HDPE–PE100 Class PN10
MH187 – MH188	21.389	160mm HDPE–PE100 Class PN10
MH188 – MH189	41.640	160mm HDPE–PE100 Class PN10
MH189 – MH94	42.389	160mm HDPE–PE100 Class PN10
MH190 – MH191	62.929	160mm HDPE–PE100 Class PN10
MH191 – MH192	62.179	160mm HDPE–PE100 Class PN10
MH192 – MH193	64.391	160mm HDPE–PE100 Class PN10
MH193 – MH194	3.691	160mm HDPE–PE100 Class PN10
MH194 – MH195	39.607	160mm HDPE–PE100 Class PN10
MH195 – MH196	43.366	160mm HDPE–PE100 Class PN10
MH196 – MH197	65.141	160mm HDPE–PE100 Class PN10
MH197 – MH198	65.141	160mm HDPE–PE100 Class PN10
MH198 – MH199	65.141	160mm HDPE–PE100 Class PN10
MH199 – MH200	62.070	160mm HDPE–PE100 Class PN10
MH200 – MH201	62.070	160mm HDPE–PE100 Class PN10
MH201 – MH202	62.070	160mm HDPE–PE100 Class PN10
MH202 – MH101	71.667	160mm HDPE–PE100 Class PN10
MH203 – MH204	53.558	160mm HDPE–PE100 Class PN10
MH204 – MH205	53.558	160mm HDPE–PE100 Class PN10
MH205 – MH206	51.180	160mm HDPE–PE100 Class PN10
MH206 – MH207	51.180	160mm HDPE–PE100 Class PN10
MH207 – MH208	4.218	160mm HDPE–PE100 Class PN10
MH208 – MH209	68.478	160mm HDPE–PE100 Class PN10
MH209 – MH210	24.924	200mm HDPE–PE100 Class PN10
MH210 – MH211	4.842	200mm HDPE–PE100 Class PN10
MH211 – MH212	38.286	200mm HDPE–PE100 Class PN10
MH212 – MH213	53.021	200mm HDPE–PE100 Class PN10
MH213 – MH214	34.125	200mm HDPE–PE100 Class PN10
MH214 – MH215	23.174	200mm HDPE–PE100 Class PN10
MH215 – MH216	19.770	200mm HDPE–PE100 Class PN10
MH216 – MH217	20.931	200mm HDPE–PE100 Class PN10
MH217 – MH218	18.404	200mm HDPE–PE100 Class PN10
MH218 – MH98	36.273	250mm HDPE–PE100 Class PN10
MH219 – MH209	20.040	160mm HDPE–PE100 Class PN10
MH220 – MH221	64.828	160mm HDPE–PE100 Class PN10
MH221 – MH222	39.473	160mm HDPE–PE100 Class PN10
MH222 – MH223	29.968	160mm HDPE–PE100 Class PN10
MH223 – MH224	45.109	160mm HDPE–PE100 Class PN10
MH224 – MH211	39.153	160mm HDPE–PE100 Class PN10
MH225 – MH226	15.516	160mm HDPE–PE100 Class PN10
MH226 – MH227	14.433	160mm HDPE–PE100 Class PN10
MH227 – MH228	16.812	160mm HDPE–PE100 Class PN10
MH228 – MH223	18.004	160mm HDPE–PE100 Class PN10
MH229 – MH212	15.358	160mm HDPE–PE100 Class PN10
MH230 – MH213	78.244	160mm HDPE–PE100 Class PN10
MH231 – MH232	42.206	160mm HDPE–PE100 Class PN10
MH232 – MH215	42.206	160mm HDPE–PE100 Class PN10
MH233 – MH234	52.767	160mm HDPE–PE100 Class PN10
MH234 – MH235	65.902	160mm HDPE–PE100 Class PN10
MH235 – MH236	21.000	160mm HDPE–PE100 Class PN10
MH236 – MH237	57.491	160mm HDPE–PE100 Class PN10
MH237 – MH218	57.491	160mm HDPE–PE100 Class PN10
MH238 – MH239	54.754	160mm HDPE–PE100 Class PN10
MH239 – MH240	40.172	160mm HDPE–PE100 Class PN10
MH240 – MH241	59.388	160mm HDPE–PE100 Class PN10
MH241 – MH242	58.648	160mm HDPE–PE100 Class PN10
MH242 – MH243	57.869	160mm HDPE–PE100 Class PN10
MH243 – MH244	57.119	160mm HDPE–PE100 Class PN10
MH244 – MH245	18.015	160mm HDPE–PE100 Class PN10
MH245 – MH246	45.054	160mm HDPE–PE100 Class PN10
MH246 – MH247	59.734	160mm HDPE–PE100 Class PN10
MH247 – MH248	58.987	160mm HDPE–PE100 Class PN10
MH248 – MH99	68.085	160mm HDPE–PE100 Class PN10

TOTAL LENGTHS OF PIPING

MH Centre to MH Centre

Diameter (mm)	Length (m)
500mm HDPE–PE100 Class PN10	353.13
500mm HDPE–PE100 Class PN10	21.94
450mm HDPE–PE100 Class PN10	793.84
400mm HDPE–PE100 Class PN10	227.85
355mm HDPE–PE100 Class PN10	111.00
315mm HDPE–PE100 Class PN10	519.24
250mm HDPE–PE100 Class PN10	622.89
200mm HDPE–PE100 Class PN10	989.75
160mm HDPE–PE100 Class PN10	13196.12
Total :	16835.76

COORDINATE LIST

WG 27

Unitas Sewer Network 1

MH No.	YLo	XLo
Constant:		
MH247	−90579.828	2946292.233
MH248	−90536.750	2946332.529
MH249	−90847.425	2946049.367
MH250	−90824.577	2946103.826
MH251	−90784.129	2946152.468
MH252	−90743.681	2946201.110
MH253	−90703.234	2946249.752
MH254	−90658.987	2946290.995
MH255	−90614.740	2946332.238
MH256	−90570.493	2946373.481
MH257	−89915.560	2945871.305
MH258	−89950.027	2945939.872
MH259	−89970.452	2945980.502
MH260	−89990.876	2946021.132
MH261	−89996.803	2946023.094
MH262	−90005.786	2946040.963
MH263	−90003.824	2946046.890
MH264	−90028.790	2946096.554
MH265	−90053.755	2946146.217
MH266	−90059.988	2946148.280
MH267	−90059.907	2946162.886
MH268	−90083.275	2946211.391
MH269	−90106.642	2946259.895
MH270	−90123.298	2946288.908
MH271	−90162.346	2946341.343
MH272	−90161.032	2946350.319
MH273	−90109.864	2946388.422
MH274	−90056.428	2946428.215
MH275	−90087.092	2946470.052
MH276	−90117.755	2946511.889
MH277	−90087.284	2946534.223
MH278	−90069.539	2946547.228
MH279	−90026.784	2946578.564
MH280	−90015.345	2946586.637
MH281	−90001.804	2946596.932
MH282	−89983.829	2946609.616
MH283	−90020.450	2946661.513
MH284	−89977.603	2946692.719
MH285	−89975.523	2946720.990
MH286	−89986.149	2946736.049
MH287	−89996.721	2946751.198
MH288	−90005.114	2946760.584
MH289	−90018.120	2946778.328
MH290	−89971.390	2946812.577
MH291	−89914.188	2946854.502
MH292	−89922.465	2946865.794
MH293	−90078.631	2945981.959
MH294	−90037.717	2946002.527
MH295	−90141.510	2946107.044
MH296	−90100.749	2946127.662
MH297	−90187.156	2946221.110
MH298	−90146.899	2946240.503
MH299	−89972.416	2946324.556
MH300	−90039.529	2946292.226
MH301	−90296.454	2946282.804
MH302	−90334.100	2946331.976
MH303	−90304.508	2946353.667
MH304	−90301.647	2946374.173
MH305	−90265.490	2946401.052
MH306	−90245.720	2946415.775
MH307	−90239.543	2946414.871
MH308	−90227.742	2946429.161
MH309	−90208.337	2946443.612
MH310	−90246.875	2946495.364
MH311	−90270.767	2946527.446
MH312	−90215.318	2946568.086
MH313	−90159.868	2946608.726
MH314	−90104.419	2946649.366
MH315	−90050.405	2946688.955
MH316	−90382.501	2946312.130
MH317	−90353.276	2946334.559
MH318	−90189.910	2946348.221
MH319	−90162.898	2946382.593
MH320	−90283.022	2946518.464
MH321	−90116.869	2946416.870
MH322	−90158.727	2946473.080
MH323	−90200.586	2946529.290
MH324	−90141.713	2946572.446
MH325	−90081.186	2946616.902
MH326	−90291.955	2946485.824
MH327	−90324.061	2946528.652
MH328	−90314.347	2946561.216
MH329	−90254.815	2946604.849
MH330	−90195.282	2946648.481
MH331	−90135.750	2946692.114

PIPE DATA LIST

MH – MH Unitas Sewer Network 1	Distance (m)	Diam. (mm)
MH249 – MH250	59.058	160mm HDPE–PE100 Class PN10
MH250 – MH251	63.262	160mm HDPE–PE100 Class PN10
MH251 – MH252	63.262	160mm HDPE–PE100 Class PN10
MH252 – MH253	63.262	160mm HDPE–PE100 Class PN10
MH253 – MH254	60.488	160mm HDPE–PE100 Class PN10
MH254 – MH255	60.488	160mm HDPE–PE100 Class PN10
MH255 – MH256	60.488	160mm HDPE–PE100 Class PN10
MH256 – MH100	70.296	160mm HDPE–PE100 Class PN10
MH257 – MH258	76.742	160mm HDPE–PE100 Class PN10
MH258 – MH259	45.475	160mm HDPE–PE100 Class PN10
MH259 – MH260	45.475	160mm HDPE–PE100 Class PN10
MH260 – MH261	6.243	160mm HDPE–PE100 Class PN10
MH261 – MH262	20.000	160mm HDPE–PE100 Class PN10
MH262 – MH263	6.243	160mm HDPE–PE100 Class PN10
MH263 – MH264	55.586	160mm HDPE–PE100 Class PN10
MH264 – MH265	55.586	160mm HDPE–PE100 Class PN10
MH265 – MH266	6.565	160mm HDPE–PE100 Class PN10
MH266 – MH267	14.607	200mm HDPE–PE100 Class PN10
MH267 – MH268	53.840	200mm HDPE–PE100 Class PN10
MH268 – MH269	53.840	200mm HDPE–PE100 Class PN10
MH269 – MH270	33.453	250mm HDPE–PE100 Class PN10
MH270 – MH271	65.377	250mm HDPE–PE100 Class PN10
MH271 – MH272	9.071	250mm HDPE–PE100 Class PN10
MH272 – MH273	63.797	250mm HDPE–PE100 Class PN10
MH273 – MH274	66.625	250mm HDPE–PE100 Class PN10
MH274 – MH275	51.871	250mm HDPE–PE100 Class PN10
MH275 – MH276	51.871	250mm HDPE–PE100 Class PN10
MH276 – MH277	37.779	250mm HDPE–PE100 Class PN10
MH277 – MH278	22.001	315mm HDPE–PE100 Class PN10
MH278 – MH279	53.009	315mm HDPE–PE100 Class PN10
MH279 – MH280	14.001	315mm HDPE–PE100 Class PN10
MH280 – MH281	17.010	315mm HDPE–PE100 Class PN10
MH281 – MH282	22.000	315mm HDPE–PE100 Class PN10
MH282 – MH283	63.516	315mm HDPE–PE100 Class PN10
MH283 – MH284	53.006	315mm HDPE–PE100 Class PN10
MH284 – MH285	28.348	315mm HDPE–PE100 Class PN10
MH285 – MH286	18.431	315mm HDPE–PE100 Class PN10
MH286 – MH287	18.473	355mm HDPE–PE100 Class PN10
MH287 – MH288	12.592	355mm HDPE–PE100 Class PN10
MH288 – MH289	22.000	355mm HDPE–PE100 Class PN10
MH289 – MH290	57.936	355mm HDPE–PE100 Class PN10
MH290 – MH291	70.921	400mm HDPE–PE100 Class PN10
MH291 – MH292	14.000	400mm HDPE–PE100 Class PN10
MH292 – MH116	18.920	400mm HDPE–PE100 Class PN10
MH293 – MH294	45.793	160mm HDPE–PE100 Class PN10
MH294 – MH261	45.793	160mm HDPE–PE100 Class PN10
MH295 – MH296	45.679	160mm HDPE–PE100 Class PN10
MH296 – MH266	45.679	160mm HDPE–PE100 Class PN10
MH297 – MH298	44.684	160mm HDPE–PE100 Class PN10
MH298 – MH269	44.685	160mm HDPE–PE100 Class PN10
MH299 – MH300	74.495	160mm HDPE–PE100 Class PN10
MH300 – MH269	74.494	160mm HDPE–PE100 Class PN10
MH301 – MH302	61.928	160mm HDPE–PE100 Class PN10
MH302 – MH303	36.690	160mm HDPE–PE100 Class PN10
MH303 – MH304	20.705	160mm HDPE–PE100 Class PN10
MH304 – MH305	45.053	160mm HDPE–PE100 Class PN10
MH305 – MH306	24.651	160mm HDPE–PE100 Class PN10
MH306 – MH307	6.243	160mm HDPE–PE100 Class PN10
MH307 – MH308	18.533	200mm HDPE–PE100 Class PN10
MH308 – MH309	24.195	200mm HDPE–PE100 Class PN10
MH309 – MH310	64.525	200mm HDPE–PE100 Class PN10
MH310 – MH311	40.001	200mm HDPE–PE100 Class PN10
MH311 – MH312	68.747	200mm HDPE–PE100 Class PN10
MH312 – MH313	68.748	200mm HDPE–PE100 Class PN10
MH313 – MH314	68.748	200mm HDPE–PE100 Class PN10
MH314 – MH315	66.969	200mm HDPE–PE100 Class PN10
MH315 – MH286	79.666	200mm HDPE–PE100 Class PN10
MH316 – MH317	36.840	160mm HDPE–PE100 Class PN10
MH317 – MH302	19.350	160mm HDPE–PE100 Class PN10
MH318 – MH307	83.100	160mm HDPE–PE100 Class PN10
MH319 – MH309	76.079	160mm HDPE–PE100 Class PN10
MH320 – MH311	15.195	160mm HDPE–PE100 Class PN10
MH321 – MH322	70.084	160mm HDPE–PE100 Class PN10
MH322 – MH323	70.084	160mm HDPE–PE100 Class PN10
MH323 – MH324	72.996	160mm HDPE–PE100 Class PN10
MH324 – MH325	75.099	160mm HDPE–PE100 Class PN10
MH325 – MH283	75.359	160mm HDPE–PE100 Class PN10
MH326 – MH327	53.526	160mm HDPE–PE100 Class PN10
MH327 – MH108	53.526	160mm HDPE–PE100 Class PN10
MH328 – MH329	73.810	160mm HDPE–PE100 Class PN10
MH329 – MH330	73.810	160mm HDPE–PE100 Class PN10
MH330 – MH331	73.810	160mm HDPE–PE100 Class PN10
MH331 – MH332	66.187	160mm HDPE–PE100 Class PN10
MH332 – MH289	79.655	160mm HDPE–PE100 Class PN10
MH333 – MH334	62.287	160mm HDPE–PE100 Class PN10

TOTAL LENGTHS OF PIPING

MH Centre to MH Centre

Diameter (mm)	Length (m)
500mm HDPE–PE100 Class PN10	353.13
500mm HDPE–PE100 Class PN10	21.94
450mm HDPE–PE100 Class PN10	793.84
400mm HDPE–PE100 Class PN10	227.85
355mm HDPE–PE100 Class PN10	111.00
315mm HDPE–PE100 Class PN10	519.24
250mm HDPE–PE100 Class PN10	622.89
200mm HDPE–PE100 Class PN10	989.75
160mm HDPE–PE100 Class PN10	13196.12
Total :	16835.76

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

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DISCIPLINE
CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
COORDINATE LIST AND PIPE DATA LIST
SHEET 2 OF 3

REF. NO. –
SCALE 1:1500
DATE 03/2021
TYPE NUMBER

DESIGNER R. MABOHO
DRAWING F. MAZIBUKO
CHECKED S. MNGUNI

DRAWING NUMBER
7001/S/A002

A1
100mm ON ORIGINAL DRAWING

COORDINATE LIST
WG 27

MH No.	Unitas Sewer Network 1	
Constant:	YLo	XLo
MH332	−90082.366	2946731.240
MH333	−89997.716	2946445.445
MH334	−90033.627	2946496.337
MH335	−89886.170	2945849.462
MH336	−89841.506	2945875.398
MH337	−89796.842	2945901.333
MH338	−89824.297	2945949.029
MH339	−89851.752	2945996.726
MH340	−89879.207	2946044.422
MH341	−89906.662	2946092.119
MH342	−89934.102	2946139.631
MH343	−89881.474	2946170.075
MH344	−89923.211	2946235.852
MH345	−89892.190	2946257.742
MH346	−89917.320	2946293.356
MH347	−89942.451	2946328.970
MH348	−89970.138	2946368.206
MH349	−89996.426	2946405.459
MH350	−89994.883	2946414.398
MH351	−89938.845	2946453.942
MH352	−89982.814	2946516.253
MH353	−89779.292	2945911.524
MH354	−89871.713	2945892.548
MH355	−89901.985	2945948.782
MH356	−89932.037	2946004.606
MH357	−89962.200	2946060.635
MH358	−89990.726	2946114.770
MH359	−90019.252	2946168.905
MH360	−90011.479	2946173.566
MH361	−89985.404	2946191.966
MH362	−89970.282	2946202.637
MH363	−89947.306	2946218.849
MH364	−89948.020	2946163.963
MH365	−89748.322	2945935.287
MH366	−89771.328	2945975.121
MH367	−89794.333	2946014.954
MH368	−89820.590	2946060.416
MH369	−89846.846	2946105.879
MH370	−89809.214	2946127.613
MH371	−89848.793	2946196.243
MH372	−89685.376	2946110.315
MH373	−89728.087	2946085.656
MH374	−89770.797	2946060.996
MH375	−89911.107	2946506.560
MH376	−89939.156	2946546.309
MH377	−89967.205	2946586.057
MH378	−89900.556	2946480.960
MH379	−89852.237	2946515.057
MH380	−89886.415	2946563.493
MH381	−89920.594	2946611.929
MH382	−89949.099	2946652.324
MH383	−89564.028	2946097.717
MH384	−89599.824	2946159.709
MH385	−89629.743	2946211.522
MH386	−89659.662	2946263.335
MH387	−89691.582	2946318.613
MH388	−89723.502	2946373.892
MH389	−89755.422	2946429.170
MH390	−89768.447	2946454.217
MH391	−89775.513	2946456.689
MH392	−89793.851	2946494.756
MH393	−89830.600	2946546.835
MH394	−89812.625	2946559.519
MH395	−89845.289	2946605.808
MH396	−89877.952	2946652.097
MH397	−89921.107	2946713.253
MH398	−89964.261	2946774.408
MH399	−89952.952	2946782.697
MH400	−89905.372	2946817.569
MH401	−89895.115	2946825.087
MH402	−89903.303	2946839.649
MH403	−89868.747	2946374.527
MH404	−89812.085	2946401.849
MH405	−89840.503	2946725.640
MH406	−89868.182	2946764.865
MH407	−89761.526	2946579.030
MH408	−89792.682	2946623.182
MH409	−89824.270	2946667.948
MH410	−89780.890	2946698.559
MH411	−89770.887	2946705.618
MH412	−89754.275	2946722.220
MH413	−89743.763	2946734.274

PIPE DATA LIST

MH – MH	Distance	Diam.
Unitas Sewer Network 1	(m)	(mm)
MH334 – MH278	62.286	160mm HDPE–PE100 Class PN10
MH335 – MH336	51.648	160mm HDPE–PE100 Class PN10
MH336 – MH337	51.648	160mm HDPE–PE100 Class PN10
MH337 – MH338	55.034	160mm HDPE–PE100 Class PN10
MH338 – MH339	55.034	160mm HDPE–PE100 Class PN10
MH339 – MH340	55.034	160mm HDPE–PE100 Class PN10
MH340 – MH341	55.034	160mm HDPE–PE100 Class PN10
MH341 – MH342	54.867	160mm HDPE–PE100 Class PN10
MH342 – MH343	60.799	160mm HDPE–PE100 Class PN10
MH343 – MH344	77.902	160mm HDPE–PE100 Class PN10
MH344 – MH345	37.967	160mm HDPE–PE100 Class PN10
MH345 – MH346	43.588	160mm HDPE–PE100 Class PN10
MH346 – MH347	43.588	160mm HDPE–PE100 Class PN10
MH347 – MH348	48.022	160mm HDPE–PE100 Class PN10
MH348 – MH349	45.594	160mm HDPE–PE100 Class PN10
MH349 – MH350	9.071	160mm HDPE–PE100 Class PN10
MH350 – MH351	68.586	160mm HDPE–PE100 Class PN10
MH351 – MH352	76.263	160mm HDPE–PE100 Class PN10
MH352 – MH279	76.263	160mm HDPE–PE100 Class PN10
MH353 – MH337	20.294	160mm HDPE–PE100 Class PN10
MH354 – MH355	63.864	160mm HDPE–PE100 Class PN10
MH355 – MH356	63.399	160mm HDPE–PE100 Class PN10
MH356 – MH357	63.632	160mm HDPE–PE100 Class PN10
MH357 – MH358	61.191	160mm HDPE–PE100 Class PN10
MH358 – MH359	61.191	160mm HDPE–PE100 Class PN10
MH359 – MH360	9.063	160mm HDPE–PE100 Class PN10
MH360 – MH361	31.913	160mm HDPE–PE100 Class PN10
MH361 – MH362	18.508	160mm HDPE–PE100 Class PN10
MH362 – MH363	28.119	160mm HDPE–PE100 Class PN10
MH363 – MH344	29.491	160mm HDPE–PE100 Class PN10
MH364 – MH362	44.623	160mm HDPE–PE100 Class PN10
MH365 – MH366	46.000	160mm HDPE–PE100 Class PN10
MH366 – MH367	45.999	160mm HDPE–PE100 Class PN10
MH367 – MH368	52.500	160mm HDPE–PE100 Class PN10
MH368 – MH369	52.500	160mm HDPE–PE100 Class PN10
MH369 – MH370	43.457	160mm HDPE–PE100 Class PN10
MH370 – MH371	79.225	160mm HDPE–PE100 Class PN10
MH371 – MH345	75.269	160mm HDPE–PE100 Class PN10
MH372 – MH373	49.318	160mm HDPE–PE100 Class PN10
MH373 – MH374	49.318	160mm HDPE–PE100 Class PN10
MH374 – MH370	76.900	160mm HDPE–PE100 Class PN10
MH375 – MH376	48.649	160mm HDPE–PE100 Class PN10
MH376 – MH377	48.649	160mm HDPE–PE100 Class PN10
MH377 – MH282	28.834	160mm HDPE–PE100 Class PN10
MH378 – MH379	59.138	160mm HDPE–PE100 Class PN10
MH379 – MH380	59.281	160mm HDPE–PE100 Class PN10
MH380 – MH381	59.281	160mm HDPE–PE100 Class PN10
MH381 – MH382	49.440	160mm HDPE–PE100 Class PN10
MH382 – MH284	49.440	160mm HDPE–PE100 Class PN10
MH383 – MH384	71.585	160mm HDPE–PE100 Class PN10
MH384 – MH385	59.831	160mm HDPE–PE100 Class PN10
MH385 – MH386	59.831	160mm HDPE–PE100 Class PN10
MH386 – MH387	63.832	160mm HDPE–PE100 Class PN10
MH387 – MH388	63.832	160mm HDPE–PE100 Class PN10
MH388 – MH389	63.833	160mm HDPE–PE100 Class PN10
MH389 – MH390	28.232	160mm HDPE–PE100 Class PN10
MH390 – MH391	7.485	160mm HDPE–PE100 Class PN10
MH391 – MH392	42.254	160mm HDPE–PE100 Class PN10
MH392 – MH393	63.739	160mm HDPE–PE100 Class PN10
MH393 – MH394	22.000	160mm HDPE–PE100 Class PN10
MH394 – MH395	56.654	160mm HDPE–PE100 Class PN10
MH395 – MH396	56.654	160mm HDPE–PE100 Class PN10
MH396 – MH397	74.849	160mm HDPE–PE100 Class PN10
MH397 – MH398	74.848	160mm HDPE–PE100 Class PN10
MH398 – MH399	14.021	160mm HDPE–PE100 Class PN10
MH399 – MH400	58.991	160mm HDPE–PE100 Class PN10
MH400 – MH401	12.717	160mm HDPE–PE100 Class PN10
MH401 – MH402	16.707	160mm HDPE–PE100 Class PN10
MH402 – MH291	18.414	160mm HDPE–PE100 Class PN10
MH403 – MH404	62.906	160mm HDPE–PE100 Class PN10
MH404 – MH389	62.906	160mm HDPE–PE100 Class PN10
MH405 – MH406	48.008	160mm HDPE–PE100 Class PN10
MH406 – MH400	64.505	160mm HDPE–PE100 Class PN10
MH407 – MH408	54.038	160mm HDPE–PE100 Class PN10
MH408 – MH409	54.789	160mm HDPE–PE100 Class PN10
MH409 – MH410	53.093	160mm HDPE–PE100 Class PN10
MH410 – MH411	12.244	160mm HDPE–PE100 Class PN10
MH411 – MH412	23.486	160mm HDPE–PE100 Class PN10
MH412 – MH413	15.994	160mm HDPE–PE100 Class PN10
MH413 – MH414	44.501	160mm HDPE–PE100 Class PN10
MH414 – MH415	50.000	160mm HDPE–PE100 Class PN10
MH415 – MH416	52.478	160mm HDPE–PE100 Class PN10

TOTAL LENGTHS OF PIPING
MH Centre to MH Centre

Diameter (mm)	Length (m)
500mm HDPE–PE100 Class PN10	353.13
500mm HDPE–PE100 Class PN10	21.94
450mm HDPE–PE100 Class PN10	793.84
400mm HDPE–PE100 Class PN10	227.85
355mm HDPE–PE100 Class PN10	111.00
315mm HDPE–PE100 Class PN10	519.24
250mm HDPE–PE100 Class PN10	622.89
200mm HDPE–PE100 Class PN10	989.75
160mm HDPE–PE100 Class PN10	13196.12
Total :	16835.76

COORDINATE LIST
WG 27

MH No.	Unitas Sewer Network 1	
Constant:	YLo	XLo
MH414	−89777.118	2946763.732
MH415	−89814.595	2946796.830
MH416	−89853.929	2946831.568
MH417	−89880.453	2946867.673
MH418	−89743.802	2946631.962
MH419	−89730.089	2946641.638
MH420	−89717.746	2946650.348
MH421	−89723.596	2946605.780
MH422	−89673.986	2946640.768
MH423	−89676.970	2946645.539
MH424	−89662.210	2946662.252
MH425	−89702.986	2946698.263
MH426	−89852.716	2946694.384
MH427	−89795.188	2946734.978
MH428	−89791.579	2946747.151
MH429	−89788.953	2946869.803
MH430	−89830.825	2946906.782
MH431	−89787.846	2946956.086
MH432	−89745.615	2947004.532
MH433	−89703.009	2947053.407
MH434	−89704.128	2946880.323
MH435	−89734.046	2946906.416
MH436	−89740.301	2946906.009
MH437	−89747.058	2946919.259
MH438	−89763.496	2946933.777
MH439	−89725.637	2946977.187
MH440	−89687.778	2947020.596
MH441	−89645.483	2947069.093
MH442	−89656.036	2947078.292
MH443	−89768.964	2946873.553
MH444	−89788.343	2946905.286

PIPE DATA LIST

MH – MH	Distance	Diam.
Unitas Sewer Network 1	(m)	(mm)
MH416 – MH417	44.801	160mm HDPE–PE100 Class PN10
MH417 – MH117	37.066	160mm HDPE–PE100 Class PN10
MH418 – MH419	16.783	160mm HDPE–PE100 Class PN10
MH419 – MH410	76.294	160mm HDPE–PE100 Class PN10
MH420 – MH419	15.106	160mm HDPE–PE100 Class PN10
MH421 – MH422	60.707	160mm HDPE–PE100 Class PN10
MH422 – MH423	5.628	160mm HDPE–PE100 Class PN10
MH423 – MH424	22.297	160mm HDPE–PE100 Class PN10
MH424 – MH425	54.402	160mm HDPE–PE100 Class PN10
MH425 – MH413	54.402	160mm HDPE–PE100 Class PN10
MH426 – MH427	70.409	160mm HDPE–PE100 Class PN10
MH427 – MH428	12.697	160mm HDPE–PE100 Class PN10
MH428 – MH414	22.000	160mm HDPE–PE100 Class PN10
MH429 – MH430	55.864	160mm HDPE–PE100 Class PN10
MH430 – MH431	65.408	160mm HDPE–PE100 Class PN10
MH431 – MH432	64.269	160mm HDPE–PE100 Class PN10
MH432 – MH433	64.838	160mm HDPE–PE100 Class PN10
MH433 – MH125	64.838	160mm HDPE–PE100 Class PN10
MH434 – MH435	39.699	160mm HDPE–PE100 Class PN10
MH435 – MH436	6.268	160mm HDPE–PE100 Class PN10
MH436 – MH437	14.874	160mm HDPE–PE100 Class PN10
MH437 – MH438	21.931	160mm HDPE–PE100 Class PN10
MH438 – MH439	57.600	160mm HDPE–PE100 Class PN10
MH439 – MH440	57.600	160mm HDPE–PE100 Class PN10
MH440 – MH441	64.349	160mm HDPE–PE100 Class PN10
MH441 – MH442	14.000	160mm HDPE–PE100 Class PN10
MH442 – MH125	24.384	160mm HDPE–PE100 Class PN10
MH443 – MH436	43.301	160mm HDPE–PE100 Class PN10
MH444 – MH438	37.804	160mm HDPE–PE100 Class PN10

TOTAL LENGTHS OF PIPING
MH Centre to MH Centre

Diameter (mm)	Length (m)
500mm HDPE–PE100 Class PN10	353.13
500mm HDPE–PE100 Class PN10	21.94
450mm HDPE–PE100 Class PN10	793.84
400mm HDPE–PE100 Class PN10	227.85
355mm HDPE–PE100 Class PN10	111.00
315mm HDPE–PE100 Class PN10	519.24
250mm HDPE–PE100 Class PN10	622.89
200mm HDPE–PE100 Class PN10	989.75
160mm HDPE–PE100 Class PN10	13196.12
Total :	16835.76

COORDINATE LIST
WG 27

MH No.	Unitas Sewer Outlet Network	
Constant:	YLo	XLo
0UT439	−89644.485	2947099.778
0UT440	−89659.990	2947116.716
MH441	−89670.565	2947128.172
MH442	−89658.487	2947140.327
MH443	−89606.492	2947185.274
MH444	−89590.363	2947193.298
MH445	−89535.473	2947251.497
MH446	−89480.583	2947309.695
MH447	−89425.692	2947367.894
MH448	−89370.802	2947426.092
MH449	−89315.912	2947484.291
0UT450	−89301.071	2947492.935

PIPE DATA LIST

MH – MH	Distance
Unitas Sewer Outlet Network	(m)
OUT439 – OUT440	22.963
OUT440 – MH441	15.591
MH441 – MH442	17.135
MH442 – MH443	68.730
MH443 – MH444	18.015
MH444 – MH445	80.000
MH445 – MH446	80.000
MH446 – MH447	80.000
MH447 – MH448	80.000
MH448 – MH449	80.000
MH449 – OUT450	17.175

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

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DISCIPLINE
CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

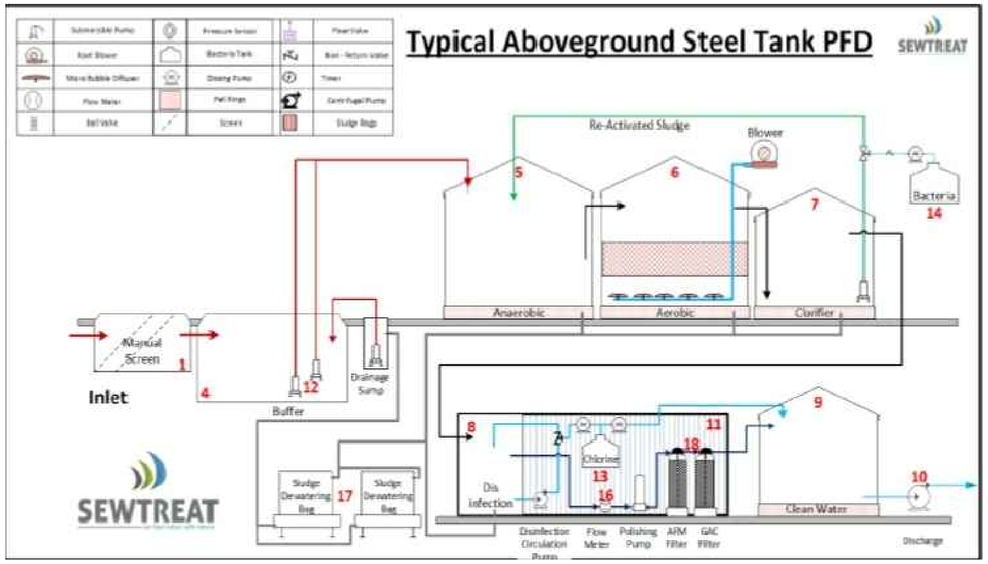
DRAWING TITLE
COORDINATE LIST AND PIPE DATA LIST
SHEET 3 OF 3

REF. NO. –
SCALE 1:1500
DATE 03/2021
TYPE NUMBER

DESIGNER R. MABOHO
DRAWING F. MAZIBUKO
CHECKED S. MNGUNI

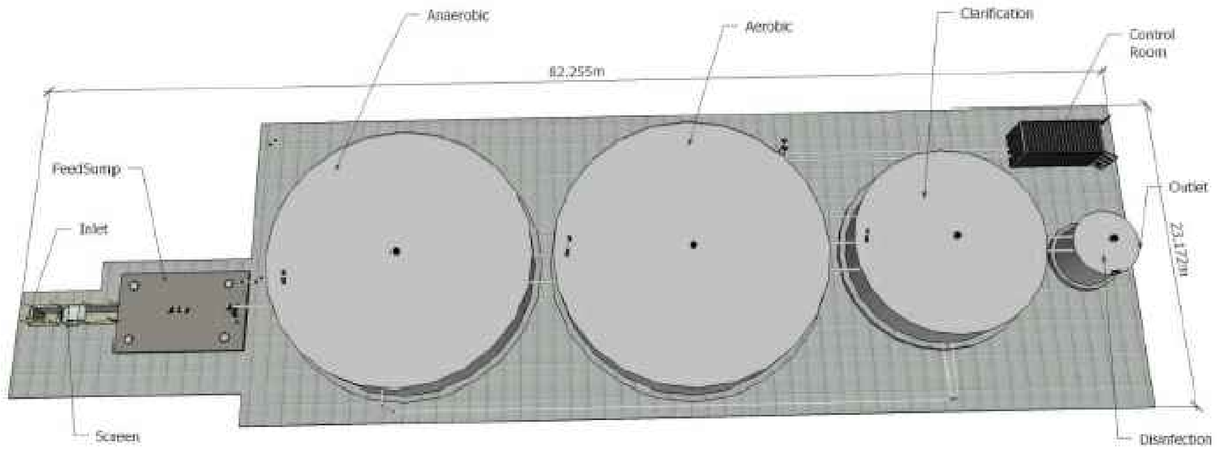
DRAWING NUMBER
7001/S/A003

A1
100mm ON ORIGINAL DRAWING



The below BoQ is for 1x 10 MLpd plant.

No.	Process	Included	Technical	Function
1	Screen	Included	TSF3 - M30	Screening is imperative to remove all inorganics from the incoming effluent. This can be done Manually or automatic. Screening remove the plastics, pads, condoms and all other material that cannot be digested in the biological wastewater treatment plant. Screen apertures is normally 20mm and/or 40mm
2	Inline Screen	Excluded	Not Included	Inline screen serves to remove smaller inorganic particles, this screen is normally a 3mm, 5mm or 10mm screen. Installed inline before the buffer or the anaerobic phase.
3	Lifting Station	Excluded	Not Included	if the incoming level of the effluent is deeper than 1m a lifting station is required. Pre-cast manhole rings are stacked on each other to the required depth, pumps are then installed, normally cutter type submersible pumps, these pumps pump the effluent to the inline screen, buffer or anaerobic tanks depending on the design.
4	Buffer Tank	Excluded	Not Included	Buffer tank also called the balancing tank is used in the event of high peaks during the day, if there is peak flows during for example shift changes, then the high flow is put into a buffer tank and the feed to the treatment plant is regulated at the required liter per minute. This ensures efficiency of the plant, reduces the treatment plants required capacities and ensures constant feed to the treatment plant.
5	Anaerobic Phase	Included	PHT-2200 - 4.16 - 9544m3 provided with 5 Tanks	If the client doesn't have a septic tank installed or the volume of the current septic tank is not sufficient, an Anaerobic treatment phase will need to be installed. The anaerobic treatment (Also called Septic Phase) assist in a 50% to 70% reduction of the COD and BOD. The Anaerobic phase also assist in the separation of solids from liquids
6	Aerobic	Included	PHT-2200 - 4.16 -7636m3 provided with 4 Tanks	Aerobic phase or Bioreactor's main objective is the reduction of Ammonia through nitrification this is done by air injection via air blower through micro bubble diffusers. Nitrification is the biological process where ammonium (NH4+) is oxidized and converted into the nitrate (NO3-). PVC Pall rings to be installed in the tank to create Moving Bed Bioreactor to allow for bacterial growth at a rate of > 148m2/m3 of surface area.
7	Clarificatio n	Included	PHT-2200 - 4.16 -5727m3 provided with 3 Tanks - Upflow rate of 133.23 - M/hour	Clarification (Also called Anoxic or Humus phase) assist with de-nitrification in a naerobic conditions. De-nitrification is biological process that involves the conversion of nitrate (NO3-) into nitrogen gas (N2). The sludge that settles in this phase is called activated sludge which is then returned to the anaerobic and aerobic phase to assist in sludge breakdown. This process also reduces the quantity of sludge removed from the system significantly.
8	Disinfectio n	Included	Con-L&S-12M - 0m3 provided with 2 Tanks	Disinfection means the removal, deactivation or killing of pathogenic microorganisms, resulting in termination of growth and reproduction. This ensure the water is safe for re-use. There are various methodologies of disinfection, we prefer Sodium hypochlorite, although this results in a monthly consumable, it is the most effective and reliable disinfection method.
9	Final Holding tank	Excluded	Not Included	Final water holding tank, stores the water for re-use in various applications such as irrigation, fire water, general cleaning, cooling tower refill and all other non-potable applications. This is optional addition and can be provided by the client.
10	Final Discharge	Excluded	Not Included	If required, a final discharge pump can be installed to pump the water to the final water holding tanks, this is optional.
11	Control Room	Included	12m - Container c/w Steel Structure & Pool Coat	A control room serves as a clean, lockable space where the equipment and electrical panels be installed into. The control room must be well ventilated to ensure the distribution of heat from the mechanical equipment. Also serves as lockable space which offers security.
12	Feed Pumps	Included	2 x 2.2KW - Submersible Sewage Pumps - 400Lpm	Feed pumps are used in the event that the tank is above ground type, invert level is too deep, or the plant cannot be gravity fed. Pumps are selected to pump at a peak factor of 3, to ensure efficiency. We recommend that feed pumps be installed on a duty-standby assembly, which ensures availability and ensure no spillages occur.
13	Chlorine Dosing	Included	1 x Chlorine Dosing with Probe	Sodium Hypochlorite dosing pump, the pump has a sensor that automatically measures and dose the correct amount of sodium hypochlorite into the final effluent. The average dosing is 8ppm with a residual of 2ppm
14	Bacteria Dosing	Included	1 x Digital Dosing Pump	A blend of 21 species of bacteria is constantly dosed into the system to enhance the system, this is imperative in high COD applications and also where there is a lot of chemicals that is fed into the plant. By dosing the bacteria, it ensures that there is always sufficient biomass.
15	Electrical Panel	Included	Large - IP65 - Electrical panel with GSM and 29 Components	We offer 4 types: the basic panel is a wall mounted DB with no indicator lights, switches or intelligence. The Small IP65 panels is small panels with indicator light and switches and a basic GSM module. The Large IP65 panel is a complete panel with labelling, indicator lights, and full GSM integration. The PLC is the ultimate in control, intelligence and integration.
16	Flow Meter	Included	Digital Flow Meter	Flow meters are optional, we prefer to install a digital IFM type flow meter that is connected to the GSM router that delivers daily flow rates via SMS.
17	Sludge Bags	Included	400 x De-Sludge Stand 1M3	Sludge bags are used for the removal of excess sludge, this will be done periodically. The sludge bags are perforated and allows the water to drain while retaining the sludge. It is also a very cost-effective solution for sludge drying beds.
18	Final Polishing	Excluded	Not Included	If the final water is to be used for cooling towers, toilet flushing or general washing, we recommend that final water polishing be included, this entails the water being pumped through multimedia filters and activated carbon filters.



NO.	DATE	AMENDMENT	APPROVED
A	03/2021	ISSUED FOR POR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS

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DISCIPLINE:
CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

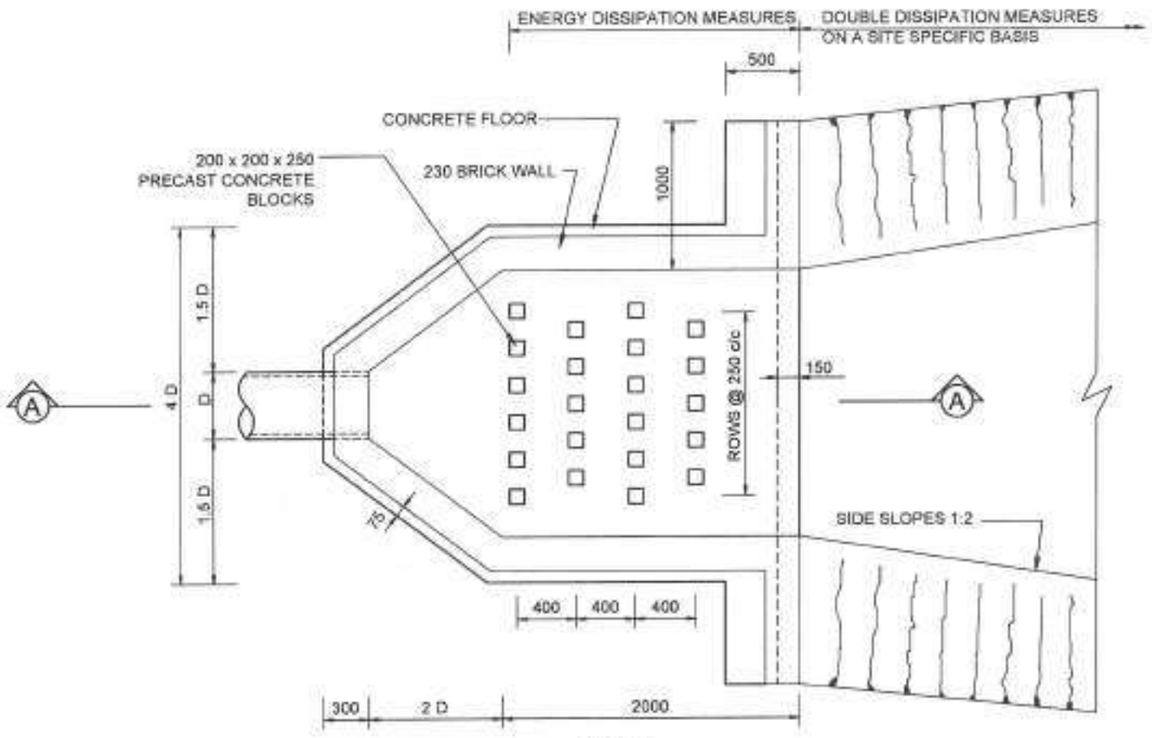
WCS NO.

DRAWING TITLE
STEEL WATER TANK

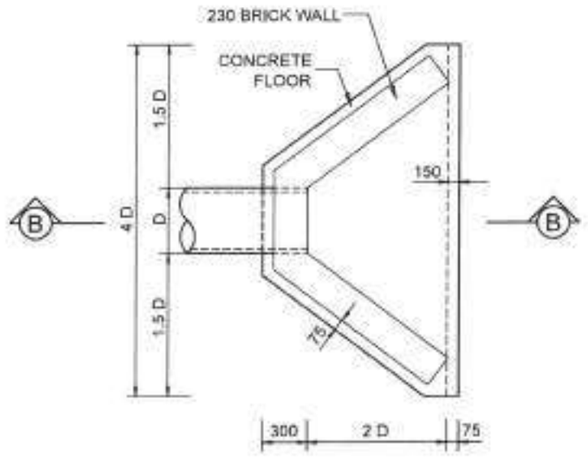
REF. NO. | DESIGNER
SCALE | DRAWING
DATE | CHECKED
TYPE NUMBER

DRAWING NUMBER
7001/RW/D006

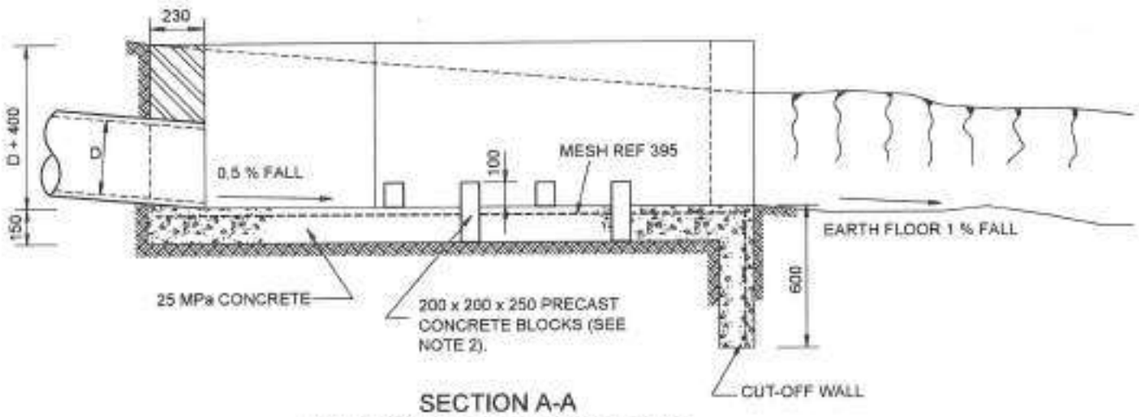
A1
100mm ON ORIGINAL DRAWINGS



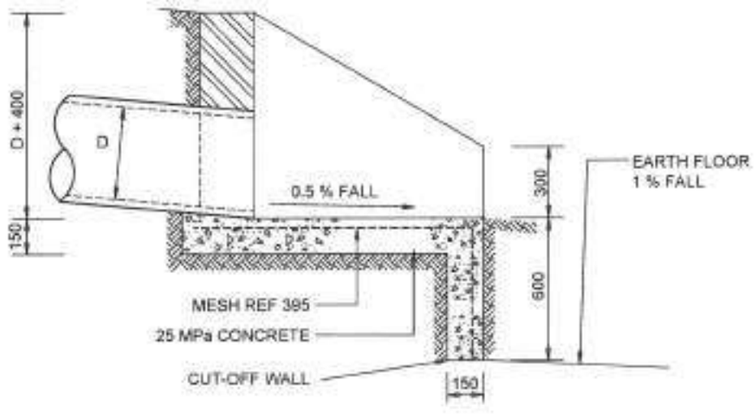
PLAN



PLAN



SECTION A-A
ENERGY DISSIPATION OUTLET



SECTION B-B

LEGEND

NOTES

1. REFER TO DWGS. JRA-SS080 & 082 FOR ADDITIONAL OUTLET STRUCTURE NOTES.
2. ONE LAYER OF MESH REF 395 TO BE PLACED ON FLOOR AND CUT-OFF WALL AS SHOWN WITH 40mm COVER AND MIN. LAP LENGTH OF 350mm.
3. ALL CONCRETE INCLUDING PRECAST CONCRETE BLOCKS IN ENERGY DISSIPATING OUTLETS TO BE CHAMFERED 25 x 25 ON EXPOSED EDGES.
4. ALL BRICKWORK TO BE IN ENGLISH BOND.
5. NO PLASTERING OF BRICKWORK WILL BE ALLOWED. ALL BRICKS TO BE OF QUALITY FBSE30 TO SANS227-2007 WITH WATER ABSORPTION <14% AND EFFLORESCENCE <10.
6. THE LOWER PORTION OF ANY BRICKWORK GREATER THAN 1m IN HEIGHT SHALL BE INCREASED IN WIDTH TO 345mm TO A MAX. OVERALL HEIGHT 1.75m.
10. IN TERMS OF THE NATIONAL WATER ACT, 36 OF 1998, A RATE OF DISCHARGE FROM AN OUTLET STRUCTURE SHALL NOT EXCEED 1m/SEC AND SHALL NOT BE GREATER THAN 100mm IN DEPTH. IF DESIGN INDICATIONS ARE THAT THESE FIGURES WILL BE EXCEEDED, ADDITIONAL ENERGY DISSIPATION MEASURES WILL BE REQUIRED.

AMENDMENTS			
No.	DATE	APPROVED	DESCRIPTION

DESIGNED BY: | DRAWN BY:
STRUCTURAL DESIGN BY: | DRAWING CHECKED BY:
CHECKED BY: | DRAWING APPROVED BY:

CITY OF JOHANNESBURG

JOHANNESBURG ROADS AGENCY (PTY) LTD

Drawing Sub-set: STORMWATER: DESIGN

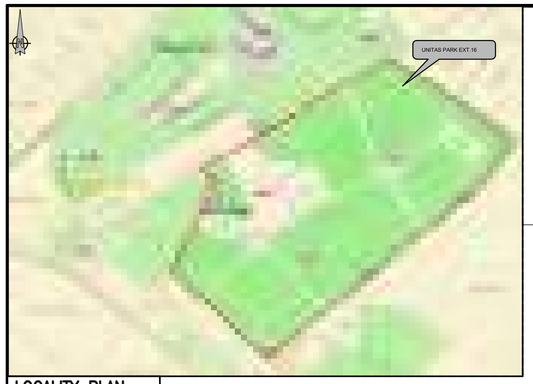
TYPICAL OUTLET STRUCTURE DETAILS

SCALE AS SHOWN: NTS

DATE: 18/05/2015

DRAWING NUMBER: JRA-SD SW-081 | EXTN.

AMENDMENT NUMBER:



LOCALITY PLAN
NTS

SEE DWG 7001/S/U002

TO BE DISCHARGED INTO A PROPOSED 2x10 MLPD aboveground Steel Tank Waste Water Treatment Facility(Refer to drawing no. 7170006 TREAMENT PLANT DRAWING

REFER TO DRAWING NO. JRA-SD-SW-001 FOR THE OUTLET STRUCTURE SEWER TREATED POTABLE WATER FROM THE WASTE WATER TREATMENT FACILITY

UNITAS PARK EXT.16 – P. BENCHMARKS WG–29				DESCRIPTION
BM1B	89603.38	2946872.99	1468.80	12mm Iron Peg in concrete
BM2B	89184.97	2946609.98	1470.33	12mm Iron Peg in concrete
BM3B	89396.12	2946070.32	1477.67	12mm Iron Peg in concrete
BM4B	90214.71	2945629.83	1478.42	12mm Iron Peg in concrete
BM5B	90982.23	2946053.61	1472.43	12mm Iron Peg in concrete
QU7	90424.23	2945692.86	1476.87	12mm Iron Peg in concrete

SEWER RETICULATION LAYOUT
SCALE 1:1500

NOTES AND SPECIFICATIONS GENERAL

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2. ALL DIMENSIONS ARE IN MILLIMETRES.(UNLESS OTHERWISE SPECIFIED).
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13. THE LOCAL AUTHORITY'S STAFF WILL BE NOTIFIED WELL IN ADVANCE TO ATTEND SITE INSPECTIONS AND MEETINGS.
14. SEWER PIPELINES SHALL BE 160mmø HDPE–PE100 Class PN10 SEWER PIPES IN ERVEN MUST BE 1.0m FROM BOUNDARY IN ROAD RESERVE < 10m SEWER PIPE MUST BE LAID 1.0m INSIDE ERF BOUNDARY IN 13m ROAD RESERVE AND MORE WIDER ROAD RESERVE SEWER PIPES MUST BE LAID 1m FROM THE ERF BOUNDARY

LEGEND:

- PROPOSED SEWER
- NEW MANHOLE
- MH10 — SEWER MANHOLE NO
- 160ø HDPE–PE100 Class PN10 — PIPE DIAMETER
- 17.31m — DISTANCE BETWEEN MH
- 1.20 — HOUSE CONNECTION
- CONNECTION DEPTH
- EXISTING RIVER
- DIRECTION OF FLOW
- BM.3 — BENCHMARK

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

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CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

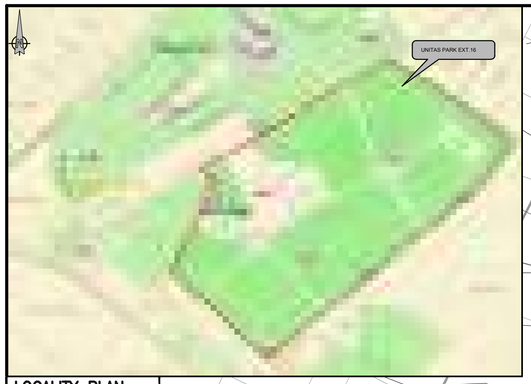
WCS NO.

DRAWING TITLE
SEWER RETICULATION LAYOUT
SHEET 1 OF 5

REF. NO. —	DESIGNER R. MABOHO
SCALE 1:1500	DRAWING F. MAZIBUKO
DATE 03/2021	CHECKED S. MNGUNI
TYPE NUMBER	

DRAWING NUMBER
7001/S/U001

A1
100mm ON ORIGINAL DRAWING



LOCALITY PLAN
NTS

SEE DWG 7001/S/U003

SEE DWG 7001/S/U003

UNITAS PARK EXT.16 – P. BENCHMARKS WG–29				DESCRIPTION
BM1B	89603.38	2946872.99	1468.80	12mm Iron Peg in concrete
BM2B	89184.97	2946609.98	1470.33	12mm Iron Peg in concrete
BM3B	89396.12	2946070.32	1477.67	12mm Iron Peg in concrete
BM4B	90214.71	2945629.83	1478.42	12mm Iron Peg in concrete
BM5B	90982.23	2946053.61	1472.43	12mm Iron Peg in concrete
QU7	90424.23	2945692.86	1476.87	12mm Iron Peg in concrete

SEWER RETICULATION LAYOUT
SCALE 1:1500

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LEGEND:

- PROPOSED SEWER
- NEW MANHOLE
- MH10 — SEWER MANHOLE NO
- 160ø HDPE–PE100 Class PN10 / 17.31m — PIPE DIAMETER / DISTANCE BETWEEN MH
- HOUSE CONNECTION
- 1.20 — CONNECTION DEPTH
- EXISTING RIVER
- DIRECTION OF FLOW
- BM3 — BENCHMARK

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS

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CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
SEWER RETICULATION LAYOUT
SHEET 2 OF 5

REF. NO.	DESIGNER
–	R. MABOHO
SCALE	DRAWING
1:1500	F. MAZIBUKO
DATE	CHECKED
03/2021	S. MNGUNI

TYPE NUMBER

DRAWING NUMBER
7001/S/U002

A1
100mm ON ORIGINAL DRAWING

LOCALITY PLAN
NTS

SEE DWG 7001/S/U004

SEE DWG 7001/S/U002

SEE DWG 7001/S/U004

SEE DWG 7001/S/U001

UNITAS PARK EXT.16 – P. BENCHMARKS WG–29				DESCRIPTION
BM1B	89603.38	2946872.99	1468.80	12mm Iron Peg in concrete
BM2B	89184.97	2946609.98	1470.33	12mm Iron Peg in concrete
BM3B	89396.12	2946070.32	1477.67	12mm Iron Peg in concrete
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SEWER RETICULATION LAYOUT
SCALE 1:1500

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LEGEND:

- PROPOSED SEWER
- NEW MANHOLE
- MH10 — SEWER MANHOLE NO
- 160⌀ HDPE–PE100 Class PN10 — PIPE DIAMETER
- 17.31m — DISTANCE BETWEEN MH
- 1.20 — HOUSE CONNECTION
- CONNECTION DEPTH
- EXISTING RIVER
- DIRECTION OF FLOW
- BM3 — BENCHMARK

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS

P.O. BOX 4049
RANDBURG-2125
FIRST FLOOR 24 PETER PLACE
LYME PARK BRYANSTON 2191
TEL (011)326-0741/90

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DISCIPLINE
CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
SEWER RETICULATION LAYOUT
SHEET 3 OF 5

REF. NO. –	DESIGNER R. MABOHO
SCALE 1:1500	DRAWING F. MAZIBUKO
DATE 03/2021	CHECKED S. MNGUNI
TYPE NUMBER	

DRAWING NUMBER
7001/S/U003

A1
100mm ON ORIGINAL DRAWING

LOCALITY PLAN
NTS

UNITAS PARK EXT.16 – P. BENCHMARKS WG-29				DESCRIPTION
BM1B	89603.38	2946872.99	1468.80	12mm Iron Peg in concrete
BM2B	89184.97	2946609.98	1470.33	12mm Iron Peg in concrete
BM3B	89396.12	2946070.32	1477.67	12mm Iron Peg in concrete
BM4B	90214.71	2945629.83	1478.42	12mm Iron Peg in concrete
BM5B	90982.23	2946053.61	1472.43	12mm Iron Peg in concrete
QU7	90424.23	2945692.86	1476.87	12mm Iron Peg in concrete

SEE DWG 7001/S/U005

SEE DWG 7001/S/U003

SEE DWG 7001/S/U005

SEE DWG 7001/S/U003

SEWER RETICULATION LAYOUT
SCALE 1:1500

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LEGEND:

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- NEW MANHOLE
- MH10 — SEWER MANHOLE NO
- 160ø HDPE-PE100 Class PN10 / 17.31m — PIPE DIAMETER / DISTANCE BETWEEN MH
- 1.20 — HOUSE CONNECTION
- CONNECTION DEPTH
- EXISTING RIVER
- DIRECTION OF FLOW
- BM3 — BENCHMARK

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ENGINEER:

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CIVIL ENGINEERING

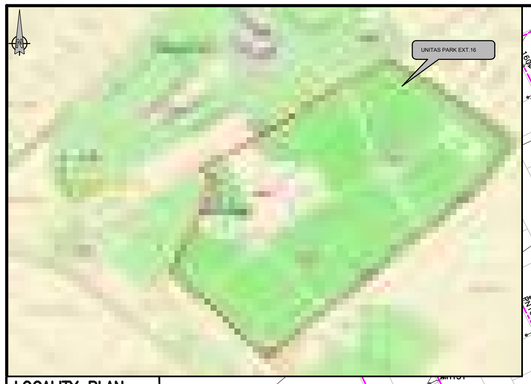
PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
SEWER RETICULATION LAYOUT
SHEET 4 OF 5

REF. NO. —	DESIGNER R. MABOHO
SCALE 1:1500	DRAWING F. MAZIBUKO
DATE 03/2021	CHECKED S. MNGUNI
TYPE NUMBER	
DRAWING NUMBER 7001/S/U004	

A1
100mm ON ORIGINAL DRAWING



LOCALITY PLAN
NTS

SEE DWG 7001/S/U004

SEE DWG 7001/S/U004

SEWER RETICULATION LAYOUT
SCALE 1:1500

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UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
SEWER RETICULATION LAYOUT
SHEET 5 OF 5

REF. NO.	–
SCALE	1:1500
DATE	03/2021
TYPE NUMBER	
DESIGNER	R. MABOHO
DRAWING	F. MAZIBUKO
CHECKED	S. MNGUNI

DRAWING NUMBER
7001/S/U005

A1
100mm ON ORIGINAL DRAWING

ANNEXURE M

PROPOSED ROADS LAYOUT

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 1	0.000	−89278.994	2946910.849	STREET 1			
BC 2	522.801	−89623.265	2946517.405				
PI 2		−89635.373	2946503.568	90	23°05'32"	18.386	36.273
EC 2	559.074	−89651.937	2946495.589				
BC 3	1170.606	−90307.008	2946179.992				
PI 3		−90203.098	2946230.080	2000	0°00'51"	0.247	0.493
EC 3	1171.100	−90343.488	2946157.561				
BC 4	1286.205	−90307.008	2946179.992				
PI 4		−90326.397	2946170.646	210	11°42'16"	21.524	42.899
EC 4	1329.104	−90343.488	2946157.561				
BC 5	1508.720	−90486.101	2946048.367				
PI 5		−90497.938	2946039.304	90	18°48'36"	14.908	29.547
EC 5	1538.267	−90506.220	2946026.909				
PI 6	1764.858	−90632.107	2945838.506				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 7	0.000	−89884.131	2946925.932	STREET 2			
BC 8	73.344	−89840.728	2946866.809				
PI 8		−89830.553	2946852.948	160	12°16'05"	17.195	34.259
EC 8	107.603	−89817.664	2946841.566				
BC 9	390.429	−89605.674	2946654.347				
PI 9		−89592.592	2946642.794	90	21°56'58"	17.453	34.478
EC 9	424.907	−89576.140	2946636.968				
PI 10	824.317	−89199.639	2946503.644				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 11	0.000	−90439.347	2946499.844	STREET 3			
BC 12	313.104	−90249.003	2946251.241				
PI 12		−90220.401	2946213.884	500	10°45'05"	47.050	93.823
EC 12	406.928	−90199.269	2946171.846				
BC 13	850.980	−89999.829	2945775.102				
PI 13		−89993.886	2945763.280	90	16°43'39"	13.232	26.276
EC 13	877.255	−89984.792	2945753.668				
BC 14	929.741	−89948.719	2945715.544				
PI 14		−89935.617	2945701.696	160	13°35'21"	19.064	37.948
EC 14	967.689	−89919.628	2945691.315				
PI 15	1066.801	−89836.501	2945637.342				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 16	0.000	−89402.417	2946769.797	STREET 4			
BC 17	231.870	−89576.691	2946922.744				
PI 17		−89585.738	2946930.684	12	90°10'42"	12.037	18.887
EC 17	250.757	−89593.650	2946921.612				
BC 18	497.618	−89755.906	2946735.565				
PI 18		−89772.091	2946717.007	205	13°41'56"	24.624	49.013
EC 18	546.632	−89792.210	2946702.810				
PI 19	784.426	−89986.503	2946565.708				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 20	0.000	−89992.793	2946762.809	STREET 5			
BC 21	319.775	−89808.425	2946501.534				
PI 21		−89800.770	2946490.686	160	9°29'14"	13.277	26.493
EC 21	346.269	−89795.008	2946478.724				
PI 22	393.167	−89774.654	2946436.473				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 23	0.000	−89960.782	2946717.444	STREET 6			
PI 24	395.557	−90279.853	2946483.653				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 55	0.000	−89481.343	2947054.189	STREET 16			
PI 56	106.373	−89551.260	2946974.021				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 57	0.000	−89521.069	2947089.273	STREET 17			
PI 58	270.295	−89698.728	2946885.566				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 59	0.000	−89710.510	2947033.335	STREET 18			
PI 60	53.212	−89670.626	2946998.111				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 61	0.000	−89622.101	2946888.989	STREET 19			
PI 62	243.819	−89439.348	2946727.592				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 63	0.000	−89738.524	2946920.273	STREET 20			
BC 64	93.794	−89667.837	2946858.625				
PI 64		−89667.452	2946858.289	200	0°17'34"	0.511	1.022
EC 64	94.816	−89667.068	2946857.951				
BC 65	122.234	−89646.497	2946839.824				
PI 65		−89646.413	2946839.751	200	0°03'50"	0.111	0.223
EC 65	122.457	−89646.330	2946839.677				
BC 66	208.097	−89582.139	2946782.987				
PI 66		−89573.145	2946775.044	12	90°00'00"	12.000	18.850
EC 66	226.946	−89581.088	2946766.049				
BC 67	255.946	−89600.285	2946744.312				
PI 67		−89608.228	2946735.318	12	90°00'00"	12.000	18.850
EC 67	274.796	−89617.223	2946743.261				
PI 68	374.258	−89691.774	2946809.101				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 69	0.000	−89948.018	2946795.619	STREET 21			
BC 70	264.972	−89795.247	2946579.121				
PI 70		−89788.330	2946569.318	12	89°59'33"	11.998	18.848
EC 70	283.820	−89778.525	2946576.234				
BC 71	385.773	−89695.216	2946635.005				
PI 71		−89682.811	2946643.756	12	103°20'59"	15.181	21.646
EC 71	407.419	−89694.190	2946653.805				
BC 72	639.371	−89868.048	2946807.347				
PI 72		−89874.516	2946813.059	80	12°18'44"	8.629	17.191
EC 72	656.562	−89879.616	2946820.019				
BC 73	718.312	−89916.120	2946869.824				
PI 73		−89923.214	2946879.503	12	90°00'00"	12.000	18.850
EC 73	737.162	−89932.892	2946872.409				
BC 74	1236.800	−90335.882	2946577.049				
PI 74		−90345.635	2946569.900	12	90°26'29"	12.093	18.942
EC 74	1255.741	−90338.412	2946560.202				
BC 75	1324.881	−90297.111	2946504.753				
PI 75		−90289.213	2946494.149	300	5°02'50"	13.222	26.427
EC 75	1351.309	−90280.413	2946484.281				
BC 76	1353.095	−90279.223	2946482.947				
PI 76		−90270.413	2946473.068	300	5°03'10"	13.237	26.456
EC 76	1379.552	−90262.507	2946462.452				
PI 77	1619.045	−90119.466	2946270.368				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 106	0.000	−89951.064	2946225.377	STREET 34			
BC 107	63.248	−89919.511	2946170.562				
PI 107		−89913.524	2946160.162	12	90°00'00"	12.000	18.850
EC 107	82.097	−89923.924	2946154.175				
PI 108	128.097	−89963.791	2946131.227				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 109	0.000	−89903.050	2946259.258	STREET 35			
BC 110	136.005	−90014.174	2946180.843				
PI 110		−90019.617	2946177.003	90	8°27'54"	6.661	13.297
EC 110	149.302	−90025.565	2946174.006				
PI 111	422.471	−90269.512	2946051.081				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 112	0.000	−90335.303	2945787.408	STREET 36			
BC 113	75.062	−90376.935	2945724.949				
PI 113		−90383.590	2945714.964	12	90°00'00"	12.000	18.850
EC 113	93.911	−90373.605	2945708.309				
BC 114	213.861	−90273.795	2945641.781				
PI 114		−90267.595	2945637.649	12	63°40'19"	7.451	13.335
EC 114	227.197	−90261.142	2945641.372				
BC 115	392.696	−90117.796	2945724.089				
PI 115		−90107.984	2945729.751	12	86°42'05"	11.328	18.159
EC 115	410.855	−90113.072	2945739.872				
BC 116	836.532	−90304.258	2946120.200				
PI 116		−90308.064	2946127.772	90	10°45'32"	8.475	16.900
EC 116	853.432	−90313.217	2946134.500				
BC 117	865.388	−90320.487	2946143.992				
PI 117		−90324.899	2946149.754	205	4°03'18"	7.257	14.508
EC 117	879.896	−90328.894	2946155.813				
BC 118	900.797	−90340.396	2946173.263				
PI 118		−90344.357	2946179.272	205	4°01'17"	7.197	14.388
EC 118	915.184	−90348.730	2946184.988				
BC 119	1093.609	−90457.133	2946326.706				
PI 119		−90461.922	2946332.966	160	5°38'25"	7.882	15.751
EC 119	1109.360	−90466.072	2946339.667				
BC 120	1122.032	−90472.745	2946350.440				
PI 120		−90476.693	2946356.815	160	5°22'00"	7.499	14.987
EC 120	1137.018	−90481.221	2946362.793				
BC 121	1212.110	−90526.558	2946422.653				
PI 121		−90533.690	2946432.070	12	89°05'56"	11.813	18.661
EC 121	1230.771	−90543.218	2946425.087				
BC 122	1279.457	−90582.486	2946396.306				
PI 122		−90586.785	2946393.155	90	6°46'42"	5.330	10.647
EC 122	1290.104	−90590.682	2946389.519				
BC 123	1460.178	−90715.032	2946273.493				
PI 123		−90722.440	2946266.581	160	7°14'48"	10.132	20.237
EC 123	1480.415	−90728.917	2946258.789				
BC 124	1660.060	−90843.757	2946120.643				
PI 124		−90846.619	2946117.201	30	16°58'33"	4.477	8.889
EC 124	1668.948	−90848.351	2946113.072				
BC 125	1733.900	−90873.479	2946053.178				
PI 125		−90877.312	2946044.044	12	79°04'35"	9.905	16.562
EC 125	1750.462	−90869.069	2946038.550				
BC 126	1918.190	−90729.501	2945945.526				
PI 126		−90719.516	2945938.870	12	90°00'00"	12.000	18.850
EC 126	1937.040	−90712.861	2945948.856				
BC 127	2034.537	−90658.787	2946029.984				
PI 127		−90652.968	2946038.715	90	13°17'57"	10.492	20.890
EC 127	2055.427	−90645.297	2946045.873				
BC 128	2091.078	−90619.231	2946070.194				
PI 128		−90610.457	2946078.380	12	90°00'00"	12.000	18.850
EC 128	2109.928	−90618.643	2946087.154				
PI 129	2196.639	−90677.799	2946150.554				

ROADS SETTING OUT DATA

NO.	DATE	AMENDMENT	APPROVED
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B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS

P.O. BOX 4049
RANDBURG-2125
FIRST FLOOR 24 PETER PLACE
LYME PARK BRYANSTON 2191
TEL (011)326-0744/ 90

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CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
ROADS SETTING OUT DATA
SHEET 1 OF 3

REF. NO. –	DESIGNER R. MABOHO
SCALE 1:1000	DRAWING F. MAZIBUKO
DATE 03/2021	CHECKED S. MNGUNI
TYPE NUMBER	

DRAWING NUMBER
7001/RW/A001

A1
100mm ON ORIGINAL DRAWING

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 25	0.000	−90135.850	2946589.167	STREET 7			
BC 26	470.175	−89864.768	2946205.007				
PI 26		−89855.540	2946191.929	350	5°14'12"	16.006	31.990
EC 26	502.164	−89847.544	2946178.064				
PI 27	785.925	−89705.784	2945932.250				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 28	0.000	−90240.165	2946432.449	STREET 8			
PI 29	236.587	−90429.355	2946290.390				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 30	0.000	−89821.057	2946132.135	STREET 9			
BC 31	171.160	−89970.246	2946048.240				
PI 31		−89980.375	2946042.545	500	2°39'45"	11.620	23.235
EC 31	194.396	−89990.756	2946037.326				
BC 32	593.001	−90346.896	2945858.298				
PI 32		−90358.710	2945852.359	50	29°37'36"	13.223	25.854
EC 32	618.855	−90366.044	2945841.356				
PI 33	769.284	−90449.476	2945716.184				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 34	0.000	−90715.863	2946272.717	STREET 10			
BC 35	204.590	−90576.427	2946123.002				
PI 35		−90566.679	2946112.535	300	5°27'34"	14.303	28.585
EC 35	233.175	−90557.971	2946101.188				
BC 36	303.356	−90515.243	2946045.514				
PI 36		−90506.826	2946034.546	300	5°16'37"	13.825	27.630
EC 36	330.986	−90497.436	2946024.399				
PI 37	555.816	−90344.730	2945859.386				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 38	0.000	−90469.245	2946344.789	STREET 11			
BC 39	42.033	−90503.145	2946319.938				
PI 39		−90517.463	2946309.442	300	6°46'24"	17.753	35.465
EC 39	77.498	−90530.443	2946297.331				
BC 40	219.003	−90633.905	2946200.794				
PI 40		−90643.397	2946191.938	205	7°14'48"	12.982	25.929
EC 40	244.932	−90651.695	2946181.955				
BC 41	389.710	−90744.246	2946070.621				
PI 41		−90752.832	2946060.293	90	16°58'33"	13.431	26.666
EC 41	416.376	−90758.028	2946047.908				
PI 42	487.027	−90785.362	2945982.758				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 43	0.000	−89296.449	2946890.901	STREET 12			
BC 44	340.379	−89551.578	2947116.217				
PI 44		−89560.628	2947124.209	12	90°21'02"	12.074	18.923
EC 44	359.302	−89568.565	2947115.111				
BC 45	669.491	−89772.470	2946881.359				
PI 45		−89780.406	2946872.261	12	90°21'02"	12.074	18.923
EC 45	688.414	−89789.456	2946880.253				
BC 46	717.620	−89811.347	2946899.586				
PI 46		−89820.286	2946907.480	12	89°38'50"	11.926	18.776
EC 46	736.395	−89812.447	2946916.468				
BC 47	956.747	−89667.603	2947082.526				
PI 47		−89659.667	2947091.625	12	90°21'10"	12.074	18.923
EC 47	975.670	−89650.617	2947083.632				
PI 48	1016.811	−89619.780	2947056.399				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 78	0.000	−89809.201	2946690.821	STREET 22			
PI 79	111.315	−89745.022	2946599.869				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 80	0.000	−89891.882	2946836.754	STREET 23			
PI 81	523.323	−90314.004	2946527.433				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 82	0.000	−90005.557	2946684.636	STREET 24			
BC 83	207.454	−89885.948	2946515.134				
PI 83		−89879.030	2946505.329	12	90°00'00"	12.000	18.850
EC 83	226.304	−89888.834	2946498.411				
PI 84	375.804	−90010.985	2946412.216				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 85	0.000	−90048.316	2946653.306	STREET 25			
PI 86	218.508	−89922.334	2946474.772				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 87	0.000	−90053.293	2946568.434	STREET 26			
PI 88	152.033	−89965.638	2946444.215				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 89	0.000	−90010.538	2946599.770	STREET 27			
BC 90	154.740	−90135.346	2946508.296				
PI 90		−90145.099	2946501.148	12	90°26'09"	12.092	18.941
EC 90	173.681	−90137.877	2946491.450				
PI 91	265.544	−90083.010	2946417.771				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 92	0.000	−90155.260	2946709.430	STREET 28			
PI 93	108.481	−90091.132	2946621.933				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 94	0.000	−90230.535	2946519.789	STREET 29			
PI 95	169.934	−90129.039	2946383.495				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 130	0.000	−90153.964	2945703.218	STREET 37			
BC 131	239.151	−90261.376	2945916.892				
PI 131		−90261.402	2945916.944	200	0°02'01"	0.059	0.117
EC 131	239.269	−90261.428	2945916.996				
BC 132	329.065	−90301.807	2945997.202				
PI 132		−90307.415	2946008.342	12	92°12'30"	12.472	19.312
EC 132	348.377	−90318.330	2946002.309				
BC 133	459.932	−90415.964	2945948.345				
PI 133		−90428.727	2945941.291	60	27°19'12"	14.582	28.609
EC 133	488.542	−90436.828	2945929.166				
BC 134	625.236	−90512.771	2945815.509				
PI 134		−90519.446	2945805.520	12	90°03'57"	12.014	18.863
EC 134	644.100	−90509.449	2945798.857				
BC 135	672.356	−90485.937	2945783.186				
PI 135		−90475.952	2945776.530	12	89°59'56"	12.000	18.849
EC 135	691.205	−90469.296	2945786.515				
PI 136	766.265	−90427.666	2945848.972				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 137	0.000	−90302.468	2945880.631	STREET 38			
PI 138	228.265	−90199.946	2945676.685				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 139	0.000	−90471.078	2945877.908	STREET 39			
BC 140	196.035	−90307.958	2945769.181				
PI 140		−90304.657	2945766.981	15	29°37'36"	3.967	7.756
EC 140	203.791	−90302.875	2945763.437				
PI 141	330.584	−90245.928	2945650.152				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 142	0.000	−90501.618	2946389.724	STREET 40			
BC 143	57.757	−90548.285	2946355.694				
PI 143		−90552.680	2946352.490	90	6°55'00"	5.439	10.865
EC 143	68.621	−90556.657	2946348.779				
BC 144	229.574	−90674.338	2946238.975				
PI 144		−90683.829	2946230.119	205	7°14'48"	12.982	25.929
EC 144	255.502	−90692.128	2946220.136				
BC 145	421.032	−90797.944	2946092.845				
PI 145		−90800.806	2946089.402	30	16°58'33"	4.477	8.889
EC 145	429.921	−90802.538	2946085.274				
PI 146	507.098	−90832.396	2946014.107				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 147	0.000	−90514.990	2946310.792	STREET 41			
BC 148	104.696	−90451.331	2946227.672				
PI 148		−90444.128	2946218.266	12	89°15'53"	11.847	18.696
EC 148	123.392	−90453.440	2946210.943				
BC 149	206.938	−90519.112	2946159.298				
PI 149		−90527.781	2946152.480	12	85°10'12"	11.029	17.838
EC 149	224.776	−90535.304	2946160.544				
PI 150	321.472	−90601.265	2946231.249				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 151	0.000	−90562.521	2946267.400	STRET 42			
PI 152	112.207	−90485.972	2946185.359				

ROADS SETTING OUT DATA

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
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CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS

P.O. BOX 4049
RANDBURG-2125
FIRST FLOOR 24 PETER PLACE
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PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
ROADS SETTING OUT DATA
SHEET 2 OF 3

REF. NO. –
SCALE 1:1000
DATE 03/2021
TYPE NUMBER

DESIGNER R. MABOHO
DRAWING F. MAZIBUKO
CHECKED S. MNGUNI

DRAWING NUMBER
7001/RW/A002

A1
100mm ON ORIGINAL DRAWING

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 49	0.000	−89441.616	2947019.105	STREET 13			
PI 50	161.523	−89547.782	2946897.373				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 51	0.000	−89476.481	2946979.128	STREET 14			
PI 52	193.585	−89330.585	2946851.889				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 53	0.000	−89591.203	2947008.856	STREET 15			
PI 54	299.498	−89365.487	2946812.003				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 96	0.000	−90038.365	2946451.018	STREET 30			
PI 97	172.943	−90177.072	2946347.725				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 98	0.000	−89752.446	2946013.162	STREET 31			
PI 99	66.266	−89809.829	2945980.021				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 100	0.000	−89878.724	2946099.707	STREET 32			
BC 101	193.214	−89782.333	2945932.254				
PI 101		−89776.369	2945921.893	12	89°47'01"	11.955	18.804
EC 101	212.018	−89786.707	2945915.890				
BC 102	327.154	−89886.274	2945858.075				
PI 102		−89897.297	2945851.674	12	93°27'15"	12.746	19.573
EC 102	346.727	−89903.022	2945863.063				
PI 103	679.552	−90052.506	2946160.430				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 104	0.000	−89998.656	2946191.794	STREET 33			
PI 105	345.029	−89826.527	2945892.768				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 153	0.000	−90726.829	2946091.573	STREET 43			
PI 154	91.369	−90656.567	2946033.165				

ROAD SETTING OUT DATA — WG27

PI No.	CH	YLo	XLo	Radius	DA	TL	AL
Const:				(m)	D M S	(m)	(m)
PI 155	0.000	−90763.494	2946034.880	STREET 44			
PI 156	89.843	−90688.735	2945985.052				

ROADS SETTING OUT DATA

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UNITAS PARK EXT.16

WCS NO.

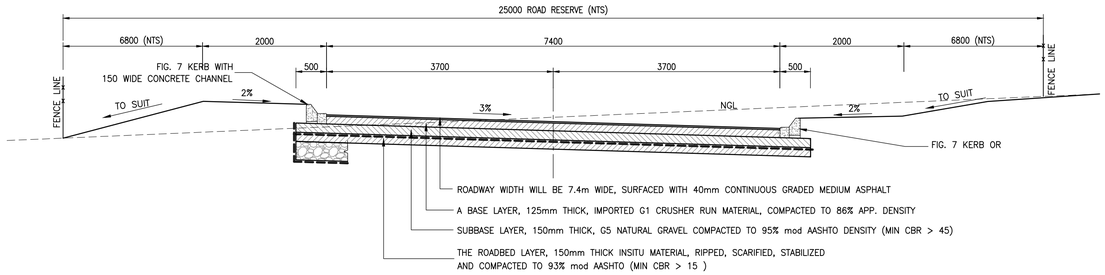
DRAWING TITLE
ROADS SETTING OUT DATA
SHEET 3 OF 3

REF. NO. —	DESIGNER R. MABOHO
SCALE 1:1000	DRAWING F. MAZIBUKO
DATE 03/2021	CHECKED S. MNGUNI

TYPE NUMBER

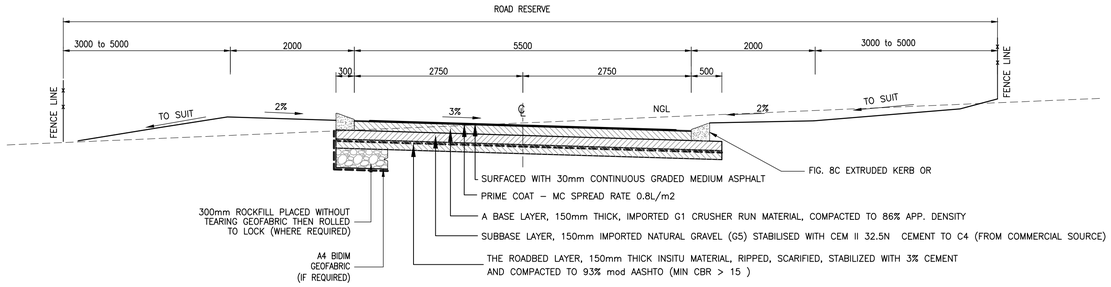
DRAWING NUMBER
7001/RW/A003

A1
100mm ON ORIGINAL DRAWING



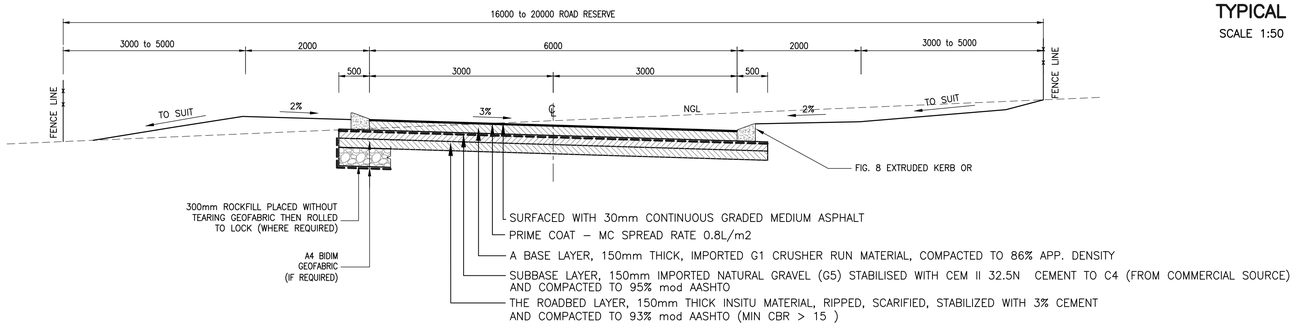
TYPICAL ROAD SECTION – 7.4m ROADS (CLASS 4)

SCALE 1:50



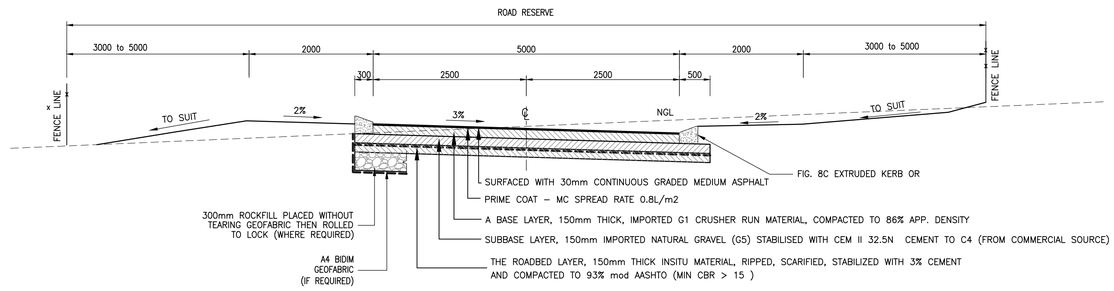
TYPICAL ROAD SECTION – 5.5m ROADS

SCALE 1:50



TYPICAL ROAD SECTION – 6.0m ROADS (CLASS 5a)

SCALE 1:50



TYPICAL ROAD SECTION – 5.0m ROADS

SCALE 1:50

NOTES:

1. DO NOT SCALE, USE FIGURED DIMENSIONS ONLY. ALL DIMENSIONS AND LEVELS TO BE CHECKED AND VERIFIED BEFORE ANY WORK COMMENCES. ANY DISCREPANCY SHALL BE REPORTED TO THE ENGINEER IMMEDIATELY.
2. THE CONTRACTOR SHALL WHERE NECESSARY DETERMINE THE EXACT LOCATION OF EXISTING SERVICES AND PROTECT THEM FROM DAMAGE THROUGHOUT THE DURATION OF THE WORKS.
3. ALL LEVELS GIVEN IN METRES ABOVE SEA LEVEL.

NO.	DATE	AMENDMENT	APPROVED
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CLIENT:

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REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

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CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

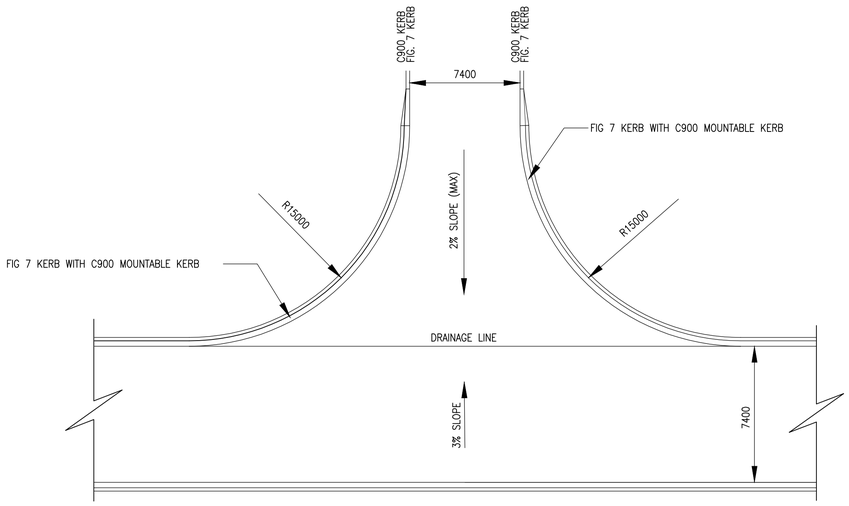
DRAWING TITLE
ROAD TYPICAL SECTION

REF. NO. | DESIGNER
SCALE | DRAWING
DATE | CHECKED

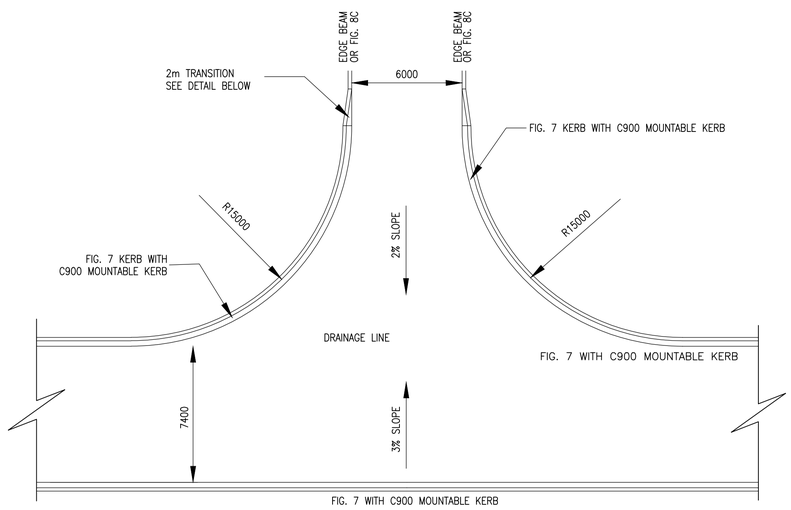
TYPE NUMBER

DRAWING NUMBER
7001/RW/D001

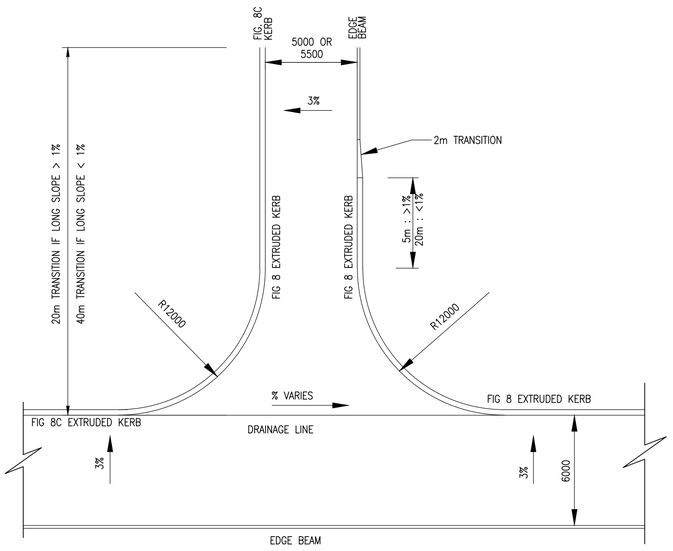
A1
100mm ON ORIGINAL DRAWING



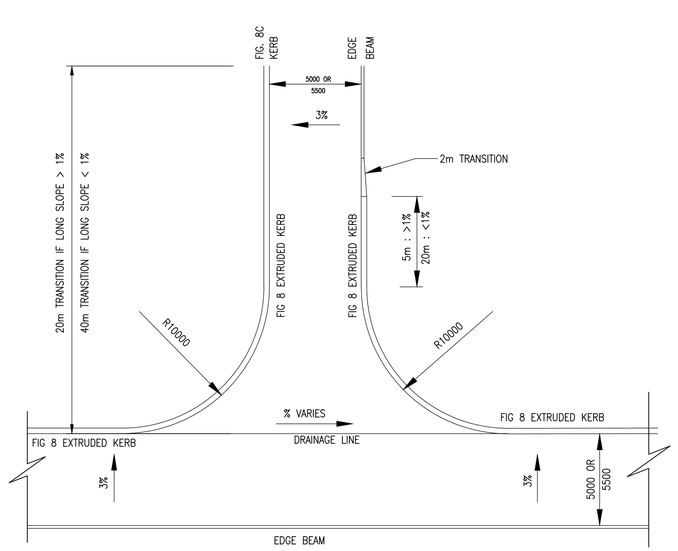
DETAIL OF TYPICAL INTERSECTION 7.4m WIDE ROAD
SCALE 1:100



DETAIL OF TYPICAL INTERSECTION 7.4m to 6m WIDE ROAD
SCALE 1:100



DETAIL OF TRANSITION AT AN INTERSECTION 6m TO 5.5m OR 5m WIDE ROAD
SCALE 1:100



DETAIL OF TRANSITION AT AN INTERSECTION 5.5m TO 5.5m OR 5m WIDE ROAD
SCALE 1:100

NOTES:

1. DO NOT SCALE, USE FIGURED DIMENSIONS ONLY. ALL DIMENSIONS AND LEVELS TO BE CHECKED AND VERIFIED BEFORE ANY WORK COMMENCES. ANY DISCREPANCY SHALL BE REPORTED TO THE ENGINEER IMMEDIATELY.
2. THE CONTRACTOR SHALL WHERE NECESSARY DETERMINE THE EXACT LOCATION OF EXISTING SERVICES AND PROTECT THEM FROM DAMAGE THROUGHOUT THE DURATION OF THE WORKS.
3. ALL LEVELS GIVEN IN METRES ABOVE SEA LEVEL.

NO.	DATE	AMENDMENT	APPROVED
A	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS

P.O. BOX 4049
RANDBURG-2125
FIRST FLOOR 24 PETER PLACE
LYME PARK BRYANSTON 2191
TEL (011)326-0741/90

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DISCIPLINE
CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT. 16

WCS NO.

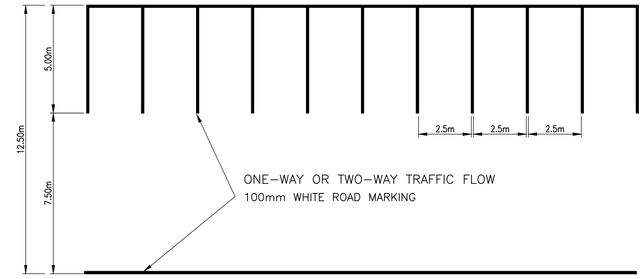
DRAWING TITLE
ROAD INTERSECTION STANDARD DETAILS

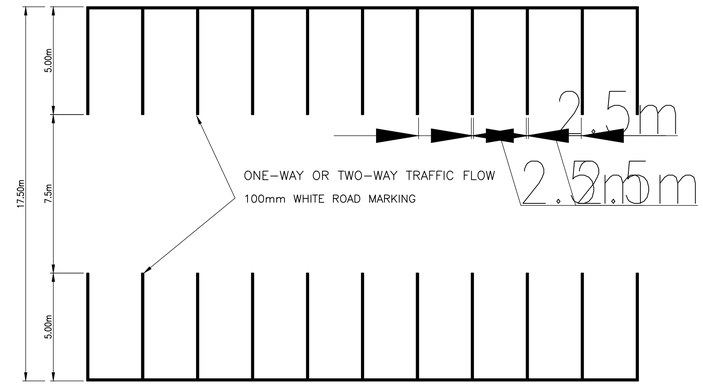
REF. NO. | DESIGNER
SCALE | DRAWING
DATE | CHECKED

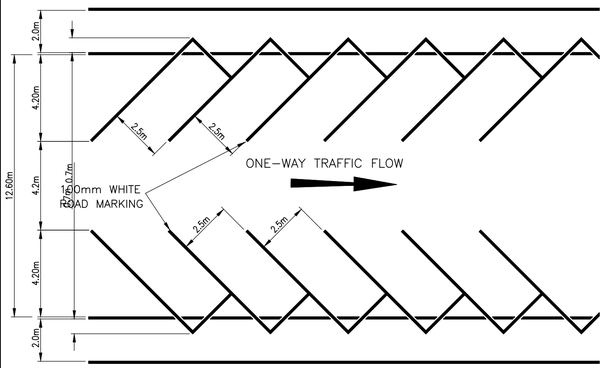
TYPE NUMBER

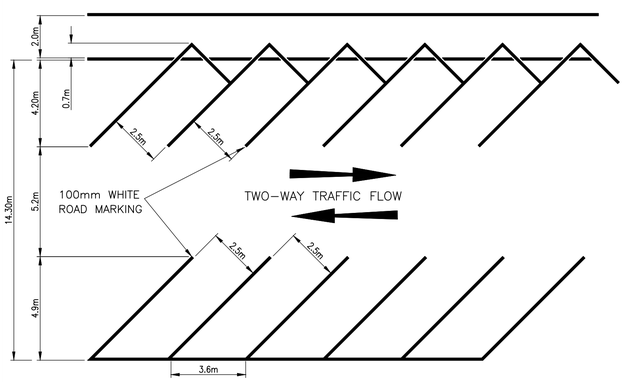
DRAWING NUMBER
7001/RW/D002

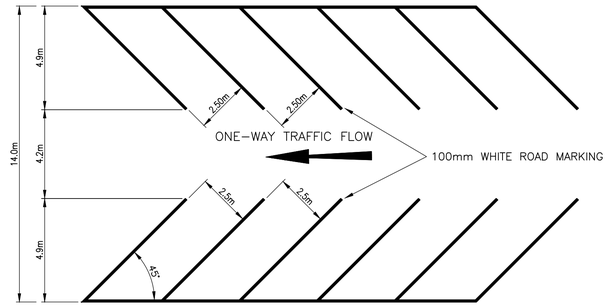
A1
100mm ON ORIGINAL DRAWING

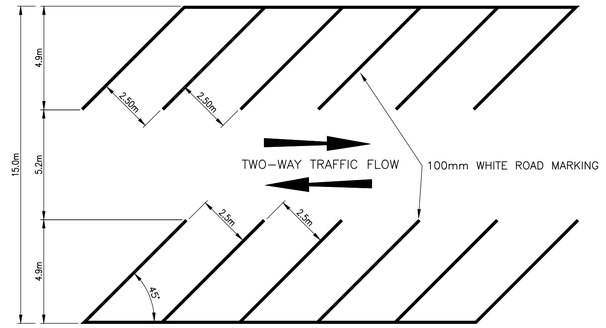


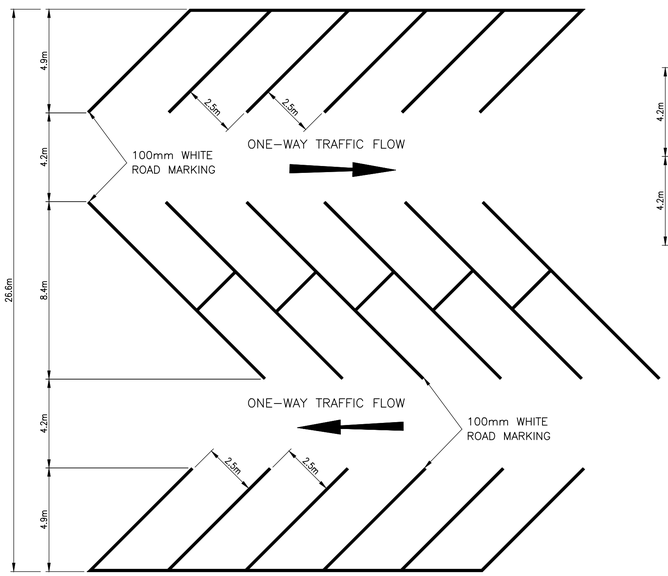


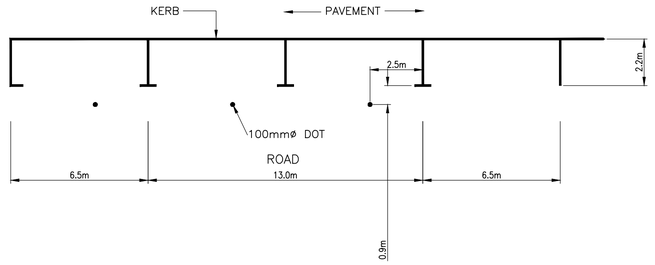


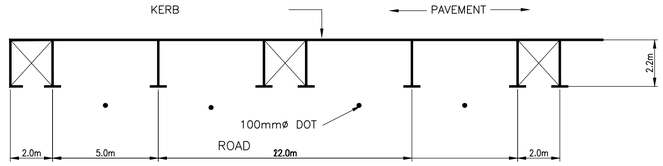


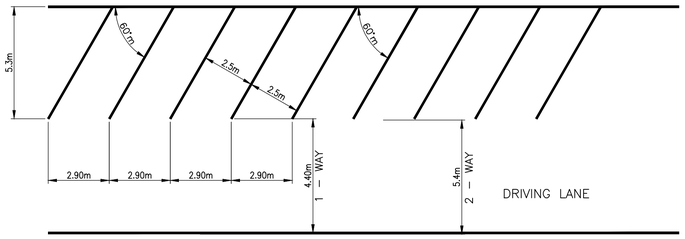


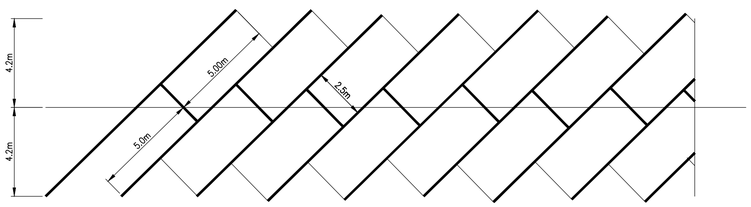


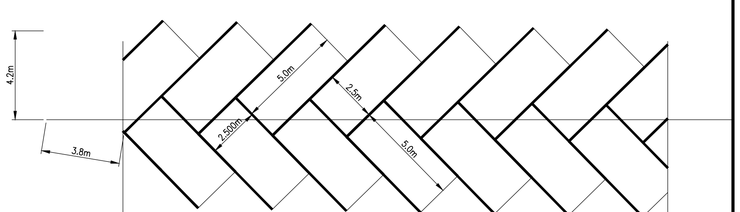












NOTES:

1. DO NOT SCALE, USE FIGURED DIMENSIONS ONLY. ALL DIMENSIONS AND LEVELS TO BE CHECKED AND VERIFIED BEFORE ANY WORK COMMENCES. ANY DISCREPANCY SHALL BE REPORTED TO THE ENGINEER IMMEDIATELY.
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3. ALL LEVELS GIVEN IN METRES ABOVE SEA LEVEL.

NO.	DATE	AMENDMENT	APPROVED
A	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS

P.O. BOX 4049
RANDBURG-2125
FIRST FLOOR 24 PETER PLACE
LYME PARK BRYANSTON 2191
TEL (011)326-0741/90

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DISCIPLINE
CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

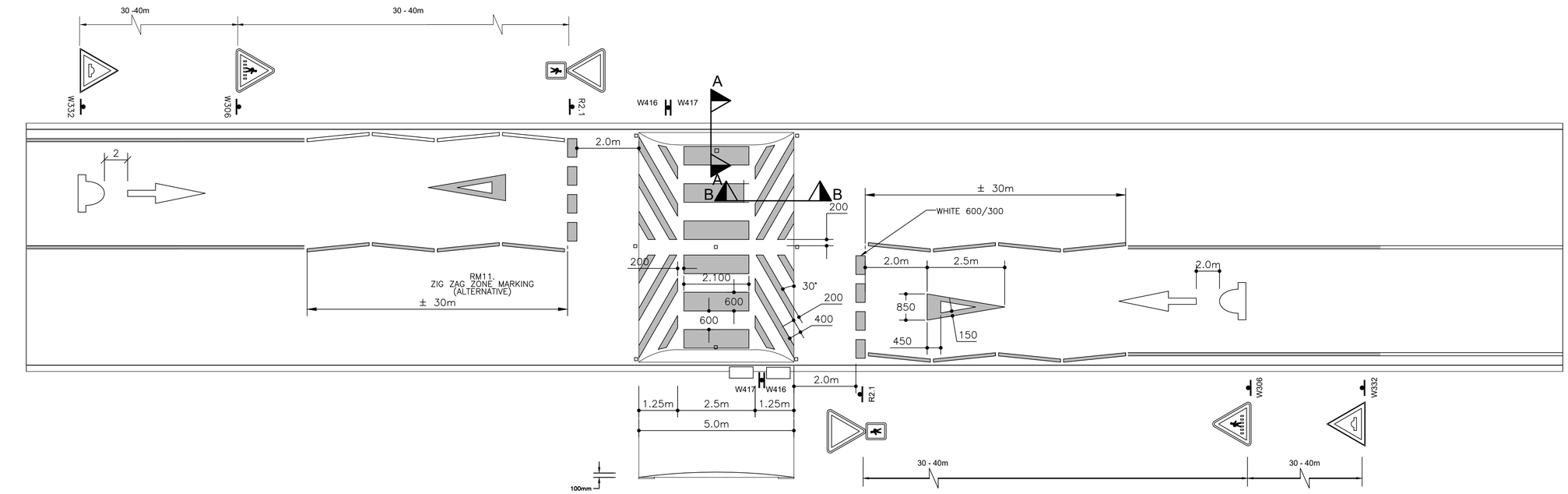
WCS NO.

DRAWING TITLE
STANDARD DETAILS
TYPICAL LAYOUT OF PARKING BAYS

REF. NO. | DESIGNER
SCALE | DRAWING
DATE | CHECKED
TYPE NUMBER

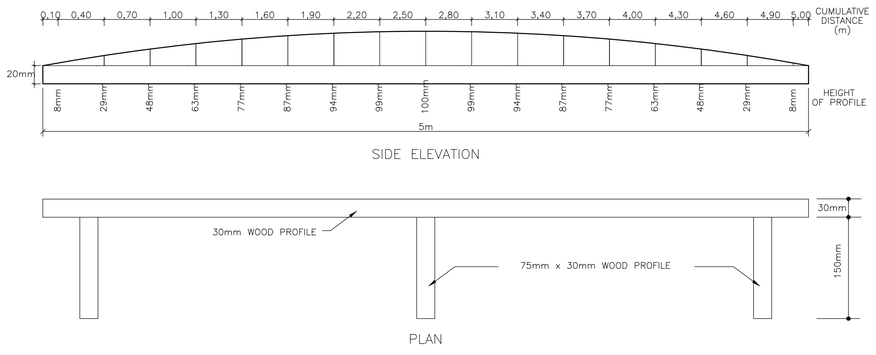
DRAWING NUMBER
STD020

A1
100mm ON ORIGINAL DRAWING



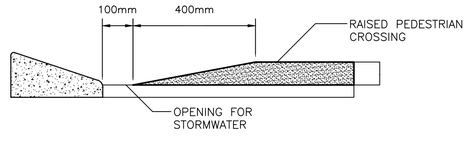
PLAN OF SPEED HUMP

SCALE 1:100



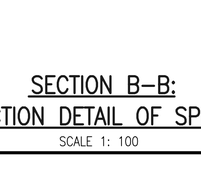
SIDE ELEVATION

PLAN



SECTION A–A:
CONSTRUCTION DETAIL OF SPEED HUMP

SCALE 1: 100

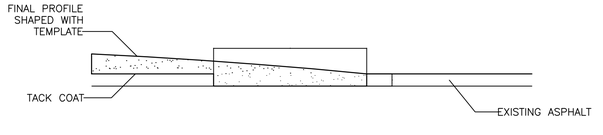


DIMENSIONS (mm)

OPERATINGG SPEED Km/h	TYPICAL APPLICATIONS	a	a*	b	c	c*	d	e	f	g
30 – 40	CITY CENTRE	1250	2000	1250	450	400	50	750	500	250
50 – 60	URBAN	2500	4000	1250	900	800	100	1500	500	250

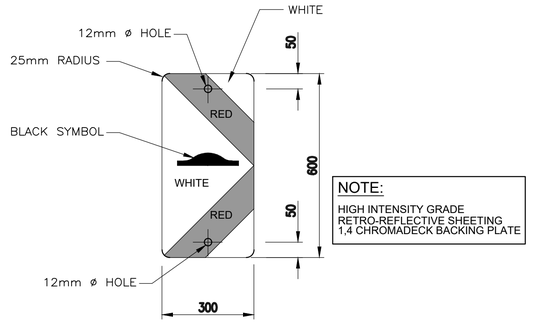
DETAIL OF SPEED HUMP ROAD MARKING

SCALE 1: 20



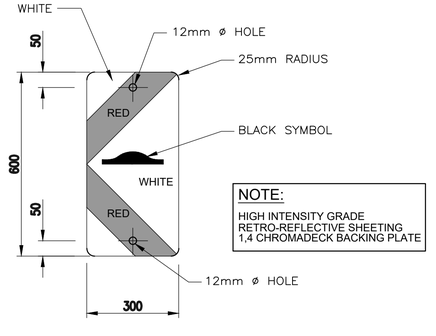
SECTION B–B:
CONSTRUCTION DETAIL OF SPEED HUMP

SCALE 1: 100



DANGER PLATE SPEEDHUMP (LEFT)
W416

SCALE 1:10



DANGER PLATE SPEEDHUMP (RIGHT)
W417

SCALE 1:10

NOTES:

CONSTRUCTION METHOD:

1. SETTING OUT OF HUMP – FEW DAYS BEFORE CONSTRUCTION.
2. SAW CUTS ONE TO TWO DAYS BEFORE CONSTRUCTION.

ON CONSTRUCTION DAY:

3. REMOVE 500 MM ASPHALT STRIPS.
4. START ERECTING ROAD SIGNS AND PAINT WARNING ROAD MARKING.
5. PLACE ASPHALT IN STRIPS AND COMPACT WITH TWO PASSES WITHOUT VIBRATOR.
6. PLACE TEMPLATES – BOTH SIDES OF ONE LANE AT A TIME.
7. PLACE ASPHALT AND RAKE TILL SLIGHTLY HIGHER THAN TEMPLATES.
8. SHAPE ASPHALT WITH STRAIGHT EDGE (CHANNEL SECTION 6 M LONG).
9. REMOVE TEMPLATES AND COMPACT WITHOUT VIBRATOR (THREE PASSES)
10. MEASURE PROFILE AND RECTIFY IF NECESSARY.
11. FINAL COMPACTION WITH THREE TO FOUR PASSES WITH VIBRATOR.
12. PLACE ROAD STUDS.
13. PAINT SPEED HUMP THE NEXT DAY.

NOTE:

THE TRAFIC ENGINEERING AND OPERATION SECTION MUST ALWAYS BE CONSULTED TO ASSIST WITH THE SETTING OUT OF SPEED HUMPS.

NO.	DATE	AMENDMENT	APPROVED
A	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF
CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS
P.O. BOX 4049
RANDBURG-2125
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LYME PARK BRYANSTON 2191
TEL (011)326-0741/90

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DISCIPLINE
CIVIL ENGINEERING

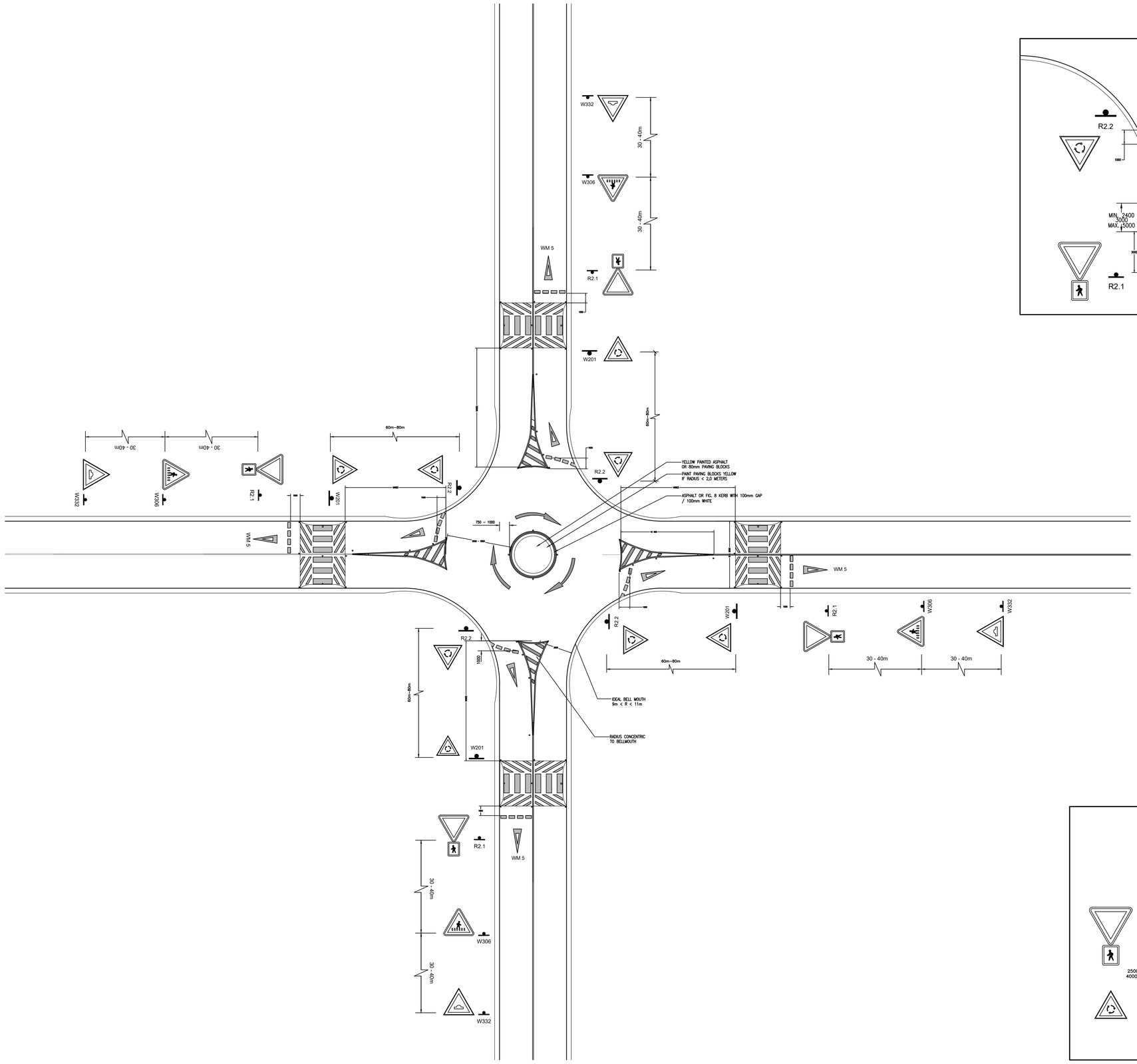
PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
TRAFFIC CALMING MEASURES
TYPICAL SPEED HUMP AND ROADMARKINGS DETAILS

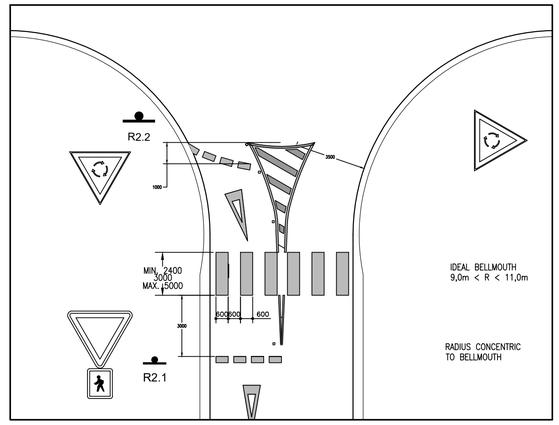
REF. NO. | DESIGNER
SCALE | DRAWING
DATE | CHECKED
TYPE NUMBER
DRAWING NUMBER
STD016 (SHEET 2 OF 7)

A1
100mm ON ORIGINAL DRAWING

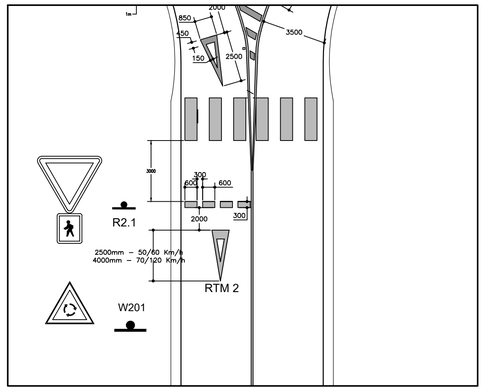


TYPICAL LAYOUT OF 4-LEGGED MINI-CIRCLE WITH RAISED PEDESTRIAN CROSSING

SCALE 1: 250



RTM 4 DETAIL



RTM 2 DETAIL

NOTES:

PAINTED PEDESTRIAN CROSSINGS ONLY AT 4-WAY INTERSECTIONS WHEN SPECIFIED.THIS IS A TYPICAL LAYOUT OF A MINI-CIRCLE WITH A RAISED PEDESTRIAN CROSSING AT A GENERIC INTERSECTION.
THE TRAFFIC ENGINEERING AND OPERATION SECTION MUST ALWAYS BE CONSULTED TO ASSIST WITH THE SETTING OUT OF TRAFFIC CALMING MEASURES.

WM 5 - 50 / 60Km/h - 2500mm
70 /120 Km/h -4000mm

NO.	DATE	AMENDMENT	APPROVED
A	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

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DISCIPLINE
CIVIL ENGINEERING

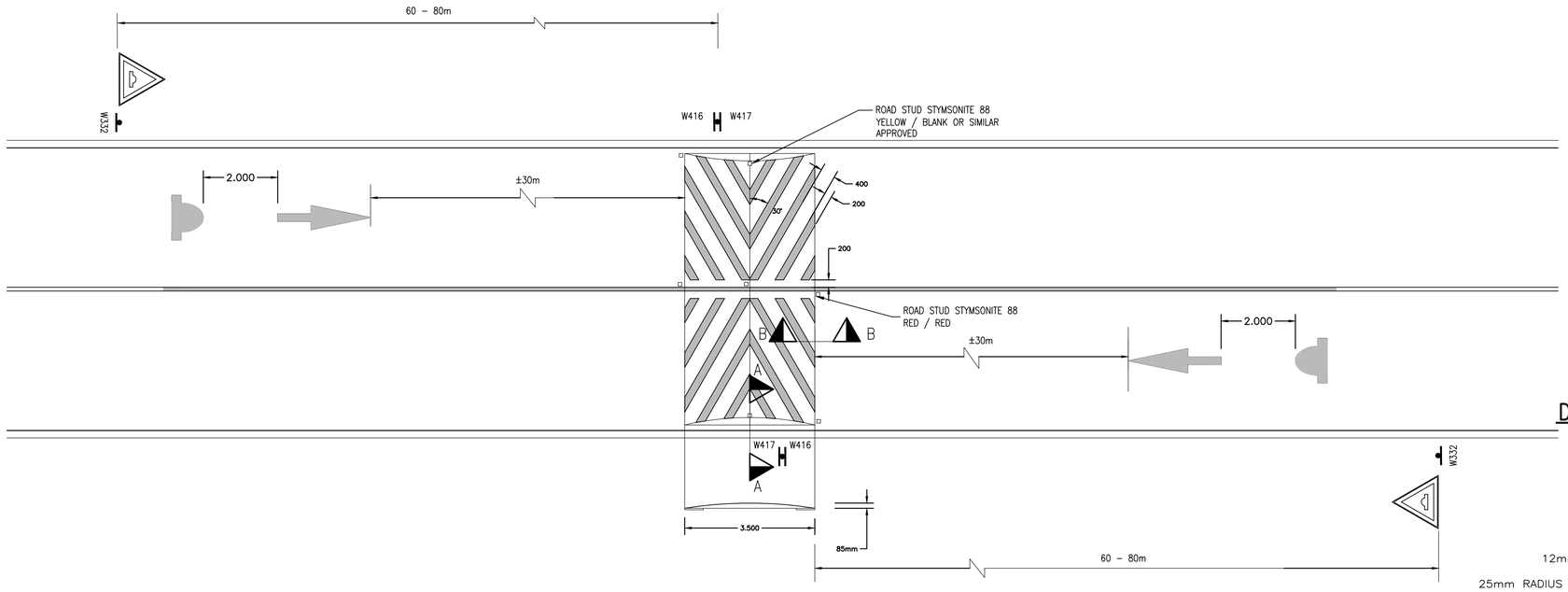
PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
TRAFFIC CALMING MEASURES
MINI-CIRCLE DETAILS (4)

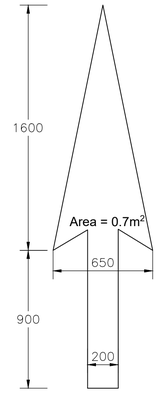
REF. NO. | DESIGNER
SCALE | DRAWING
DATE | CHECKED
TYPE NUMBER
DRAWING NUMBER
STD016 (SHEET 6 OF 7)

A1
100mm ON ORIGINAL DRAWING



PLAN OF SPEED HUMP

SCALE 1:100



DETAIL OF SPEED HUMP ROAD MARKING

SCALE 1: 20

NOTES:

CONSTRUCTION METHOD:

1. SETTING OUT OF HUMP – FEW DAYS BEFORE CONSTRUCTION.
2. SAW CUTS ONE TO TWO DAYS BEFORE CONSTRUCTION.

ON CONSTRUCTION DAY:

3. REMOVE 500 MM ASPHALT STRIPS.
4. START ERECTING ROAD SIGNS AND PAINT WARNING ROAD MARKING.
5. PLACE ASPHALT IN STRIPS AND COMPACT WITH TWO PASSES WITHOUT VIBRATOR.
6. PLACE TEMPLATES – BOTH SIDES OF ONE LANE AT A TIME.
7. PLACE ASPHALT AND RAKE TILL SLIGHTLY HIGHER THAN TEMPLATES.
8. SHAPE ASPHALT WITH STRAIGHT EDGE (CHANNEL SECTION 6 M LONG).
9. REMOVE TEMPLATES AND COMPACT WITHOUT VIBRATOR (THREE PASSES)
10. MEASURE PROFILE AND RECTIFY IF NECESSARY.
11. FINAL COMPACTION WITH THREE TO FOUR PASSES WITH VIBRATOR.
12. PLACE ROAD STUDS.
13. PAINT SPEED HUMP THE NEXT DAY.

NOTE:

THE TRAFIC ENGINEERING AND OPERATION SECTION MUST ALWAYS BE CONSULTED TO ASSIST WITH THE SETTING OUT OF SPEED HUMPS.

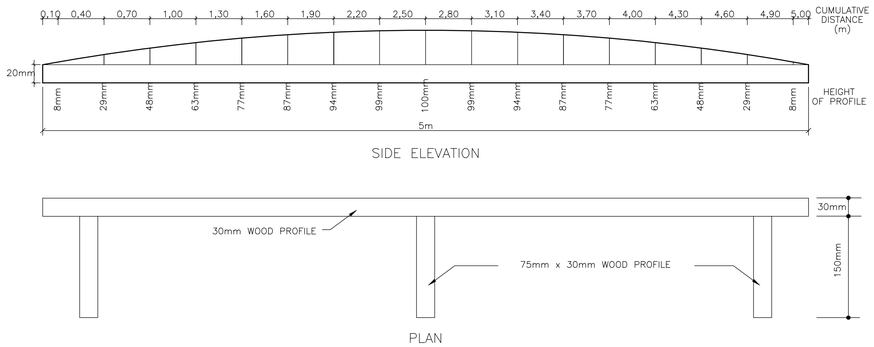
NO.	DATE	AMENDMENT	APPROVED
A	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

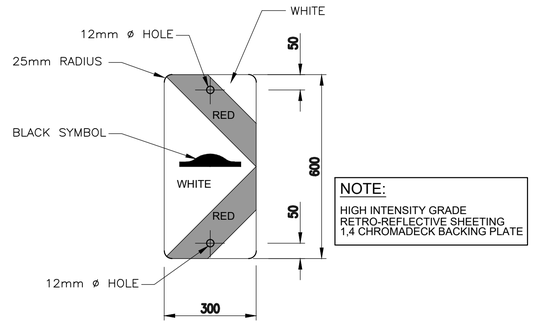
SECTION A–A:
CONSTRUCTION DETAIL OF SPEED HUMP

SCALE 1: 100



TEMPLATE DETAIL FOR CONSTRUCTION OF SPEED HUMP

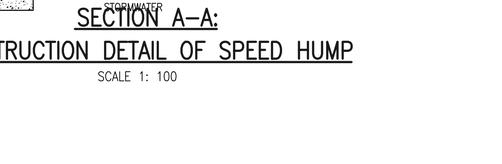
SCALE 1: 20



NOTE:
HIGH INTENSITY GRADE RETRO-REFLECTIVE SHEETING 1,4 CHROMADECK BACKING PLATE

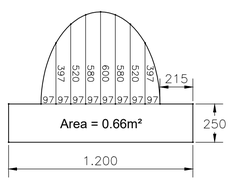
DANGER PLATE SPEEDHUMP (LEFT)
W416

SCALE 1:10



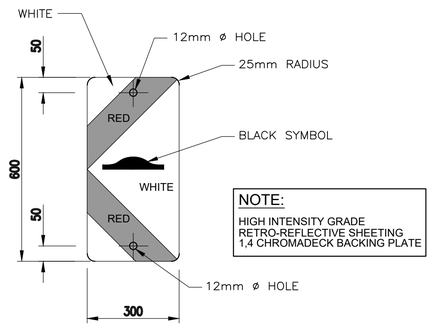
SECTION B–B:
CONSTRUCTION DETAIL OF SPEED HUMP

SCALE 1: 100



DETAIL OF SPEED HUMP ROAD MARKING

SCALE 1: 20



NOTE:
HIGH INTENSITY GRADE RETRO-REFLECTIVE SHEETING 1,4 CHROMADECK BACKING PLATE

DANGER PLATE SPEEDHUMP (RIGHT)
W417

SCALE 1:10

ENGINEER:

PHUMAF

CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS

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RANDBURG 2125
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DISCIPLINE
CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
TRAFFIC CALMING MEASURES
TYPICAL SPEED HUMP AND ROADMARKINGS DETAILS

REF. NO. | DESIGNER
SCALE | DRAWING
DATE | CHECKED
TYPE NUMBER
DRAWING NUMBER
STD016 (SHEET 1 OF 7)

A1
100mm ON ORIGINAL DRAWING

LOCALITY PLAN
NTS

NOTES:

1. DO NOT SCALE, USE FIGURED DIMENSIONS ONLY. ALL DIMENSIONS AND LEVELS TO BE CHECKED AND VERIFIED BEFORE ANY WORK COMMENCES. ANY DISCREPANCY SHALL BE REPORTED TO THE ENGINEER IMMEDIATELY.
2. THE CONTRACTOR SHALL WHERE NECESSARY DETERMINE THE EXACT LOCATION OF EXISTING SERVICES AND PROTECT THEM FROM DAMAGE THROUGHOUT THE DURATION OF THE WORKS.
3. ALL LEVELS GIVEN IN METRES ABOVE SEA LEVEL.
4. ALL DIMENSIONS GIVEN IN MILLIMETRES UNLESS SHOWN OTHERWISE
5. MINIMUM LONG SLOPE = 0.50%
6. MAXIMUM LONG SLOPE SHOULD BE SUCH THAT FLOW VELOCITIES DO NOT EXCEED 3.5 m/s
7. UNLINED SIDE DRAINS ARE ONLY PERMITTED WHERE FLOW VELOCITIES ARE LESS THAN 2.0 m/s FOR MINOR STORMS.(1:2 YEAR RECURRANCE INTERVAL)

LEGEND

- EDGE BEAM
- FIG 7 + C900
- FIG 8B + C900
- CHAINAGE: CH 20
- PI 39 — POINT OF INTERSECTION NUMBER 39
- BC: CH 17.081 — BEGINNING OF CURVE CHAINAGE
- EC: CH 23.110 — END OF CURVE CHAINAGE
- PROPOSED ROADS
- PROPOSED SIDE WALKS
- BM3 — BENCHMARK

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS

P.O. BOX 4049
RANDBURG-2125
FIRST FLOOR 24 PETER PLACE
LYME PARK BRYANSTON 2191
TEL (011)326-0741/90

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DISCIPLINE
CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
ROADS LAYOUT
SHEET 1 OF 5

REF. NO.	–
SCALE	1:1500
DATE	03/2021
TYPE NUMBER	
DRAWING NUMBER	7001/RW/U001
DESIGNER	R. MABOHO
DRAWING	F. MAZIBUKO
CHECKED	S. MNGUNI

A1
100mm ON ORIGINAL DRAWING

UNITAS PARK EXT.16 – P. BENCHMARKS WG–29				DESCRIPTION
BM1B	89603.38	2946872.99	1468.80	12mm Iron Peg in concrete
BM2B	89184.97	2946609.98	1470.33	12mm Iron Peg in concrete
BM3B	89396.12	2946070.32	1477.67	12mm Iron Peg in concrete
BM4B	90214.71	2945629.83	1478.42	12mm Iron Peg in concrete
BM5B	90982.23	2946053.61	1472.43	12mm Iron Peg in concrete
QU7	90424.23	2945692.86	1476.87	12mm Iron Peg in concrete

ROADS LAYOUT
SCALE 1:1500

SEE DWG 7001/RW/U002

SEE DWG 7001/RW/U002

LOCALITY PLAN
NTS

SEE DWG 7001/S/U001

SEE DWG 7001/S/U001

SEE DWG 7001/RW/U003

ROADS LAYOUT
SCALE 1:1500

TRAFFIC CALMING MEASURES MINI-CIRCLE DETAILS (4) STD016 SHEET NO. 6 OF 7

UNITAS PARK EXT.16 – P. BENCHMARKS WG–29				DESCRIPTION
BM1B	89603.38	2946872.99	1468.80	12mm Iron Peg in concrete
BM2B	89184.97	2946609.98	1470.33	12mm Iron Peg in concrete
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4. ALL DIMENSIONS GIVEN IN MILLIMETRES UNLESS SHOWN OTHERWISE
5. MINIMUM LONG SLOPE = 0.50%
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7. UNLINED SIDE DRAINS ARE ONLY PERMITTED WHERE FLOW VELOCITIES ARE LESS THAN 2.0 m/s FOR MINOR STORMS.(1:2 YEAR RECURRANCE INTERVAL)

LEGEND

- EDGE BEAM
- FIG 7 + C900
- FIG 8B + C900
- PI 39 — POINT OF INTERSECTION NUMBER 39
- CH 20 — CHAINAGE
- BC: CH 17.081 — BEGINNING OF CURVE CHAINAGE
- EC: CH 23.110 — END OF CURVE CHAINAGE
- PROPOSED ROADS
- PROPOSED SIDE WALKS
- BM3 — BENCHMARK

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

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PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
ROADS LAYOUT
SHEET 2 OF 5

REF. NO. –
SCALE 1:1500
DATE 03/2021
TYPE NUMBER

DESIGNER R. MABOHO
DRAWING F. MAZIBUKO
CHECKED S. MNGUNI

DRAWING NUMBER
7001/RW/U002

A1
100mm ON ORIGINAL DRAWING

LOCALITY PLAN
NTS

SEE DWG 7001/RW/U002

SEE DWG 7001/RW/U004

ROADS LAYOUT
SCALE 1:1500

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CLIENT:

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HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

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CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
ROADS LAYOUT
SHEET 3 OF 5

REF. NO. –	DESIGNER R. MABOHO
SCALE 1:1500	DRAWING F. MAZIBUKO
DATE 03/2021	CHECKED S. MNGUNI
TYPE NUMBER	

DRAWING NUMBER
7001/RW/U003

A1
100mm ON ORIGINAL DRAWING

LOCALITY PLAN
NTS

SEE DWG 7001/RW/U003

TRAFFIC CALMING MEASURES MINI-CIRCLE DETAILS (4) STD016 SHEET NO. 6 OF 7

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SEE DWG 7001/RW/U003

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ROADS LAYOUT
SCALE 1:1500

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CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
ROADS LAYOUT
SHEET 4 OF 4

REF. NO.	–
SCALE	1:1500
DATE	03/2021
TYPE NUMBER	
DESIGNER	R. MABOHO
DRAWING	F. MAZIBUKO
CHECKED	S. MNGUNI

DRAWING NUMBER
7001/RW/U004

A1
100mm ON ORIGINAL DRAWING

LOCALITY PLAN
NTS

TRAFFIC CALMING MEASURES MINI-CIRCLE DETAILS (4): STD016 SHEET NO. 6 OF 7

SEE DWG 7001/RW/U006

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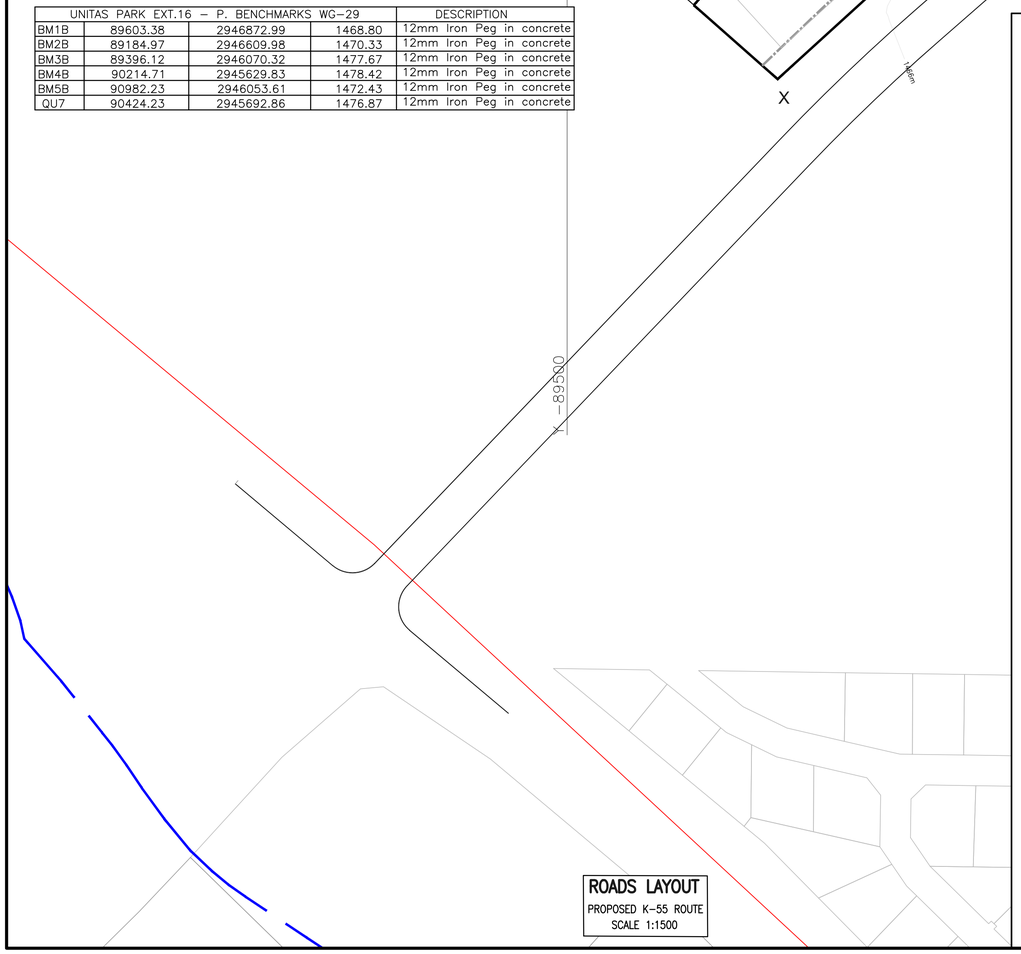
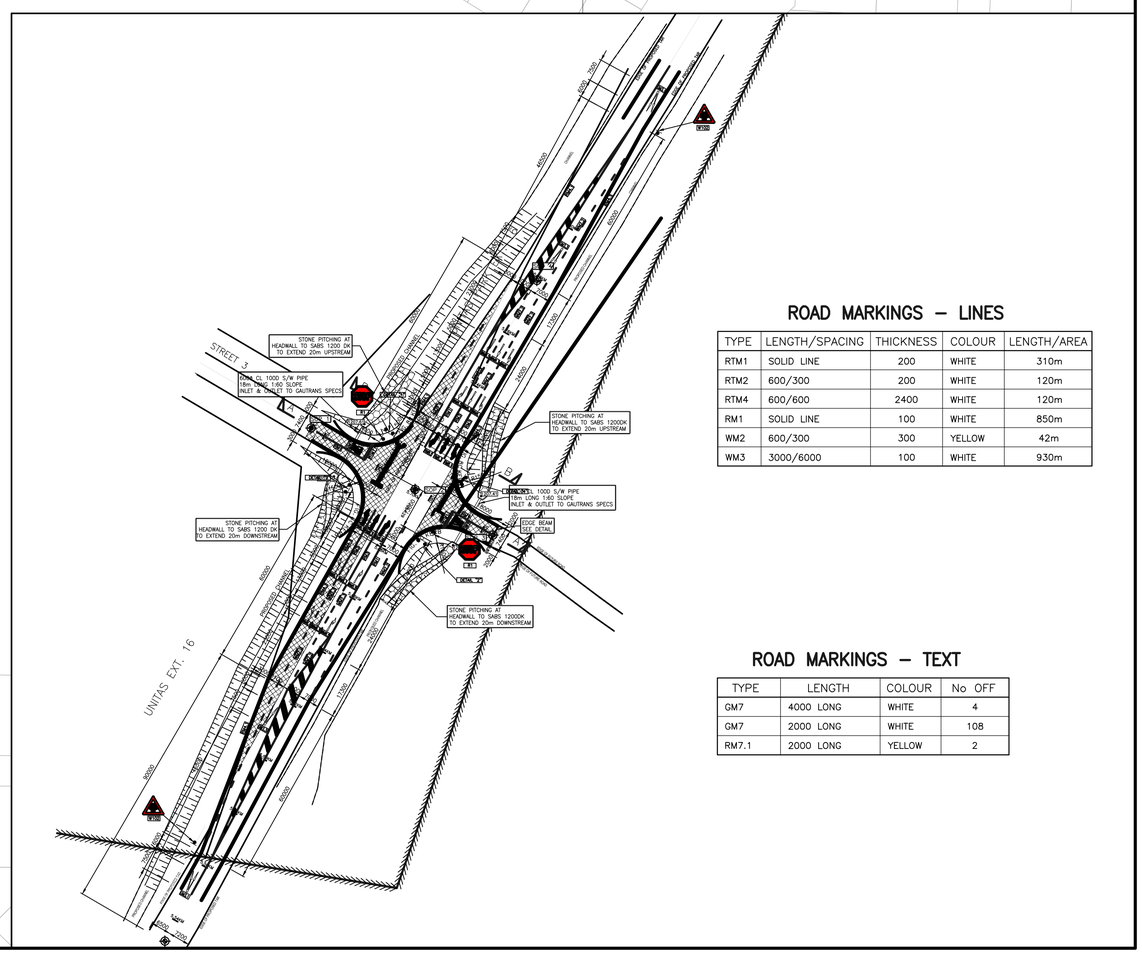


ROADS LAYOUT
PROPOSED K-55 ROUTE
SCALE 1:1500



ROAD MARKINGS – LINES

TYPE	LENGTH/SPACING	THICKNESS	COLOUR	LENGTH/AREA
RTM1	SOLID LINE	200	WHITE	310m
RTM2	600/300	200	WHITE	120m
RTM4	600/600	2400	WHITE	120m
RM1	SOLID LINE	100	WHITE	850m
WM2	600/300	300	YELLOW	42m
WM3	3000/6000	100	WHITE	930m

ROAD MARKINGS – TEXT

TYPE	LENGTH	COLOUR	No OFF
GM7	4000 LONG	WHITE	4
GM7	2000 LONG	WHITE	108
RM7.1	2000 LONG	YELLOW	2

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PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
ROADS LAYOUT
PROPOSED K-55 ROUTE
SHEET 1 OF 2

REF. NO. –
SCALE 1:1500
DATE 03/2021
TYPE NUMBER

DESIGNER R. MABOHO
DRAWING F. MAZIBUKO
CHECKED S. MNGUNI

DRAWING NUMBER
7001/RW/U005

A1
100mm ON ORIGINAL DRAWING

LOCALITY PLAN
NTS
SHEET NO. 6 OF 7

ANNEXURE N

PROPOSED STORMWATER RETICULATION LAYOUT

COORDINATE LIST

WG 27

Unitas StormWater Net 1

MH No.	YLo	XLo
Constant:		
KI1	−90340.391	2945772.831
KI2	−90347.400	2945790.937
KI3	−90369.344	2945805.478
KI4	−90394.610	2945822.312
KI5	−90417.401	2945837.503
KI6	−90439.335	2945852.123
KI7	−90460.825	2945866.447
KI8	−90460.785	2945886.382
KI9	−90432.922	2945928.082
KI10	−90434.698	2945950.568
KI11	−90489.034	2946009.284
KI12	−90517.351	2946041.526
KI13	−90560.790	2946098.127
KI14	−90579.428	2946120.208
KI15	−90631.980	2946176.637
KI16	−90653.214	2946199.434
KI17	−90670.283	2946217.761
KI18	−90690.949	2946239.951
KI19	−90706.693	2946256.855
KI20	−90703.093	2946268.566
KI21	−90702.707	2946279.728
KI22	−90663.985	2946315.857
KI23	−90605.493	2946370.434
KI24	−90588.079	2946386.682
KI25	−90580.184	2946393.220
KI26	−90543.077	2946420.417
KI27	−90539.773	2946422.838
KI28	−90539.861	2946432.224
KI29	−90529.210	2946440.278
KI30	−90538.848	2946453.101
KI31	−90526.142	2946462.834
KI32	−90472.733	2946485.471
KI33	−90441.435	2946494.675
KI34	−90434.614	2946510.204
KI35	−90411.347	2946527.353
KI36	−90377.010	2946571.165
KI37	−90365.307	2946580.127
KI38	−90356.878	2946569.120
KI39	−90334.853	2946573.029
KI40	−90278.250	2946614.514
KI41	−90221.647	2946656.000
KI42	−90165.044	2946697.485
KI43	−90144.145	2946712.802
KI44	−90091.207	2946751.602
KI45	−90038.269	2946790.401
KI46	−89985.330	2946829.201
KI47	−89932.392	2946868.000
KI48	−89929.333	2946870.242
KI49	−89925.090	2946884.892
KI50	−89939.280	2946904.404
KI51	−89937.914	2946909.328
KI52	−89914.874	2946918.913
KI53	−89879.442	2946936.352
KI54	−89870.303	2946952.888
KI55	−89833.416	2946999.954
KI56	−89784.054	2947040.169
KI57	−89734.692	2947080.383
KI58	−89685.331	2947120.598
KI59	−89645.666	2947156.621
KI60	−89606.001	2947192.644
KI61	−89596.101	2947193.560
KI62	−89591.110	2947198.803
KI63	−90323.014	2945783.844
KI64	−90336.748	2945792.998
KI65	−90387.751	2945801.393
KI66	−90392.274	2945810.637
KI67	−90433.031	2945833.978
KI68	−90437.555	2945843.221
KI69	−90476.453	2945862.934
KI70	−90045.057	2945875.762
KI71	−90067.374	2945920.225
KI72	−90089.691	2945964.689
KI73	−90122.019	2945966.752
KI74	−90190.774	2945932.190
KI75	−90217.141	2945918.936
KI76	−90238.127	2945908.387
KI77	−90264.494	2945895.132
KI78	−90285.480	2945884.582
KI79	−90311.848	2945871.328
KI80	−90333.467	2945860.461
KI81	−90350.391	2945871.763
KI82	−90361.444	2945871.410
KI83	−90415.780	2945930.126
KI84	−90152.671	2945827.220
KI85	−90174.687	2945871.016
KI86	−90196.703	2945914.812
KI87	−90206.545	2945915.430
KI88	−90200.024	2945803.416
KI89	−90222.040	2945847.212
KI90	−90244.056	2945891.008
KI91	−90253.898	2945891.626
KI92	−90247.378	2945779.612
KI93	−90269.394	2945823.408
KI94	−90291.409	2945867.204
KI95	−90301.252	2945867.822

PIPE DATA LIST

MH − MH	Distance
Unitas StormWater	Net 1 (m)
KI1 − KI2	19.416
KI2 − KI3	26.325
KI3 − KI4	30.360
KI4 − KI5	27.389
KI5 − KI6	26.361
KI6 − KI7	25.826
KI7 − KI8	19.935
KI8 − KI9	50.152
KI9 − KI10	22.556
KI10 − KI11	80.000
KI11 − KI12	42.911
KI12 − KI13	71.349
KI13 − KI14	28.894
KI14 − KI15	77.111
KI15 − KI16	31.154
KI16 − KI17	25.045
KI17 − KI18	30.323
KI18 − KI19	23.100
KI19 − KI20	12.252
KI20 − KI21	11.168
KI21 − KI22	52.959
KI22 − KI23	80.000
KI23 − KI24	23.817
KI24 − KI25	10.251
KI25 − KI26	46.007
KI26 − KI27	4.096
KI27 − KI28	9.386
KI28 − KI29	13.353
KI29 − KI30	16.041
KI30 − KI31	16.005
KI31 − KI32	58.008
KI32 − KI33	32.623
KI33 − KI34	16.961
KI34 − KI35	28.905
KI35 − KI36	55.664
KI36 − KI37	14.740
KI37 − KI38	13.864
KI38 − KI39	22.370
KI39 − KI40	70.178
KI40 − KI41	70.178
KI41 − KI42	70.178
KI42 − KI43	25.911
KI43 − KI44	65.635
KI44 − KI45	65.635
KI45 − KI46	65.635
KI46 − KI47	65.634
KI47 − KI48	3.793
KI48 − KI49	15.251
KI49 − KI50	24.126
KI50 − KI51	5.110
KI51 − KI52	24.954
KI52 − KI53	39.491
KI53 − KI54	18.894
KI54 − KI55	59.798
KI55 − KI56	63.670
KI56 − KI57	63.670
KI57 − KI58	63.669
KI58 − KI59	53.582
KI59 − KI60	53.581
KI60 − KI61	9.942
KI61 − KI62	7.239
KI63 − KI64	16.505
KI64 − KI2	10.850
KI65 − KI66	10.291
KI66 − KI4	11.907
KI67 − KI68	10.291
KI68 − KI6	9.078
KI69 − KI8	28.201
KI70 − KI71	49.750
KI71 − KI72	49.750
KI72 − KI73	32.394
KI73 − KI74	76.953
KI74 − KI75	29.511
KI75 − KI76	23.489
KI76 − KI77	29.511
KI77 − KI78	23.489
KI78 − KI79	29.511
KI79 − KI80	24.197
KI80 − KI81	20.351
KI81 − KI82	11.058
KI82 − KI83	80.000
KI83 − KI10	27.853
KI84 − KI85	49.018
KI85 − KI86	49.018
KI86 − KI87	9.862
KI87 − KI75	11.160
KI88 − KI89	49.018
KI89 − KI90	49.018
KI90 − KI91	9.862
KI91 − KI77	11.160
KI92 − KI93	49.018
KI93 − KI94	49.018
KI94 − KI95	9.862
KI95 − KI79	11.161
KI96 − KI97	4.040
KI97 − KI98	8.868
KI98 − KI99	73.697

TOTAL LENGTHS OF PIPING

MH Centre to MH Centre

Diameter (mm)	Length (m)
1800mm 75D Spigot & Socket	1624.43
1800mm 100D Spigot & Socket	89.88
1650mm 75D Spigot & Socket	392.69
1650mm 100D Spigot & Socket	49.540
1500mm 75D Spigot & Socket	295.80
1500mm 100D Spigot & Socket	109.43
1350mm 75D Spigot & Socket	483.46
1350mm 100D Spigot & Socket	98.16
1200mm 75D Spigot & Socket	400.37
1200mm 100D Spigot & Socket	57.65
1050mm 75D Spigot & Socket	1101.14
1050mm 100D Spigot & Socket	246.85
900mm 75D Spigot & Socket	189.833
900mm 100D Spigot & Socket	61.74
825mm 75D Spigot & Socket	325.68
825mm 100D Spigot & Socket	178.89
750mm 75D Spigot & Socket	307.92
750mm 100D Spigot & Socket	171.12
675mm 75D Spigot & Socket	397.09
600mm 75D Spigot & Socket	457.18
600mm 100D Spigot & Socket	71.65
525mm 75D Spigot & Socket	601.411
525mm 100D Spigot & Socket	442.25
450mm 75D Spigot & Socket	4521.26
450mm 100D Spigot & Socket	1014.76
Total :	13693.93

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS

P.O. BOX 4049
RANDBURG-2125
FIRST FLOOR 24 PETER PLACE
LYME PARK BRYANSTON 2191
TEL (011)326-0741/90

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DISCIPLINE

CIVIL ENGINEERING

PROJECT TITLE

UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE

COORDINATE LIST AND PIPE DATA LIST

SHEET 1 OF 5

REF. NO. –

DESIGNER R. MABOHO

SCALE 1:1000

DRAWING F. MAZIBUKO

DATE 03/2021

CHECKED S. MNGUNI

TYPE NUMBER

DRAWING NUMBER 7001/SW/A001

A1

100mm ON ORIGINAL DRAWING

COORDINATE LIST

WG 27

Unitas StormWater Net 1

MH No.	YLo	XLo
Constant:		
KI96	-90304.364	2945993.717
KI97	-90306.179	2945997.326
KI98	-90314.653	2945999.942
KI99	-90379.153	2945964.290
KI100	-90404.548	2945950.255
KI101	-90415.538	2945953.792
KI102	-90569.343	2945923.791
KI103	-90541.565	2945965.363
KI104	-90513.787	2946006.935
KI105	-90516.709	2946021.615
KI106	-90669.102	2946007.567
KI107	-90650.013	2946036.206
KI108	-90618.559	2946065.554
KI109	-90621.008	2946075.881
KI110	-90620.736	2946083.754
KI111	-90667.524	2946133.897
KI112	-90666.793	2946157.353
KI113	-90651.554	2946175.709
KI114	-90653.346	2946189.355
KI115	-90734.825	2946075.540
KI116	-90687.126	2946132.992
KI117	-90759.941	2946132.532
KI118	-90724.885	2946174.667
KI119	-90689.828	2946216.803
KI120	-90869.375	2946034.125
KI121	-90868.837	2946045.058
KI122	-90869.929	2946051.688
KI123	-90843.291	2946115.182
KI124	-90804.250	2946162.144
KI125	-90765.209	2946209.106
KI126	-90726.168	2946256.068
KI127	-90259.469	2946039.675
KI128	-90271.238	2946063.087
KI129	-90304.787	2946129.824
KI130	-90320.791	2946150.723
KI131	-90340.605	2946180.700
KI132	-90351.185	2946181.861
KI133	-90388.502	2946230.646
KI134	-90425.818	2946279.430
KI135	-90463.135	2946328.215
KI136	-90479.250	2946353.814
KI137	-90495.799	2946375.663
KI138	-90511.816	2946396.812
KI139	-90528.298	2946418.573
KI140	-90530.487	2946421.464
KI141	-90425.459	2946088.738
KI142	-90385.724	2946119.089
KI143	-90345.990	2946149.440
KI144	-90348.532	2946168.602
KI145	-90347.426	2946176.947
KI146	-90452.790	2946206.555
KI147	-90454.278	2946217.315
KI148	-90453.388	2946224.026
KI149	-90480.215	2946259.041
KI150	-90507.043	2946294.055
KI151	-90503.182	2946303.560
KI152	-90501.201	2946316.279
KI153	-90481.709	2946330.568
KI154	-90592.352	2946216.050
KI155	-90588.840	2946227.665
KI156	-90588.497	2946237.555
KI157	-90572.048	2946252.901
KI158	-90550.022	2946273.454
KI159	-90526.450	2946295.449
KI160	-90553.608	2946252.203
KI161	-90550.400	2946262.550
KI162	-90632.134	2946273.149
KI163	-90573.644	2946327.724
KI164	-90550.223	2946349.516
KI165	-90511.599	2946377.681
KI166	-90512.919	2946389.362
KI167	-90395.946	2946435.263
KI168	-89946.048	2945940.082
KI169	-89966.260	2945980.288
KI170	-89986.471	2946020.494
KI171	-89981.018	2946028.674
KI172	-89977.400	2946039.606
KI173	-89941.917	2946059.466
KI174	-89915.399	2946074.379
KI175	-89891.359	2946087.897
KI176	-89864.565	2946102.965
KI177	-89833.900	2946120.210
KI178	-89833.709	2946131.803
KI179	-89828.134	2946152.594
KI180	-89833.868	2946162.557
KI181	-89852.082	2946194.140
KI182	-89888.863	2946246.264
KI183	-89912.038	2946279.107
KI184	-89946.518	2946327.971
KI185	-89958.199	2946326.990
KI186	-89979.436	2946332.496
KI187	-90039.414	2946303.603
KI188	-90099.392	2946274.710
KI189	-90113.979	2946284.708
KI190	-90137.381	2946287.978
KI191	-90185.162	2946352.142
KI192	-90232.944	2946416.305
KI193	-90251.293	2946440.946
KI194	-90273.400	2946470.632
KI195	-90292.396	2946491.977
KI196	-90340.184	2946556.136

PIPE DATA LIST

MH – MH	Distance
Unitas StormWater	Net 1 (m)
KI99 – KI100	29.016
KI100 – KI101	11.545
KI101 – KI10	19.429
KI102 – KI103	49.999
KI103 – KI104	49.999
KI104 – KI105	14.968
KI105 – KI12	19.922
KI106 – KI107	34.418
KI107 – KI108	43.019
KI108 – KI109	10.613
KI109 – KI110	7.878
KI110 – KI111	68.582
KI111 – KI112	23.468
KI112 – KI113	23.857
KI113 – KI114	13.763
KI114 – KI16	10.080
KI115 – KI116	74.672
KI116 – KI112	31.731
KI117 – KI118	54.812
KI118 – KI119	54.812
KI119 – KI18	23.175
KI120 – KI121	10.946
KI121 – KI122	6.720
KI122 – KI123	68.855
KI123 – KI124	61.071
KI124 – KI125	61.071
KI125 – KI126	61.071
KI126 – KI21	33.320
KI127 – KI128	26.203
KI128 – KI129	74.695
KI129 – KI130	26.323
KI130 – KI131	35.934
KI131 – KI132	10.643
KI132 – KI133	61.420
KI133 – KI134	61.420
KI134 – KI135	61.420
KI135 – KI136	30.249
KI136 – KI137	27.409
KI137 – KI138	26.530
KI138 – KI139	27.298
KI139 – KI140	3.627
KI140 – KI27	9.387
KI141 – KI142	50.000
KI142 – KI143	50.000
KI143 – KI144	19.331
KI144 – KI145	8.417
KI145 – KI132	6.188
KI146 – KI147	10.862
KI147 – KI148	6.770
KI148 – KI149	44.111
KI149 – KI150	44.111
KI150 – KI151	10.259
KI151 – KI152	12.872
KI152 – KI153	24.169
KI153 – KI136	23.376
KI154 – KI155	12.134
KI155 – KI156	9.895
KI156 – KI157	22.496
KI157 – KI158	30.126
KI158 – KI159	32.240
KI159 – KI152	32.732
KI160 – KI161	10.833
KI161 – KI158	10.910
KI162 – KI163	79.997
KI163 – KI164	31.991
KI164 – KI165	47.803
KI165 – KI166	11.755
KI166 – KI138	7.531
KI167 – KI33	74.827
KI168 – KI169	45.000
KI169 – KI170	45.000
KI170 – KI171	9.831
KI171 – KI172	11.515
KI172 – KI173	40.663
KI173 – KI174	30.424
KI174 – KI175	27.581
KI175 – KI176	30.740
KI176 – KI177	35.182
KI177 – KI178	11.595
KI178 – KI179	21.526
KI179 – KI180	11.495
KI180 – KI181	36.459
KI181 – KI182	63.795
KI182 – KI183	40.197
KI183 – KI184	59.803
KI184 – KI185	11.722
KI185 – KI186	21.939
KI186 – KI187	66.575
KI187 – KI188	66.575
KI188 – KI189	17.685
KI189 – KI190	23.630
KI190 – KI191	80.000
KI191 – KI192	80.000
KI192 – KI193	30.723
KI193 – KI194	37.013
KI194 – KI195	28.574
KI195 – KI196	80.000
KI196 – KI197	11.093
KI197 – KI39	6.754
KI198 – KI172	29.783
KI199 – KI200	3.430

TOTAL LENGTHS OF PIPING

MH Centre to MH Centre

Diameter (mm)	Length (m)
1800mm 75D Spigot & Socket	1624.43
1800mm 100D Spigot & Socket	89.88
1650mm 75D Spigot & Socket	392.69
1650mm 100D Spigot & Socket	49.540
1500mm 75D Spigot & Socket	295.80
1500mm 100D Spigot & Socket	109.43
1350mm 75D Spigot & Socket	483.46
1350mm 100D Spigot & Socket	98.16
1200mm 75D Spigot & Socket	400.37
1200mm 100D Spigot & Socket	57.65
1050mm 75D Spigot & Socket	1101.14
1050mm 100D Spigot & Socket	246.85
900mm 75D Spigot & Socket	189.833
900mm 100D Spigot & Socket	61.74
825mm 75D Spigot & Socket	325.68
825mm 100D Spigot & Socket	178.89
750mm 75D Spigot & Socket	307.92
750mm 100D Spigot & Socket	171.12
675mm 75D Spigot & Socket	397.09
600mm 75D Spigot & Socket	457.18
600mm 100D Spigot & Socket	71.65
525mm 75D Spigot & Socket	601.411
525mm 100D Spigot & Socket	442.25
450mm 75D Spigot & Socket	4521.26
450mm 100D Spigot & Socket	1014.76
Total :	13693.93

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ENGINEER:

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DISCIPLINE
CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
COORDINATE LIST AND PIPE DATA LIST

SHEET 2 OF 5

REF. NO. –
SCALE 1:1000
DATE 03/2021
TYPE NUMBER

DESIGNER R. MABOHO
DRAWING F. MAZIBUKO
CHECKED S. MNGUNI

DRAWING NUMBER
7001/SW/A002

A1
100mm ON ORIGINAL DRAWING

COORDINATE LIST

WG 27

Unitas StormWater Net 1

MH No.	YLo	XLo
Constant:		
KI197	-90335.856	2946566.350
KI198	-90003.947	2946026.104
KI199	-89917.259	2946058.109
KI200	-89918.971	2946061.082
KI201	-89799.013	2945968.948
KI202	-89832.857	2946027.744
KI203	-89866.702	2946086.539
KI204	-89868.253	2946089.234
KI205	-89774.765	2946059.869
KI206	-89801.449	2946106.231
KI207	-90153.014	2946090.522
KI208	-90147.076	2946108.465
KI209	-90105.607	2946129.362
KI210	-90064.138	2946150.258
KI211	-90041.215	2946161.808
KI212	-90017.636	2946173.690
KI213	-90009.646	2946179.326
KI214	-89986.885	2946195.445
KI215	-89962.056	2946212.908
KI216	-89914.872	2946246.203
KI217	-89915.798	2946257.324
KI218	-90049.332	2946145.544
KI219	-90043.882	2946153.751
KI220	-89994.038	2946176.055
KI221	-89989.374	2946184.152
KI222	-89940.582	2946351.212
KI223	-90140.058	2946255.143
KI224	-90139.109	2946267.176
KI225	-90134.781	2946284.487
KI226	-90220.197	2946200.057
KI227	-90241.256	2946206.347
KI228	-90242.554	2946234.425
KI229	-90284.044	2946288.837
KI230	-90325.000	2946342.550
KI231	-90315.284	2946370.924
KI232	-90251.307	2946418.955
KI233	-90252.791	2946430.710
KI234	-90348.352	2946346.098
KI235	-90254.438	2946054.364
KI236	-90264.122	2946060.732
KI237	-90106.388	2946395.570
KI238	-90049.855	2946437.723
KI239	-90051.394	2946450.895
KI240	-90049.898	2946460.281
KI241	-90091.485	2946519.182
KI242	-90109.237	2946544.341
KI243	-90129.127	2946572.526
KI244	-90124.631	2946582.408
KI245	-90122.686	2946593.757
KI246	-90058.189	2946641.088
KI247	-90035.852	2946657.480
KI248	-90015.454	2946672.450
KI249	-89991.222	2946690.232
KI250	-89970.809	2946705.012
KI251	-89972.148	2946717.102
KI252	-89965.569	2946731.340
KI253	-89980.955	2946753.144
KI254	-89982.716	2946755.641
KI255	-89980.902	2946766.747
KI256	-89957.988	2946783.538
KI257	-89936.329	2946799.409
KI258	-89901.666	2946824.810
KI259	-89902.897	2946835.905
KI260	-89901.705	2946843.642
KI261	-89917.923	2946865.771
KI262	-89920.165	2946868.829
KI263	-89938.779	2946458.456
KI264	-89994.787	2946418.934
KI265	-90004.341	2946423.294
KI266	-90026.521	2946427.122
KI267	-90032.987	2946436.285
KI268	-90109.879	2946522.186
KI269	-90224.602	2946505.376
KI270	-90215.872	2946525.450
KI271	-90181.696	2946550.492
KI272	-90147.520	2946575.533
KI273	-89774.584	2946574.304
KI274	-89784.138	2946578.664
KI275	-89791.055	2946579.858
KI276	-89815.248	2946614.143
KI277	-89839.441	2946648.427
KI278	-89849.210	2946647.596
KI279	-89860.566	2946649.556
KI280	-89881.509	2946634.778
KI281	-89905.709	2946617.701
KI282	-89927.060	2946602.635
KI283	-89970.364	2946572.077
KI284	-89979.386	2946576.195
KI285	-89990.550	2946578.122
KI286	-89995.919	2946585.730
KI287	-90004.931	2946585.143
KI288	-90020.149	2946606.711
KI289	-90042.564	2946638.478
KI290	-89617.689	2946516.488
KI291	-89632.406	2946499.670
KI292	-89700.106	2946467.056
KI293	-89767.806	2946434.442
KI294	-89779.022	2946455.212
KI295	-89797.224	2946492.772
KI296	-89841.491	2946555.504
KI297	-89884.584	2946616.573

PIPE DATA LIST

MH – MH	Distance
Unitas StormWater Net 1	(m)
KI200 – KI174	13.769
KI201 – KI202	67.841
KI202 – KI203	67.841
KI203 – KI204	3.109
KI204 – KI176	14.218
KI205 – KI206	53.494
KI206 – KI179	53.494
KI207 – KI208	18.900
KI208 – KI209	46.437
KI209 – KI210	46.437
KI210 – KI211	25.668
KI211 – KI212	26.404
KI212 – KI213	9.778
KI213 – KI214	27.891
KI214 – KI215	30.355
KI215 – KI216	57.748
KI216 – KI217	11.160
KI217 – KI183	22.105
KI218 – KI219	9.852
KI219 – KI211	8.487
KI220 – KI221	9.344
KI221 – KI214	11.565
KI222 – KI186	43.127
KI223 – KI224	12.071
KI224 – KI225	17.844
KI225 – KI190	4.353
KI226 – KI227	21.979
KI227 – KI228	28.108
KI228 – KI229	68.426
KI229 – KI230	67.546
KI230 – KI231	29.991
KI231 – KI232	80.001
KI232 – KI233	11.848
KI233 – KI193	10.345
KI234 – KI231	41.350
KI235 – KI236	11.590
KI236 – KI128	7.495
KI237 – KI238	70.518
KI238 – KI239	13.262
KI239 – KI240	9.504
KI240 – KI241	72.103
KI241 – KI242	30.792
KI242 – KI243	34.497
KI243 – KI244	10.857
KI244 – KI245	11.514
KI245 – KI246	80.000
KI246 – KI247	27.707
KI247 – KI248	25.302
KI248 – KI249	30.056
KI249 – KI250	25.202
KI250 – KI251	12.164
KI251 – KI252	15.685
KI252 – KI253	26.686
KI253 – KI254	3.056
KI254 – KI255	11.254
KI255 – KI256	28.407
KI256 – KI257	26.852
KI257 – KI258	42.974
KI258 – KI259	11.164
KI259 – KI260	7.828
KI260 – KI261	27.436
KI261 – KI262	3.792
KI262 – KI48	9.277
KI263 – KI264	68.549
KI264 – KI265	10.502
KI265 – KI266	22.509
KI266 – KI267	11.214
KI267 – KI240	29.357
KI268 – KI242	22.165
KI269 – KI270	21.891
KI270 – KI271	42.368
KI271 – KI272	42.368
KI272 – KI245	30.803
KI273 – KI274	10.502
KI274 – KI275	7.020
KI275 – KI276	41.961
KI276 – KI277	41.961
KI277 – KI278	9.804
KI278 – KI279	11.524
KI279 – KI280	25.632
KI280 – KI281	29.618
KI281 – KI282	26.132
KI282 – KI283	53.000
KI283 – KI284	9.917
KI284 – KI285	11.329
KI285 – KI286	9.312
KI286 – KI287	9.031
KI287 – KI288	26.397
KI288 – KI289	38.879
KI289 – KI247	20.153
KI290 – KI291	22.348
KI291 – KI292	75.147
KI292 – KI293	75.147
KI293 – KI294	23.605
KI294 – KI295	41.738
KI295 – KI296	76.778
KI296 – KI297	74.742
KI297 – KI298	9.804
KI298 – KI281	11.524
KI299 – KI300	3.078
KI300 – KI301	11.223
KI301 – KI302	26.154
KI302 – KI288	19.039

TOTAL LENGTHS OF PIPING

MH Centre to MH Centre

Diameter (mm)	Length (m)
1800mm 75D Spigot & Socket	1624.43
1800mm 100D Spigot & Socket	89.88
1650mm 75D Spigot & Socket	392.69
1650mm 100D Spigot & Socket	49.540
1500mm 75D Spigot & Socket	295.80
1500mm 100D Spigot & Socket	109.43
1350mm 75D Spigot & Socket	483.46
1350mm 100D Spigot & Socket	98.16
1200mm 75D Spigot & Socket	400.37
1200mm 100D Spigot & Socket	57.65
1050mm 75D Spigot & Socket	1101.14
1050mm 100D Spigot & Socket	246.85
900mm 75D Spigot & Socket	189.833
900mm 100D Spigot & Socket	61.74
825mm 75D Spigot & Socket	325.68
825mm 100D Spigot & Socket	178.89
750mm 75D Spigot & Socket	307.92
750mm 100D Spigot & Socket	171.12
675mm 75D Spigot & Socket	397.09
600mm 75D Spigot & Socket	457.18
600mm 100D Spigot & Socket	71.65
525mm 75D Spigot & Socket	601.411
525mm 100D Spigot & Socket	442.25
450mm 75D Spigot & Socket	4521.26
450mm 100D Spigot & Socket	1014.76
Total :	13693.93

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

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DISCIPLINE

CIVIL ENGINEERING

PROJECT TITLE

UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE

COORDINATE LIST AND PIPE DATA LIST

SHEET 3 OF 5

REF. NO. –	DESIGNER R. MABOHO
SCALE 1:1000	DRAWING F. MAZIBUKO
DATE 03/2021	CHECKED S. MNGUNI

TYPE NUMBER

DRAWING NUMBER

7001/SW/A003

A1

100mm ON ORIGINAL DRAWING

COORDINATE LIST

WG 27

Unitas StormWater Net 1

MH No.	YLo	XLo
Constant:		
KI298	−89894.352	2946615.742
KI299	−90041.653	2946558.625
KI300	−90043.428	2946561.139
KI301	−90041.619	2946572.215
KI302	−90020.524	2946587.676
KI303	−90214.391	2946595.652
KI304	−90174.060	2946625.206
KI305	−90133.729	2946654.760
KI306	−90069.199	2946702.045
KI307	−90020.085	2946738.035
KI308	−90002.965	2946750.581
KI309	−89936.382	2946785.806
KI310	−89938.143	2946788.302
KI311	−89886.149	2946822.419
KI312	−90149.538	2946695.110
KI313	−90145.346	2946705.014
KI314	−89694.681	2946630.531
KI315	−89695.811	2946650.100
KI316	−89728.413	2946678.893
KI317	−89761.016	2946707.686
KI318	−89756.176	2946729.125
KI319	−89741.278	2946746.109
KI320	−89745.060	2946757.350
KI321	−89746.007	2946771.878
KI322	−89782.612	2946804.205
KI323	−89819.217	2946836.532
KI324	−89834.115	2946849.690
KI325	−89860.203	2946885.226
KI326	−89886.290	2946920.763
KI327	−89796.137	2946678.985
KI328	−89797.898	2946681.481
KI329	−89795.628	2946695.380
KI330	−89783.616	2946703.856
KI331	−89777.064	2946709.279
KI332	−89643.576	2946681.416
KI333	−89681.054	2946714.514
KI334	−89718.533	2946747.612
KI335	−89110.805	2946758.315
KI336	−89164.587	2946805.808
KI337	−89218.368	2946853.301
KI338	−89270.637	2946899.457
KI339	−89298.057	2946904.664
KI340	−89316.550	2946903.516
KI341	−89372.964	2946953.339
KI342	−89432.924	2947006.300
KI343	−89452.510	2947023.588
KI344	−89472.650	2947041.384
KI345	−89492.237	2947058.674
KI346	−89512.377	2947076.468
KI347	−89531.963	2947093.758
KI348	−89552.503	2947111.897
KI349	−89555.468	2947114.516
KI350	−89553.878	2947125.586
KI351	−89558.074	2947129.291
KI352	−89542.850	2947146.528
KI353	−89269.262	2946523.206
KI354	−89337.289	2946547.295
KI355	−89349.144	2946551.492
KI356	−89362.055	2946577.031
KI357	−89368.029	2946590.298
KI358	−89353.403	2946631.546
KI359	−89333.651	2946687.247
KI360	−89369.205	2946718.254
KI361	−89402.891	2946747.622
KI362	−89407.121	2946757.156
KI363	−89354.438	2946817.360
KI364	−89304.443	2946874.477
KI365	−89310.277	2946891.306
KI366	−89310.715	2946898.363
KI367	−89443.697	2946584.976
KI368	−89379.580	2946562.272
KI369	−89459.764	2946696.971
KI370	−89442.657	2946873.523
KI371	−89502.618	2946926.481
KI372	−89501.055	2946945.094
KI373	−89483.406	2946965.328
KI374	−89466.320	2946984.922
KI375	−89448.594	2947005.244
KI376	−89451.929	2947015.085
KI377	−89407.998	2946913.622
KI378	−89467.783	2946966.425
KI379	−89465.778	2946976.994
KI380	−89488.321	2947040.328
KI381	−89491.656	2947050.169
KI382	−89579.632	2946761.882
KI383	−89582.836	2946771.164
KI384	−89583.316	2946778.890
KI385	−89614.941	2946806.820
KI386	−89646.565	2946834.750
KI387	−89644.727	2946844.616
KI388	−89645.472	2946856.042
KI389	−89630.292	2946873.517
KI390	−89610.286	2946896.550
KI391	−89592.007	2946917.256
KI392	−89590.456	2946919.013
KI393	−89591.921	2946941.486
KI394	−89619.078	2946965.471
KI395	−89619.490	2946970.565
KI396	−89598.130	2946995.057
KI397	−89580.629	2947015.121

PIPE DATA LIST

MH − MH	Distance
Unitas StormWater	Net 1 (m)
KI301 − KI302	26.154
KI302 − KI288	19.039
KI303 − KI304	50.000
KI304 − KI305	50.000
KI305 − KI306	80.000
KI306 − KI307	60.889
KI307 − KI308	21.225
KI308 − KI255	27.352
KI309 − KI310	3.055
KI310 − KI257	11.255
KI311 − KI260	26.314
KI312 − KI313	10.754
KI313 − KI43	7.880
KI314 − KI315	19.602
KI315 − KI316	43.497
KI316 − KI317	43.497
KI317 − KI318	21.978
KI318 − KI319	22.592
KI319 − KI320	11.860
KI320 − KI321	14.559
KI321 − KI322	48.837
KI322 − KI323	48.836
KI323 − KI324	19.877
KI324 − KI325	44.084
KI325 − KI326	44.084
KI326 − KI53	17.027
KI327 − KI328	3.055
KI328 − KI329	14.084
KI329 − KI330	14.701
KI330 − KI331	8.505
KI331 − KI318	28.813
KI332 − KI333	50.001
KI333 − KI334	50.001
KI334 − KI321	36.656
KI335 − KI336	71.750
KI336 − KI337	71.750
KI337 − KI338	69.731
KI338 − KI339	27.910
KI339 − KI340	18.528
KI340 − KI341	75.265
KI341 − KI342	80.000
KI342 − KI343	26.125
KI343 − KI344	26.876
KI344 − KI345	26.126
KI345 − KI346	26.875
KI346 − KI347	26.126
KI347 − KI348	27.403
KI348 − KI349	3.956
KI349 − KI350	11.184
KI350 − KI351	5.598
KI351 − KI352	22.997
KI352 − KI61	71.047
KI353 − KI354	72.166
KI354 − KI355	12.576
KI355 − KI356	28.617
KI356 − KI357	14.550
KI357 − KI358	43.765
KI358 − KI359	59.099
KI359 − KI360	47.175
KI360 − KI361	44.690
KI361 − KI362	10.430
KI362 − KI363	80.000
KI363 − KI364	75.907
KI364 − KI365	17.812
KI365 − KI366	7.071
KI366 − KI340	7.785
KI367 − KI368	68.018
KI368 − KI356	22.912
KI369 − KI362	79.959
KI370 − KI371	80.000
KI371 − KI372	18.678
KI372 − KI373	26.850
KI373 − KI374	25.997
KI374 − KI375	26.967
KI375 − KI376	10.390
KI376 − KI343	8.523
KI377 − KI378	79.764
KI378 − KI379	10.758
KI379 − KI374	7.946
KI380 − KI381	10.390
KI381 − KI345	8.524
KI382 − KI383	9.820
KI383 − KI384	7.741
KI384 − KI385	42.193
KI385 − KI386	42.193
KI386 − KI387	10.036
KI387 − KI388	11.450
KI388 − KI389	23.147
KI389 − KI390	30.508
KI390 − KI391	27.620
KI391 − KI392	2.343
KI392 − KI393	22.521
KI393 − KI394	36.233
KI394 − KI395	5.111
KI395 − KI396	32.498
KI396 − KI397	26.624
KI397 − KI398	80.000
KI398 − KI399	10.390
KI399 − KI347	8.524
KI400 − KI401	12.487
KI401 − KI397	6.691

TOTAL LENGTHS OF PIPING

MH Centre to MH Centre

Diameter (mm)	Length (m)
1800mm 75D Spigot & Socket	1624.43
1800mm 100D Spigot & Socket	89.88
1650mm 75D Spigot & Socket	392.69
1650mm 100D Spigot & Socket	49.540
1500mm 75D Spigot & Socket	295.80
1500mm 100D Spigot & Socket	109.43
1350mm 75D Spigot & Socket	483.46
1350mm 100D Spigot & Socket	98.16
1200mm 75D Spigot & Socket	400.37
1200mm 100D Spigot & Socket	57.65
1050mm 75D Spigot & Socket	1101.14
1050mm 100D Spigot & Socket	246.85
900mm 75D Spigot & Socket	189.833
900mm 100D Spigot & Socket	61.74
825mm 75D Spigot & Socket	325.68
825mm 100D Spigot & Socket	178.89
750mm 75D Spigot & Socket	307.92
750mm 100D Spigot & Socket	171.12
675mm 75D Spigot & Socket	397.09
600mm 75D Spigot & Socket	457.18
600mm 100D Spigot & Socket	71.65
525mm 75D Spigot & Socket	601.411
525mm 100D Spigot & Socket	442.25
450mm 75D Spigot & Socket	4521.26
450mm 100D Spigot & Socket	1014.76
Total :	13693.93

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS

P.O. BOX 4049
RANDBURG-2125
FIRST FLOOR 24 PETER PLACE
LYME PARK BRYANSTON 2191
TEL (011)326-0741/90

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DISCIPLINE

CIVIL ENGINEERING

PROJECT TITLE

UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE

COORDINATE LIST AND PIPE DATA LIST

SHEET 4 OF 5

REF. NO. –

SCALE 1:1000

DATE 03/2021

DESIGNER R. MABOHO

DRAWING F. MAZIBUKO

CHECKED S. MNGUNI

TYPE NUMBER

DRAWING NUMBER 7001/SW/A004

A1

100mm ON ORIGINAL DRAWING

COORDINATE LIST

WG 27

Unitas StormWater Outlet Net 2		
MH No.	YLo	XLo
Constant:		
MH427	-89591.110	2947198.803
MH428	-89536.867	2947257.605
MH429	-89482.625	2947316.408
MH430	-89428.382	2947375.210
MH431	-89374.139	2947434.013
MH432	-89319.897	2947492.815
OUT433	-89310.114	2947503.420

PIPE DATA LIST

MH – MH	Distance
Unitas StormWater Outlet Net 2	(m)
MH427 – MH428	80.000
MH428 – MH429	80.000
MH429 – MH430	80.000
MH430 – MH431	80.000
MH431 – MH432	80.000
MH432 – OUT433	14.428

TOTAL LENGTHS OF PIPING

MH Centre to MH Centre

Diameter (mm)	Length (m)
1800mm 75D Spigot & Socket	1624.43
1800mm 100D Spigot & Socket	89.88
1650mm 75D Spigot & Socket	392.69
1650mm 100D Spigot & Socket	49.540
1500mm 75D Spigot & Socket	295.80
1500mm 100D Spigot & Socket	109.43
1350mm 75D Spigot & Socket	483.46
1350mm 100D Spigot & Socket	98.16
1200mm 75D Spigot & Socket	400.37
1200mm 100D Spigot & Socket	57.65
1050mm 75D Spigot & Socket	1101.14
1050mm 100D Spigot & Socket	246.85
900mm 75D Spigot & Socket	189.833
900mm 100D Spigot & Socket	61.74
825mm 75D Spigot & Socket	325.68
825mm 100D Spigot & Socket	178.89
750mm 75D Spigot & Socket	307.92
750mm 100D Spigot & Socket	171.12
675mm 75D Spigot & Socket	397.09
600mm 75D Spigot & Socket	457.18
600mm 100D Spigot & Socket	71.65
525mm 75D Spigot & Socket	601.411
525mm 100D Spigot & Socket	442.25
450mm 75D Spigot & Socket	4521.26
450mm 100D Spigot & Socket	1014.76
Total :	13693.93

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

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DISCIPLINE
CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
COORDINATE LIST AND PIPE DATA LIST

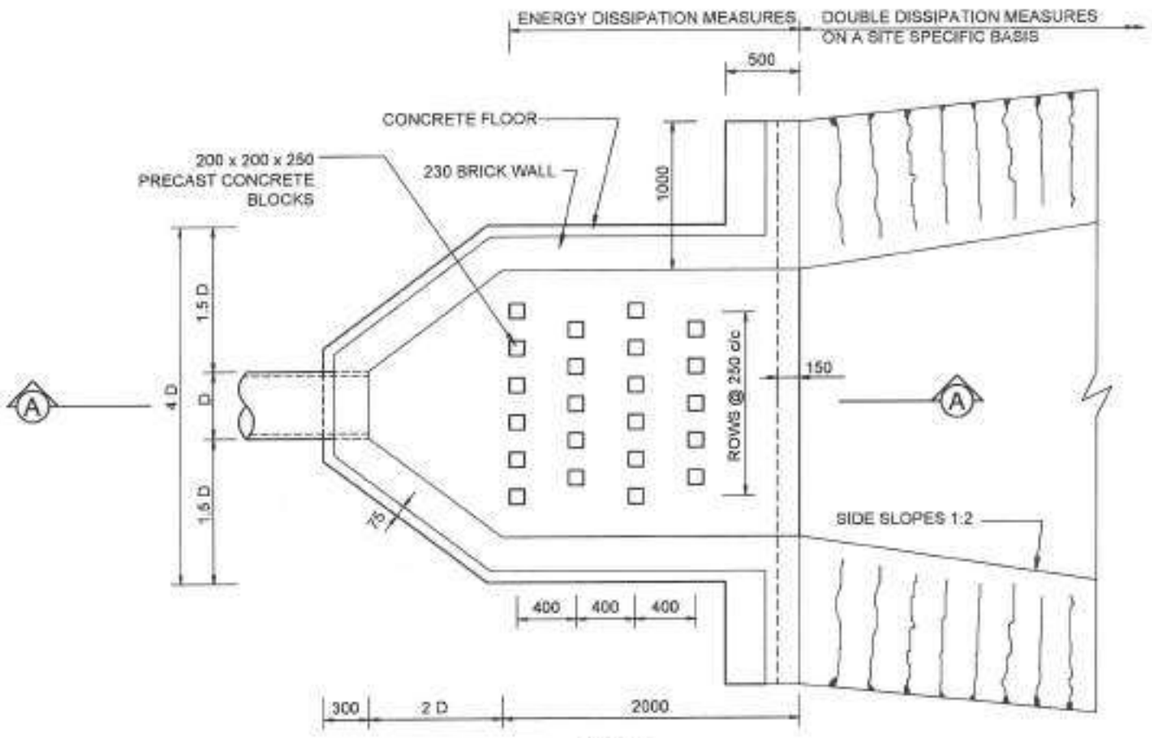
SHEET 5 OF 5

REF. NO. –
SCALE 1:1000
DATE 03/2021
TYPE NUMBER

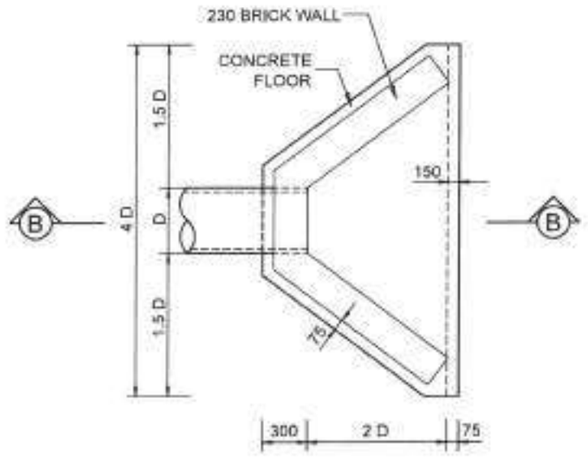
DESIGNER R. MABOHO
DRAWING F. MAZIBUKO
CHECKED S. MNGUNI

DRAWING NUMBER
7001/SW/A005

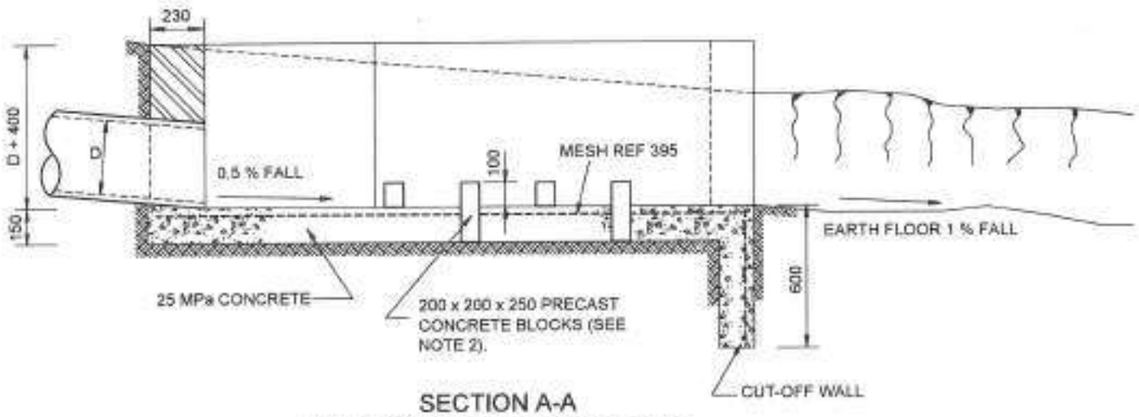
A1
100mm ON ORIGINAL DRAWING



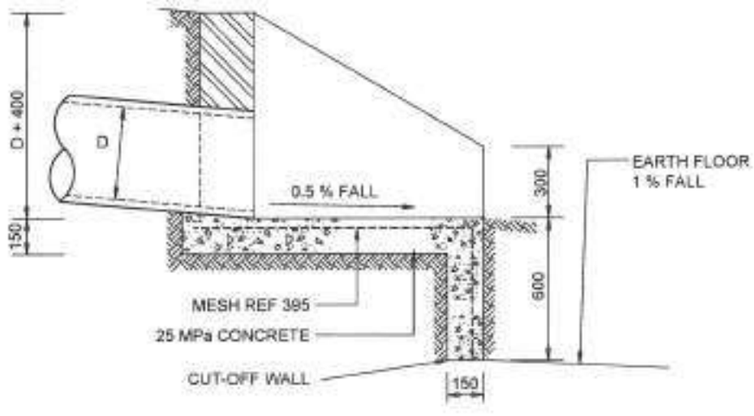
PLAN



PLAN



SECTION A-A
ENERGY DISSIPATION OUTLET



SECTION B-B

LEGEND

NOTES

1. REFER TO DWGS. JRA-SS080 & 082 FOR ADDITIONAL OUTLET STRUCTURE NOTES.
2. ONE LAYER OF MESH REF 395 TO BE PLACED ON FLOOR AND CUT-OFF WALL AS SHOWN WITH 40mm COVER AND MIN. LAP LENGTH OF 350mm.
3. ALL CONCRETE INCLUDING PRECAST CONCRETE BLOCKS IN ENERGY DISSIPATING OUTLETS TO BE CHAMFERED 25 x 25 ON EXPOSED EDGES.
4. ALL BRICKWORK TO BE IN ENGLISH BOND.
5. NO PLASTERING OF BRICKWORK WILL BE ALLOWED. ALL BRICKS TO BE OF QUALITY FBSE30 TO SANS227-2007 WITH WATER ABSORPTION <14% AND EFFLORESCENCE <10.
6. THE LOWER PORTION OF ANY BRICKWORK GREATER THAN 1m IN HEIGHT SHALL BE INCREASED IN WIDTH TO 345mm TO A MAX. OVERALL HEIGHT 1.75m.
10. IN TERMS OF THE NATIONAL WATER ACT, 36 OF 1998, A RATE OF DISCHARGE FROM AN OUTLET STRUCTURE SHALL NOT EXCEED 1m/SEC AND SHALL NOT BE GREATER THAN 100mm IN DEPTH. IF DESIGN INDICATIONS ARE THAT THESE FIGURES WILL BE EXCEEDED, ADDITIONAL ENERGY DISSIPATION MEASURES WILL BE REQUIRED.

AMENDMENTS			
No.	DATE	APPROVED	DESCRIPTION

DESIGNED BY: | DRAWN BY:
STRUCTURAL DESIGN BY: | DRAWING CHECKED BY:
CHECKED BY: | DRAWING APPROVED BY:

CITY OF JOHANNESBURG

JOHANNESBURG ROADS AGENCY (PTY) LTD

Drawing Sub-set: STORMWATER: DESIGN

TYPICAL OUTLET STRUCTURE DETAILS

SCALE AS SHOWN: NTS

DATE: 18/05/2015

DRAWING NUMBER: JRA-SD SW-081 | EXTN.

AMENDMENT NUMBER:

LOCALITY PLAN
NTS

UNITAS PARK EXT.16 – P. BENCHMARKS WG–29				DESCRIPTION
BM1B	89603.38	2946872.99	1468.80	12mm Iron Peg in concrete
BM2B	89184.97	2946609.98	1470.33	12mm Iron Peg in concrete
BM3B	89396.12	2946070.32	1477.67	12mm Iron Peg in concrete
BM4B	90214.71	2945629.83	1478.42	12mm Iron Peg in concrete
BM5B	90982.23	2946053.61	1472.43	12mm Iron Peg in concrete
QU7	90424.23	2945692.86	1476.87	12mm Iron Peg in concrete

SEE DWG 7001/SW/U002

SEE DWG 7001/SW/U002

STORMWATER RETICULATION LAYOUT
SCALE 1:1500

NOTES

1. ALL MATERIAL AND WORKMANSHIP MUST COMPLY WITH THE REQUIREMENTS OF THE LATEST RELEVANT SABS REQUIREMENTS.
2. ALL DIMENSIONS ARE IN MILLIMETERS. (UNLESS OTHERWISE SPECIFIED)
3. DO NOT SCALE FROM THESE DRAWINGS.
4. ALL DIMENSIONS MUST BE CHECKED AND APPROVED ON SITE.
5. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, THIRD EDITION 2005 AND THE STANDARD CTMM DETAIL DRAWINGS
6. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS. (IF APPLICABLE)
7. THIS DRAWING MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, SERIES 4.
8. THE SIGNATURE OR INITIALS ON THIS DRAWING, OF ANY MANAGER OF THE TRANSPORT DEPARTMENT, IN NO WAY REMOVES ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT.
9. THE CONSULTANT REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARD DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE TRANSPORT DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH.
10. FINAL POSITION OF SERVICES TO BE DETERMINED ON SITE.
11. THE CONTRACTOR SHALL WHERE NECESSARY DETERMINE THE EXACT LOCATION OF EXISTING SERVICES AND PROTECT THEM FROM DAMAGE THROUGHOUT THE DURATION OF THE WORKS.

LEGEND

- EDGE BEAM
- PROPOSED STORMWATER PIPE
- PIPE DIAMETER AND DISTANCE BETWEEN MANHOLES (49.02m)
- MH7 PROPOSED SW MANHOLE
- KI7 PROPOSED KERB INLET
- DIRECTION OF FLOW
- BM3 BENCHMARK

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS

P.O. BOX 4049
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LYME PARK BRYANSTON 2191
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CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
STORMWATER RETICULATION LAYOUT
SHEET 1 OF 5

REF. NO. –	DESIGNER R. MABOHO
SCALE 1:1000	DRAWING F. MAZIBUKO
DATE 03/2021	CHECKED S. MNGUNI

TYPE NUMBER

DRAWING NUMBER
7001/SW/U001

A1
100mm ON ORIGINAL DRAWING

LOCALITY PLAN
NTS

UNITAS PARK EXT.16 – P. BENCHMARKS WG–29				DESCRIPTION
BM1B	89603.38	2946872.99	1468.80	12mm Iron Peg in concrete
BM2B	89184.97	2946609.98	1470.33	12mm Iron Peg in concrete
BM3B	89396.12	2946070.32	1477.67	12mm Iron Peg in concrete
BM4B	90214.71	2945629.83	1478.42	12mm Iron Peg in concrete
BM5B	90982.23	2946053.61	1472.43	12mm Iron Peg in concrete
QU7	90424.23	2945692.86	1476.87	12mm Iron Peg in concrete

SEE DWG 7001/SW/U002

SEE DWG 7001/SW/U002

SEE DWG 7001/SW/U003

STORMWATER RETICULATION LAYOUT
SCALE 1:1500

NOTES

1. ALL MATERIAL AND WORKMANSHIP MUST COMPLY WITH THE REQUIREMENTS OF THE LATEST RELEVANT SABS REQUIREMENTS.
2. ALL DIMENSIONS ARE IN MILLIMETERS. (UNLESS OTHERWISE SPECIFIED)
3. DO NOT SCALE FROM THESE DRAWINGS.
4. ALL DIMENSIONS MUST BE CHECKED AND APPROVED ON SITE.
5. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, THIRD EDITION 2005 AND THE STANDARD CTMM DETAIL DRAWINGS
6. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS. (IF APPLICABLE)
7. THIS DRAWING MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, SERIES 4.
8. THE SIGNATURE OR INITIALS ON THIS DRAWING, OF ANY MANAGER OF THE TRANSPORT DEPARTMENT, IN NO WAY REMOVES ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT.
9. THE CONSULTANT REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARD DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE TRANSPORT DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH.
10. FINAL POSITION OF SERVICES TO BE DETERMINED ON SITE.
11. THE CONTRACTOR SHALL WHERE NECESSARY DETERMINE THE EXACT LOCATION OF EXISTING SERVICES AND PROTECT THEM FROM DAMAGE THROUGHOUT THE DURATION OF THE WORKS.

LEGEND

- EDGE BEAM
- PROPOSED STORMWATER PIPE
- 49.02m — PIPE DIAMETER AND DISTANCE BETWEEN MANHOLES
- MH7 — PROPOSED SW MANHOLE
- K17 — PROPOSED KERB INLET
- DIRECTION OF FLOW
- BM3 — BENCHMARK

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS

P.O. BOX 4049
RANDBURG 2125
FIRST FLOOR 24 PETER PLACE
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CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
STORMWATER RETICULATION LAYOUT
SHEET 2 OF 5

REF. NO. –	DESIGNER R. MABOHO
SCALE 1:1500	DRAWING F. MAZIBUKO
DATE 03/2021	CHECKED S. MNGUNI
TYPE NUMBER	
DRAWING NUMBER 7001/SW/U002	

A1
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STORMWATER RETICULATION LAYOUT
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UNITAS PARK EXT.16 – P. BENCHMARKS WG–29				DESCRIPTION
BM1B	89603.38	2946872.99	1468.80	12mm Iron Peg in concrete
BM2B	89184.97	2946609.98	1470.33	12mm Iron Peg in concrete
BM3B	89396.12	2946070.32	1477.67	12mm Iron Peg in concrete
BM4B	90214.71	2945629.83	1478.42	12mm Iron Peg in concrete
BM5B	90982.23	2946053.61	1472.43	12mm Iron Peg in concrete
QU7	90424.23	2945692.86	1476.87	12mm Iron Peg in concrete

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LEGEND

- EDGE BEAM
- PROPOSED STORMWATER PIPE
- PIPE DIAMETER AND DISTANCE BETWEEN MANHOLES (49.02m)
- MH7 PROPOSED SW MANHOLE
- KI7 PROPOSED KERB INLET
- DIRECTION OF FLOW
- BM3 BENCHMARK

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- MH7 — PROPOSED SW MANHOLE
- KI7 — PROPOSED KERB INLET
- DIRECTION OF FLOW
- BM3 — BENCHMARK
- EXISTING RIVER
- ROUTE R54

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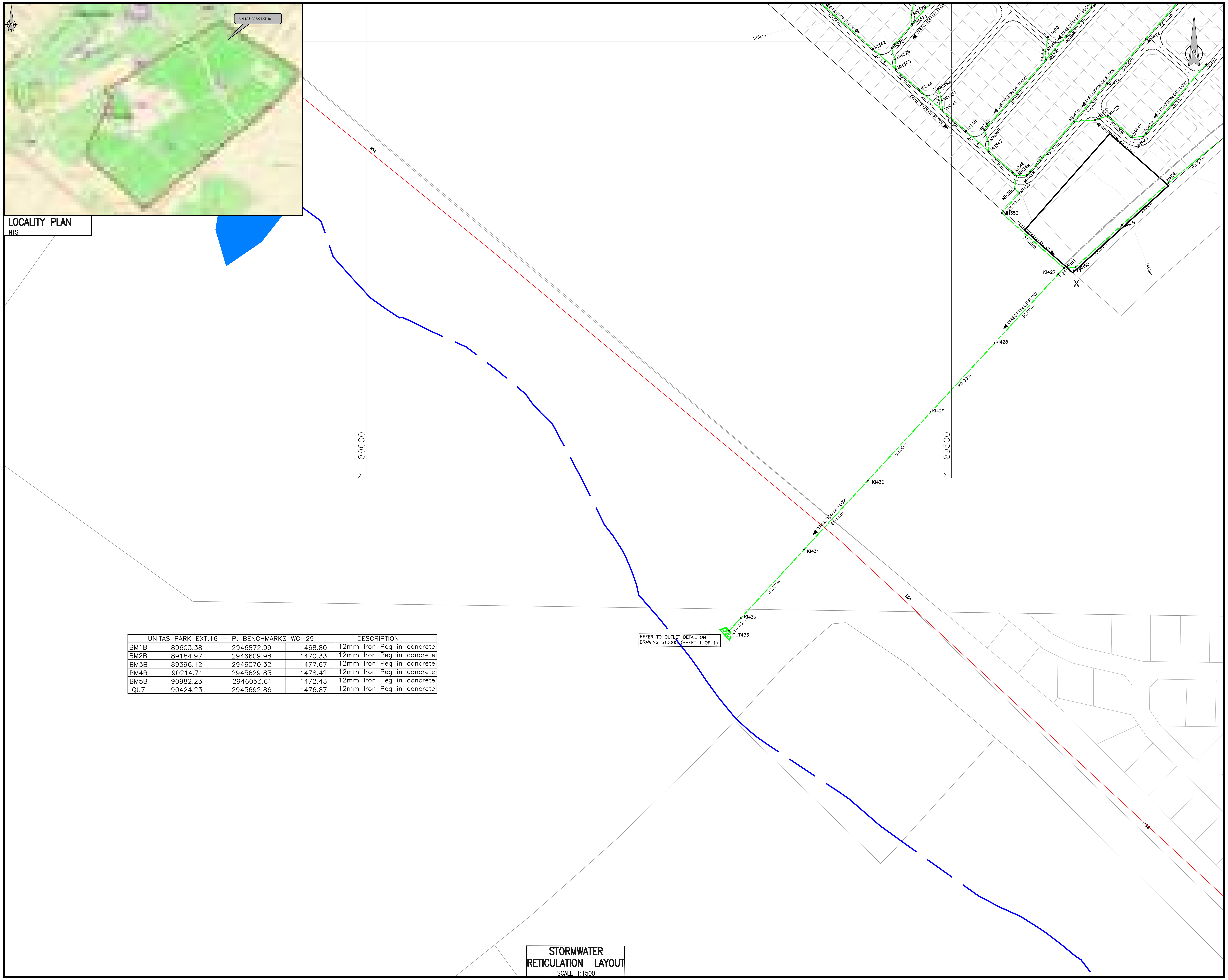

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APPENDIX B4
Ecological Study

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Proposed Residential and Mixed-Use Development in Unitas Park Extension 16, Emfuleni Local Municipality Gauteng: Ecological & Wetland Impact Assessment Report

Version – 02

11 June 2021

GCS Project Number: 19-0921

Prepared for: Phumaf Engineering

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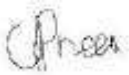
Author	Gareth Preen		14 June 2021
Author, Document Reviewer & Ecology Unit Manager	Magnus Van Rooyen		14 June 2021
Director	Magnus Van Rooyen		14 June 2021

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DECLARATION

I, Gareth Preen, declare that:

- I act as an independent specialist;
- Results will be interpreted in an objective manner, even if the viewpoints are not favourable to the applicant;
- I have the relevant expertise to conduct a report of this nature, including knowledge of the National Environmental Management Act (Act 107 of 1998) and the National Water Act (Act 36 of 1998);
- I will comply with the act(s) and other relevant legislation; and
- I understand that any false information published in this document is an offense in terms of regulation 71 and is punishable in terms of Section 24 (f) of the Act.

_____

Gareth Preen
Environmental Scientist

EXECUTIVE SUMMARY

GCS Water and Environmental Consultants (Pty) Ltd (GCS) have been appointed by Phumaf Engineering (Phumaf) to undertake the Environmental Impact Assessment (EIA) process for the proposed development of residential and mixed land uses as part of the Gauteng Rapid Land Release Programme (GRLRP) hereafter referred to as the 'proposed development'. As part of the EIA process, Phumaf require terrestrial ecological and wetland assessments of portion 222 of the farm, Houtkop 594, otherwise known as Unitas Park Extension 16 and will hereafter be referred to as the 'proposed development area'.

Wetland Assessment

The wetland impact assessment identified one (1) unchanneled valley bottom wetland within the 500m regulated area. Further assessment of the wetland determined the wetland to be moderately modified (Class C) and providing moderate low ecosystem goods and services. The results of the RAM indicated that the proposed residential development poses a low risk of impact on the wetland. However, the proposed construction of a WWTP and direct discharge of effluent into the wetland poses high risk of permanent impact on the wetland. It was determined that the PES of the wetland will reduce to largely modified with a loss of 4.89 Ha of functional wetland. Additionally, the ability of the wetland to provide ecosystem goods and services will be measurably negatively impacted.

Based on the findings of the wetland assessment, the following recommendations have been highlighted for consideration

- The wetland system must be demarcated as a no-go zone;
- Further investigation should take place into piping and discharging the effluent into the Vaal River as this will present the least impacts to the wetland;
- The impacts associated with this on the Vaal River will need to be assessed by an aquatic scientist; and
- The mitigation measures outlined within this report must be implemented.

Ecological Assessment

The ecological assessment identified 3 habitat types as follows:

- Open grassland;
- Degraded grassland; and
- Freshwater hydrophytes.

The open and degraded grassland were determined to have low to very low naturalness due to the extensive commercial agriculture taking place within the study area. During the infield floral assessment, no species of conservation concern were observed. The study area falls

within the Soweto Highveld Grassland which is considered to be endangered. However, very small and scattered areas of open grassland was identified.

Although the area has the potential to provide habitat for a diverse range of fauna species in a natural state, the degraded nature resulted in very few fauna species being observed. One (1) mammal species, namely the *Lepus saxtilis* (Scrub Hare) (LC) was observed. Additionally, large flocks of *Streptopelia decipiens* (African Dove) (LC) were observed.

Based on the findings of the ecological assessment, the following recommendations have been highlighted for consideration:

- The open grassland areas must be avoided as far as reasonably practicable;
- Vegetation clearing must be limited to the site plan only. No unnecessary vegetation clearing is permitted;
- An Invasive Alien Plant Species (IAPS) management plan must be compiled prior to the commencement of the construction phase. This plan must be implemented throughout the construction and operational phase and must be monitored by the ECO;
- Soil disturbance must be limited to the site plan only. Construction machinery may only use the existing pathways. Suitable drip trays must be placed beneath stationary construction machinery;
- No fires are permitted on site;
- Dust control measures must be implemented;
- Erosion control measures must be implemented throughout the site. Stockpiles may not exceed 5 m in height and must be covered using an impermeable material; and
- Suitable waste receptacles must be placed around the site which are both scavenger and wind proof.

CONTENTS PAGE

1 INTRODUCTION 9
1.1 LOCALITY 10
1.2 SCOPE OF WORK 12
1.2.1 Wetland Study 12
1.2.2 Ecological Study 12
2 METHODOLOGIES 12
2.1 WETLAND STUDY 12
2.1.1 Desktop Assessment 12
2.1.2 Present Ecological State (PES) 15
2.1.3 Wetland Functional Importance (EcoServices) 17
2.2 ECOLOGICAL ASSESSMENT 18
2.2.1 Desktop Assessments 18
2.2.2 Phytosociological Classification 21
3 LEGISLATION APPLICABLE TO WETLANDS AND BIODIVERSITY 21
3.1 LEGISLATION APPLICABLE TO WETLANDS 21
3.2 LEGISLATION APPLICABLE TO BIODIVERSITY 23
4 LOCAL SETTING AND CONTEXT 25
4.1 CLIMATE 25
4.2 TOPOGRAPHY, DRAINAGE AND WATERCOURSES 25
4.3 GEOLOGY AND SOILS 27
4.4 LAND COVER & LAND USE OF THE REGION 27
4.5 FLORA AND FAUNA 28
4.5.1 Mucina & Rutherford Vegetation Units (2006) 28
4.5.2 NEMBA Threatened Ecosystems 28
4.5.3 Gauteng Conservation Plan/Ecological Support Areas 29
4.6 NATIONAL FRESHWATER ECOSYSTEM PRIORITY AREAS (NFEPAS) 29
5 RESULTS AND FINDINGS 31
5.1 WETLAND ASSESSMENT 31
5.1.1 Catchment and site-specific impacts 34
5.1.2 Present Ecological State (PES) 35
5.1.3 Wetland Functional Importance 38
5.2 ECOLOGICAL ASSESSMENT 39
5.2.1 Study area and site-specific impacts 39
5.2.2 Habitat Diversity 41
5.2.3 Flora of Conservation Concern 48
5.2.4 Mammals 48
5.2.5 Amphibians 51
5.2.6 Reptiles 52
5.2.7 Dragonflies and Damselflies 53
5.2.8 Avifauna 54
6 PRELIMINARY WETLAND IMPORTANCE AND SENSITIVITY 54
6.1 WETLAND AND RIVER FEPA'S 54
7 POTENTIAL PLANNING IMPLICATIONS AND CONSTRAINTS 57
7.2 ECOLOGICAL IMPORTANCE AND SENSITIVITY CONSTRAINTS 57
7.3 RECOMMENDED BUFFER ZONES FOR PLANNING PURPOSES 58
7.3.1 Background to Buffer Determination 58
7.3.2 Site Specific Buffers 58
8 POTENTIAL IMPACTS AND RECOMMENDED MITIGATION MEASURES 60

8.1 CONSTRUCTION AND OPERATIONAL PHASE 60
9 RISK ASSESSMENT MATRIX 66
9.1 RISK IDENTIFICATION AND CATEGORIZATION 66
9.2 RISK ASSESSMENT ASSUMPTIONS 67
9.3 RAM RESULTS AND DISCUSSION 67
10 HYPOTHETICAL OPERATION PHASE SCENARIO 69
10.1 ECOSYSTEM GOODS AND SERVICES – OPERATION PHASE SCENARIO 69
10.2 PRESENT ECOLOGICAL STATE – OPERATION PHASE SCENARIO 71
10.3 ADDITIONAL MITIGATION MEASURES 72
11 MONITORING REQUIREMENTS 77
12 REASONED OPINION BY THE SPECIALIST 77
13 CONCLUSION AND RECOMMENDATIONS 79
13.1 WETLAND ASSESSMENT 79
13.2 ECOLOGICAL ASSESSMENT 79
14 REFERENCES 81

LIST OF FIGURES

Figure 1-1: Map illustrating the site locality. 11
Figure 2-1: National Wetland Classification System (Source: SANBI, 2009)..... 15
Figure 4-1: Map illustrating the quaternary catchments and WMAs 26
Figure 4-2: Map illustrating sensitive environments. 30
Figure 5-1: Topographical profile of UVB01 (Source: Google Earth Pro, 2020). 32
Figure 5-2: Map illustrating the location of UVB01..... 33
Figure 5-3: Map illustrating the canalisation at the head and toe of the wetland. 37
Figure 5-4: Diagram illustrating the extent and variety of ecosystems services provided by UVB01..... 38
Figure 5-5: Aerial photograph taking at the northern portion of the site looking south illustrating the expanse of agriculture across the study site. 40
Figure 5-6: Aerial photograph taking near the southern portion of the site looking east illustrating the level of urban sprawl. The canalised valley bottom wetland is indicated. . 40
Figure 5-7: Photograph illustrating the phytosociological classification being undertaken in the open grassland (Red lines indicate the 4 x 4m quadrant). 42
Figure 5-8: Photograph illustrating the phytosociological classification being undertaken in the degraded grassland (Red lines indicate the quadrant)..... 42
Figure 5-9: Map illustrating the different habitats..... 46
Figure 5-10: Map illustrating the floral survey points..... 47
Figure 5-11: Graph illustrating the relationship between population size and extinction risk. (Source: SANBI, 2010). 48
Figure 5-12: Pie chart illustrating the red data status distribution of mammal species. 50
Figure 5-13: Photograph of a Scrub Hare (Source: www.fascinatingafrica.com) 50
Figure 5-14: Pie chart illustrating the red data status distribution of amphibian species... 51
Figure 5-15: Photograph of a Giant Bullfrog (Source: www.lafebar.com) 52
Figure 5-16: Pie chart illustrating the red data status distribution of reptile species. 53
Figure 5-17: Pie chart illustrating the red data status distribution of dragonfly and damselfly species..... 53
Figure 5-18: Pie chart illustrating the red data status distribution of avifauna species. 54
Figure 6-1: Map illustrating the ephemeral drainage line flowing into an FEPA Rive 56
Figure 7-1: Map illustrating the buffer zone requirements 59
Figure 10-1: Diagram illustrating the extent and variety of ecosystems services provided by UVB01 pre-construction (Source: GCS, 2020). 70

Figure 10-2: Diagram illustrating the extent and variety of ecosystems services provided by UVB01 in an operational phase scenario. 70
Figure 10-3: Aerial photograph illustrating the proximity of infrastructure to the canal. .. 72

LIST OF TABLES

Table 1-1: Approximate centre point coordinates of the proposed development. 10
Table 2-1: Data sources utilised during the desktop wetland assessment. 13
Table 2-2: National Wetland Classification System (Source: SANBI, 2009). 13
Table 2-3: Guideline for determining the magnitude of impacts (Source: Macfarlane *et al*, 2008). 16
Table 2-4: Description of health scores used in the WET-Health tool (Source: Macfarlane *et al*, 2008). 16
Table 2-5: List of EcoServices provided by wetlands (Source: Kotze *et al*, 2007). 17
Table 2-6: EcoServices rating classes (Source: Kotze *et al*, 2009). 18
Table 2-7: Internet based and geospatial datasets utilised during the desktop assessment. 20
Table 4-1: Summary of description of the Soweto Highveld Grassland unit. (Source: Mucina and Rutherford, 2006). 28
Table 5-1: Wetlands within the study area and potential risk of impact. 32
Table 5-2: Summary of the WET-Health Scores for the UVB01 wetland system. 35
Table 5-3: WET-Health Assessment. 36
Table 5-4: Description of the open grassland. 43
Table 5-5: Description of the degraded grassland. 44
Table 5-6: Description of the freshwater hydrophytes. 44
Table 5-7: Description of the red data list categories (Source: IUCN, 2019). 48
Table 8-1: Potential environmental impacts associated with the construction phase. 61
Table 8-2: Potential environmental impacts associated with the operational phase. 65
Table 9-1: Summary of risks that were assessed. 66
Table 9-2: Summary of risk scores and ratings. 68
Table 10-1: WET-Health Scores. 72

LIST OF APPENDICES

Appendix 1 Amphibian species list 84
Appendix 2 Avifauna species list 85
Appendix 3 Dragonflies and damselflies 87
Appendix 4 Mammal species list 88
Appendix 5 Reptile species list. 91
Appendix 6 Flora species 92
Annexure 7 wetland risk assessment matrix residential infrastructure 93
Annexure 8 wetland risk assessment matrix WWTP 95

1 INTRODUCTION

GCS Water and Environmental Consultants (Pty) Ltd (GCS) have been appointed by Phumaf Engineering (Phumaf) to undertake the Environmental Impact Assessment (EIA) process for the proposed development of residential and mixed land uses as part of the Gauteng Rapid Land Release Programme (GRLRP) hereafter referred to as the 'proposed development'. As part of the EIA process, Phumaf require terrestrial ecological and wetland assessments of portion 222 of the farm, Houtkop 594, otherwise known as Unitas Park Extension 16 and will hereafter be referred to as the 'proposed development area'.

The proposed development is expected to consist of 7 250 housing units that will be supplied with potable water. Domestic wastewater will be generated by each unit which will be directed to the on-site Waste Water Treatment Plant (WWTP) for treatment. Following treatment, the effluent will need to be discharged. Several measures have been proposed as follows:

- Discharge of 20 000m^3 of treated effluent per day into the wetland;
- Reduction of effluent to 5 000m^3 per day with gradual increases in volume to 20 000m^3 once the wetland has adapted in terms of functionality.
- Pipe the effluent approximately 6.12km downstream and discharge directly into the Vaal River. This will likely require authorisation in terms of a Water Use License (WUL), however, this will not impact on the wetland.
- The storage of effluent was identified as an alternative but will not be feasible as the volumes are too great.
- Using the treated effluent for irrigation was also identified as an alternative but the site is located in a semi-urban setting with no agricultural activity requiring irrigation in the immediate vicinity.
- The treatment of effluent to potable drinking water by a water treatment plant is not feasible due to the stigma around it and potential rejection of future residents. Additionally, there is currently political opposition to the treatment of effluent to potable drinking standards as opposed to discharge into the environment.
- The construction of a formalised channel within the wetland was suggested. However, this will present a direct impact to the wetland.
- Lastly, the construction of an artificial wetland to attenuate and treat effluent before releasing it into the wetland was suggested. However, this will be a costly venture.

GCS undertook the infield assessment on the 04th of March 2020. The proposed development site is approximately 146.54 hectares (Ha) in size and the current land use practices observed are commercial agriculture, residential infrastructure and road infrastructure. Following the

completion of the initial field assessment, GCS were requested to assess the potential impact of the WWTW on the wetland.

1.1 Locality

The proposed development area and associated study area are located approximately 5.1 kilometers (kms) north west of the town of Vereeniging, within the Emfuleni Local and Sedibeng District Municipalities, Gauteng (Figure 1-1). The approximated centre point coordinates for the proposed development area are provided in Table 1-1 below.

Table 1-1: Approximate centre point coordinates of the proposed development.

DESCRIPTION	LATITUDE	LONGITUDE
Approximate centre point of the proposed development	26°37'30.35"S	27°54'12.42"E

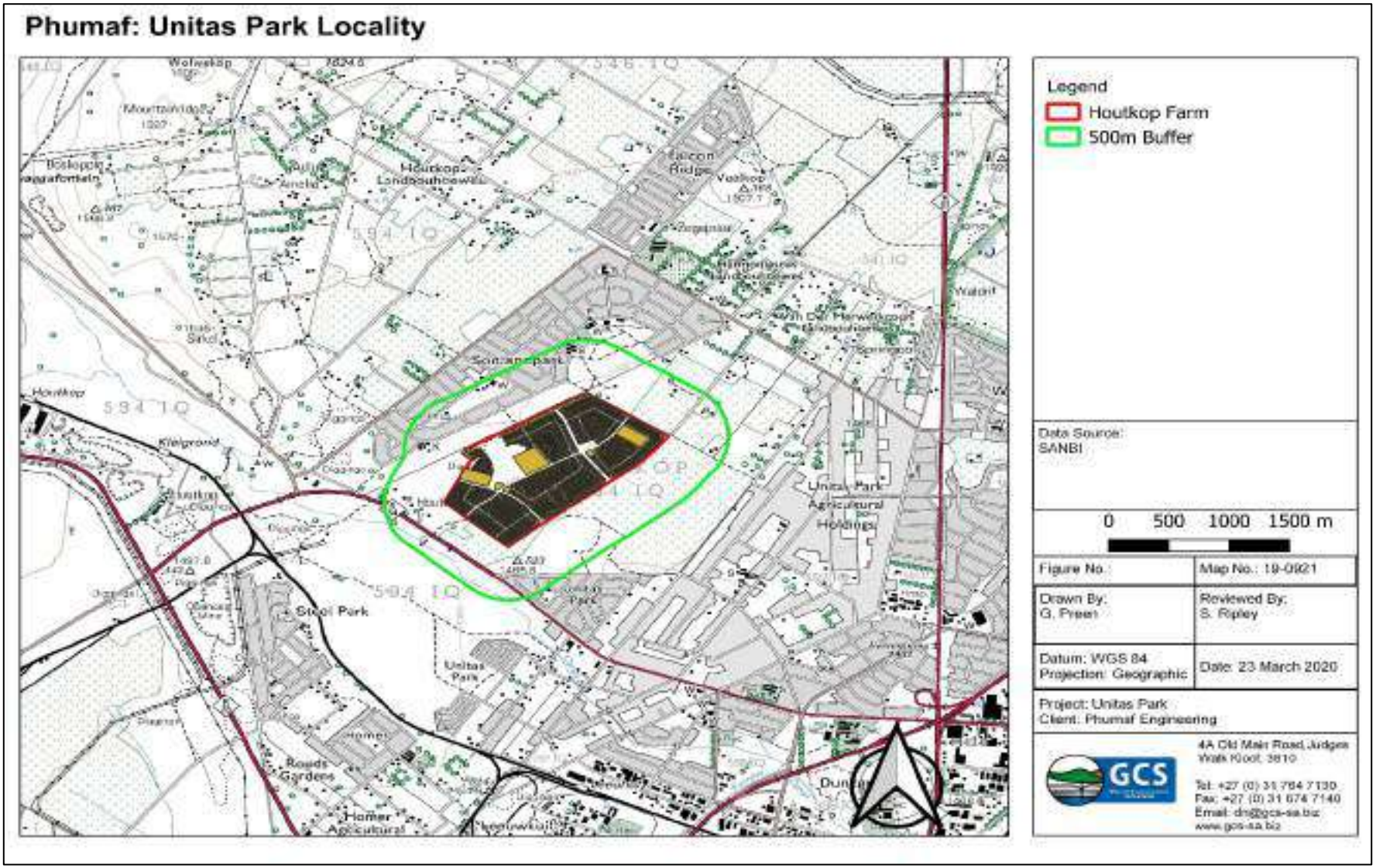

Figure 1-1: Map illustrating the site locality.

1.2 Scope of Work

The scope of work to undertake the wetland and biodiversity assessments are as follows:

1.2.1 Wetland Study

- Desktop delineation and illustration of the wetland systems within the study area utilising available satellite imagery and relevant geospatial data sources;
- Infield ground truthing and delineation of wetland boundaries in accordance with the methodologies outlined in 'A Practical Field Procedure for the Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2009);
- Classification of the Hydrogeomorphic (HGM) setting of the wetlands identified on site using the National Wetland Classification System by the South African National Biodiversity Institute (SANBI) (2009);
- Assessment of the Present Ecological State (PES) and Ecological Goods and Services (EcoServices) of the Wetland;
- Identification, prediction and description of the potential impacts of the proposed development on the wetland systems within the study area;
- Mitigation measures for the identified potential impacts;
- Rehabilitation guidelines for disturbed areas associated with the proposed development; and
- Monitoring protocol for the proposed development.

1.2.2 Ecological Study

- Desktop assessment of relevant internet based and geospatial data sources;
- Phytosociological classification to identify dominant vegetation species;
- Visual based survey of fauna species within the study area;
- Identification, prediction and description of the potential impacts of the proposed development on the biodiversity within the study area;
- Mitigation measures for the identified potential impacts;
- Rehabilitation guidelines for disturbed areas associated with the proposed development; and
- Monitoring protocol for the proposed development.

2 METHODOLOGIES

2.1 Wetland Study

2.1.1 Desktop Assessment

The desktop assessment made use of satellite imagery of the study area as well as geospatial data as listed in Table 2-1. The data sources were utilised to identify potential wetland systems within the study are and the expected boundaries were mapped. The potential

wetland areas were then classed into their respective Hydrogeomorphic (HGM) units based on the 'National Classification System (SANBI, 2009) (Table 2-2) (Figure 2-1). The completed map was then used as a guide during the infield assessment and the location, boundaries and classification of the HGM units were confirmed.

Table 2-1: Data sources utilised during the desktop wetland assessment.

DATA	SOURCE	APPLICABILITY
Google Earth Satellite Imagery	Google Earth Pro ™	Up to date and historical satellite imagery of the study area, desktop wetland identification and delineation.
Contour Lines	Surveyor General	Desktop identification of drainage lines and potential freshwater resources.
Vegetation of South Arica, Lesotho and Swaziland.	Mucina and Rutherford (2006)	Determination of the vegetation unit within which the study area is located.
National Freshwater Ecosystem Priority Areas (NFEPAs)	CSIR (2011)	Identification of any conservation important freshwater resources.

Table 2-2: National Wetland Classification System (Source: SANBI, 2009).

HGM Type	Landscape Setting	Hydrological Characteristics		
		Inputs	Throughputs	Outputs
1. Channelled Valley Bottom Wetland	Valley floor	• Overland flow from adjacent valley-side slopes • Lateral seepage from adjacent hillslope seeps • Channel overspill during flooding	• Diffuse surface flow • Temporary storage in depressions • Short-lived concentrated flows during flood events	• Diffuse surface flow and interflow into adjacent channel • Infiltration and evaporation
2. Un-channelled Valley Bottom Wetland	Valley floor / plain	• Concentrated or diffuse surface flow from upstream • Channels and tributaries • Overland flow from adjacent valley-side slopes • Lateral seepage from adjacent hillslope seeps • Groundwater	• Diffuse surface flow, • interflow, temporary storage of water in depressions, • Possible short-lived concentrated flows during high-flow events	• Diffuse or concentrated surface flow, • Infiltration and evaporation (particularly from depressional areas)

HGM Type	Landscape Setting	Hydrological Characteristics		
		Inputs	Throughputs	Outputs
3. Floodplain Wetland	Valley floor / plain	• Channel overspill during flooding (predominantly) • Some overland flow from adjacent valley-side slopes (if present) • Lateral seepage from adjacent hillslope seeps (if present)	• Diffuse surface flow • interflow temporary storage of water in depressions • possible short-lived concentrated flows during flooding events	• Diffuse surface flow and interflow into adjacent channel • Infiltration and evaporation (particularly from depressional areas)
4. Exorheic Depression with channelled inflow	Slope / valley floor / plain / bench	• Precipitation • Concentrated and (possibly) diffuse surface flow • Interflow • Groundwater	• Storage of water • Slow through-flow	• Concentrated surface flow
5. Exorheic Depression without channelled inflow	Slope / valley floor / plain / bench	• Precipitation • Diffuse surface flow • Interflow • Groundwater	• Storage of water • Slow through-flow	• Concentrated surface flow
6. Endorheic Depression with channelled inflow	Slope / valley floor / plain / bench	• Precipitation • Concentrated and (possibly) diffuse surface flow • Interflow • Groundwater	• Containment and storage of water	• Evaporation • Infiltration
7. Endorheic Depression without channelled inflow	Slope / valley floor / plain / bench	• Precipitation • Diffuse surface flow • Interflow • Groundwater	• Containment and storage of water	• Evaporation • Infiltration
8. Flat	Plain / bench	• Precipitation • Groundwater	• Containment of water • Some diffuse surface flow and/or interflow	• Evaporation • infiltration
9. Hillsope Seep with channelled outflow	Slope	• Groundwater • Precipitation (perched)	• Diffuse surface flow • Interflow	• Concentrated surface flow
10. Hillslope Seep without channelled outflow	Slope	• Groundwater • Precipitation (perched)	• Diffuse surface flow • Interflow	• Diffuse surface flow • Interflow • Evaporation • Infiltration
11. Valley Head Seep	Valley floor	• Groundwater • Diffuse surface flow • Precipitation	• Diffuse surface flow • Interflow	• Concentrated surface flow

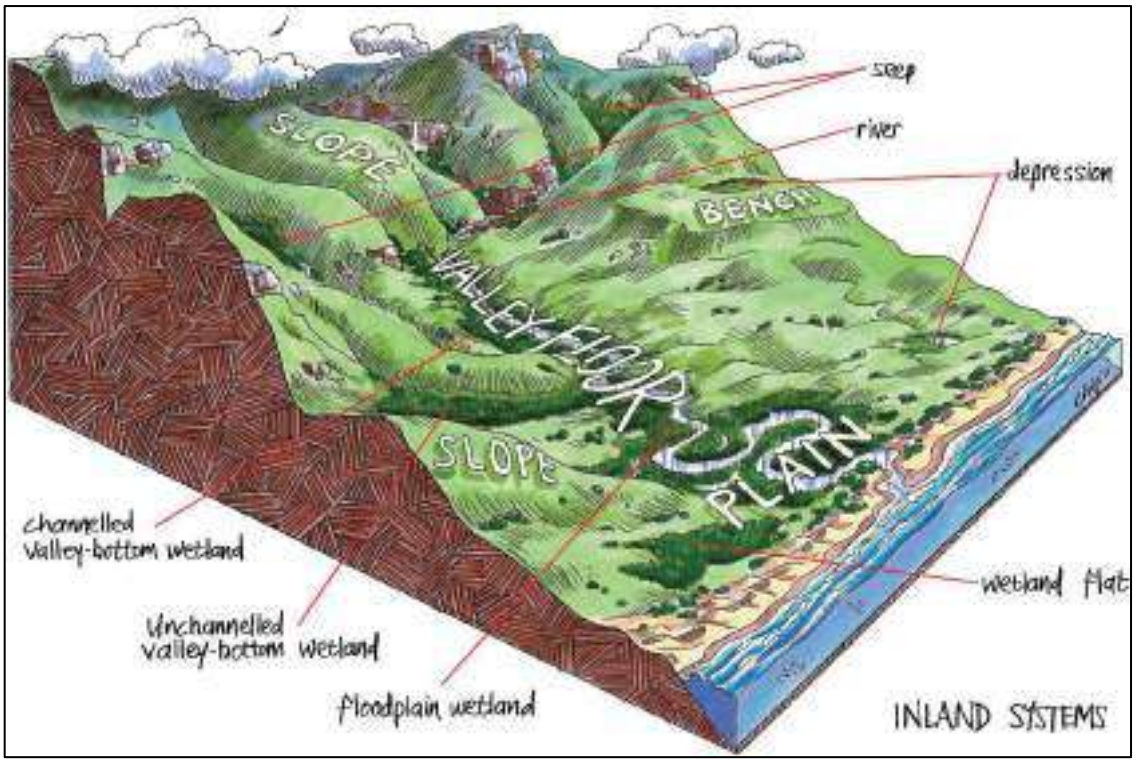

Figure 2-1: National Wetland Classification System (Source: SANBI, 2009).

2.1.2 Present Ecological State (PES)

For the purposes of this report, Present Ecological State (PES) of a wetland is a measure of how much a wetland's structure and functioning has been changed from its natural state. The 'WET-Health: A technique for rapidly assessing wetland health' by Macfarlane *et al*(2007) was applied to determine the PES. The WET-Health assists in determining the health of wetlands using indicators based on geomorphology, hydrology and vegetation. The tool allows for the determination of the source of ecosystem degradation.

WET-Health was utilised to quantify the impacts of anthropogenic impacts on wetland health which was then converted to an impact score (PES). It was necessary to assess the spatial extent and intensity of each identified impact on the wetland system. Subsequent to this, an overall magnitude of impact score was determined as outlined in Table 2:3 for geomorphology, hydrology and vegetation within the wetland system.Table 2:3: Guideline for determining the magnitude of impacts (Source: Macfarlane *et al*, 2008).

Table 2-3: Guideline for determining the magnitude of impacts (Source: Macfarlane *et al*, 2008).

IMPACT CATEGORY	DESCRIPTION	SCORE
None	No discernible modification or the modification is such that it has no impact on this component of wetland integrity.	0 - 0.9
Small	Although identifiable, the impact of this modification on this component of wetland integrity is small.	1 - 1.9
Moderate	The impact of this modification on this component of wetland integrity is clearly identifiable, but limited.	2 - 3.9
Large	The modification has a clearly detrimental impact on this component of wetland integrity. Approximately 50% of wetland integrity has been lost.	4 - 5.9
Serious	The modification has a highly detrimental effect on this component of wetland integrity. Much of the wetland integrity has been lost but remaining integrity is still clearly identifiable.	6 - 7.9
Critical	The modification is so great that the ecosystem processes of this component of wetland integrity are almost totally destroyed, and	8 - 10

Impact scores obtained for each of the above-mentioned components indicate the degree of change from natural conditions. The resultant health scores fall into one of six health categories on a gradient from 'unmodified/natural (Category A) to 'critically modified' (Category F). The descriptions of each health score category is provided in Table 2-4.

Table 2-4: Description of health scores used in the WET-Health tool (Source: Macfarlane *et al*, 2008).

IMPACT CATEGORY	DESCRIPTION	RANGE	PES CATEGORY
None	Unmodified, natural.	0 - 0.9	**A**
Small	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1 - 1.9	**B**
Moderate	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2 - 3.9	**C**
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4 - 5.9	**D**
Serious	The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6 - 7.9	**E**
Critical	Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8 - 10	**F**

The overall wetland health score was calculated by weighting the scores obtained for hydrology, geomorphology and vegetation and combining them to produce an overall health score using the following formula:

$$Overall\ Health\ Rating = [(Hydrology \times 3) + (Geomorphology \times 2) + (Vegetation \times 2)] \div 7$$

2.1.3 Wetland Functional Importance (EcoServices)

WET-Ecoservices was utilised to determine and assess the goods and services that the wetland provides. The first step that needed to be undertaken was to classify the wetland according to its HGM unit. Ecosystem service delivery was then assessed either at Level 1, based on existing knowledge or at Level 2, based on a field assessment of key descriptors. For the purposes of this assessment, a Level 2 assessment was undertaken. Several ecosystem goods and services were assessed as outlined in Table 2-5.

Table 2-5: List of EcoServices provided by wetlands (Source: Kotze *et al*, 2007).

Ecosystem services supplied by wetlands	Indirect benefits	Regulating and supporting benefits	Flood attenuation		The spreading out and slowing down of floodwaters in the wetland, thereby reducing the severity of floods downstream
			Streamflow regulation		Sustaining streamflow during low flow periods
			Water quality enhancement benefits	Sediment trapping	The trapping and retention in the wetland of sediment carried by runoff waters
				Phosphate assimilation	Removal by the wetland of phosphates carried by runoff waters
				Nitrate assimilation	Removal by the wetland of nitrates carried by runoff waters
				Toxicant assimilation	Removal by the wetland of toxicants (e.g. metals, biocides and salts) carried by runoff waters
				Erosion control	Controlling of erosion at the wetland site, principally through the protection provided by vegetation.
			Carbon storage		The trapping of carbon by the wetland, principally as soil organic matter
	Direct benefits	**Biodiversity maintenance[2]**			Through the provision of habitat and maintenance of natural process by the wetland, a contribution is made to maintaining biodiversity
		Provisioning benefits	Provision of water for human use		The provision of water extracted directly from the wetland for domestic, agriculture or other purposes
			Provision of harvestable resources		The provision of natural resources from the wetland, including livestock grazing, craft plants, fish, etc.
			Provision of cultivated foods		The provision of areas in the wetland favourable for the cultivation of foods
		Cultural benefits	Cultural heritage		Places of special cultural significance in the wetland, e.g., for baptisms or gathering of culturally significant plants
			Tourism and recreation		Sites of value for tourism and recreation in the wetland, often associated with scenic beauty and abundant birdlife
			Education and research		Sites of value in the wetland for education or research

As with the WET-Health tool, the WET-EcoServices tool a gradient of rating classes is provided

based on the overall scores allocated to the different ecosystem services. The allocation of the rating classes is based on Table 2-6.

Table 2-6: EcoServices rating classes (Source: Kotze *et al*, 2009).

SCORE	<0.5	0.5 - 1.2	1.3 - 2.0	2.1 - 2.8	>2.8
Rating of the likely extent to which a benefit is being supplied.	Low	Moderately	Intermediate	Moderately High	High

2.2 Ecological Assessment

In order to determine the current status of biodiversity within the study area and evaluate the extent of site-related impacts in terms of certain ecological indicators as well as the identification of specific important ecological attributes such as conservation important species, the ecological assessment was split into a floral and faunal component. The floral component consisted of conducting a phytosociological classification as guided by Brown *et al*, (2013). The faunal field assessment component involved sight-based observations in the field and adetailed desktop animal assessment per animal group (mammals, birds, amphibians, reptiles and invertebrates).

Prior to the infield investigation of the flora and fauna, detailed desktop assessments were undertaken for each which is described in the following section.

2.2.1 Desktop Assessments

The desktop ecological assessment made use of internet-based data sources and relevant geospatial datasets in order to compile species lists and to highlight the conservation status of each species which may occur within the study area. The International Union for Conservation of Nature (IUCN) website (https://www.iucnredlist.org/resources/grid) and the Fitzpatrick Institute of African Ornithology: Virtual Museum website (http://vmus.adu.org.za) were utilised to compile species lists for the study area (Table 2-7). The data from both websites were merged to form one comprehensive table of faunal species for the study area. Within these species lists, an outline is provided of species which have been recorded within the study area in the past or have been known to inhabit the area and, where data was available, the number of species recorded, and the date of last record. The red data and protected status of each species, according to the IUCN website, have also been included to gather an indication or the conservation importance of the study area from a faunal perspective.

The geospatial dataset produced by the South African National Biodiversity Institute (SANBI) (2018) in conjunction with Mucina and Rutherford (2012) was utilised to identify the vegetation type within which the study area occurs (Table 2-7). This dataset also provides the conservation status of the relevant vegetation type as well as species of conservation concern which are known to occur within the vegetation type. A species list with accompanying conservation status of the aforementioned species was also compiled.

Table 2-7: Internet based and geospatial datasets utilised during the desktop assessment.

DATASET	SOURCE/S	APPLICABILITY
Amphibian Geospatial Dataset	IUCN (2019) Virtual Museum. Accessed 25 February 2020. www.vmus.org.za	Identification of amphibian species within the study area.
Avifaunal Dataset	Virtual Museum. Accessed 25 February 2020. www.vmus.org.za	Identification of avifaunal species within the study area.
Butterfly Dataset	Virtual Museum. Accessed 25 February 2020. www.vmus.org.za	Identification of butterfly species within the study area.
Dragonflies and Damselflies	Virtual Museum. Accessed 25 February 2020. www.vmus.org.za	Identification of dragonfly and damselfly species within the study area.
Mammal Geospatial Dataset	IUCN (2019) Virtual Museum. Accessed 25 February 2020. www.vmus.org.za	Identification of mammal species within the study area.
Reptile Dataset	IUCN (2019) Virtual Museum. Accessed 25 February 2020. www.vmus.org.za	Identification of reptile species within the study area.
Vegetation Map of South Africa, Lesotho and Swaziland	Mucina and Rutherford (2012) SANBI (2018)	Identification of the vegetation type and species of conservation concern within the study area.

The primary objective of the compilation of the fauna and flora species lists, as described above, was to provide a guide for the field assessment. The lists highlighted the species of conservation concern which needed to be identified if present within the study area. This allowed for any special mitigation and rehabilitation measures to be suggested. However, any other species included in the list which are not of conservation concern were not overlooked during the field assessment. The field assessment was, therefore, necessary to confirm the presence or absence of the listed species within the study area. Where applicable, additional sightings not included in the lists, were included in the final dataset produced within this report.

2.2.2 Phytosociological Classification

The methodology outlined in the 'Guidelines for phytosociological classifications and descriptions of vegetation in Southern Africa' by Brown *et al* (2013) was implemented to carry out the phytosociological classification.

As per the guidelines, it was necessary to identify homogenous vegetation units within the study area using Remote Sensing and a Geographic Information System (GIS). Relevant geospatial datasets such as land use and land cover were utilised in conjunction with satellite imagery to aid in the identification of the vegetation units for the infield survey. During the field assessment, sampling plots were randomly identified ensuring that the plot is representative of the perceived plant community within the larger study area. The sample plots were outlined into quadrants using nylon rope. In order to comply with statistical requirements in local phytosociological studies, a minimum of three (3) sample plots per stratified physiognomic-physiographic units would need to be identified.

Each plant species within the sample plots were identified and recorded. Cover abundance of each species was then assigned based on visual inspection.

3 LEGISLATION APPLICABLE TO WETLANDS AND BIODIVERSITY

3.1 Legislation Applicable to Wetlands

LEVEL	LEGISLATION/POLICY	DESCRIPTION
National	National Water Act (Act 36 of 1998) (NWA)	The NWA protects South Africa's water resources and associated ecosystems and their biological diversity. This act serves to reduce and prevent the pollution and degradation of water resources. Section 21 (c) and (i) of the NWA makes provision for impeding or diverting the flow of a watercourse and the altering of the bed, banks, course or characteristics of a

LEVEL	LEGISLATION/POLICY	DESCRIPTION
		watercourse, respectively. Should a watercourse be located within the 500 m regulated area of a proposed development, a water use license in respect of the above-mentioned water uses will need to be applied for. General Notice 509 published in Government Gazette no. 40229 under section 39 of the NWA makes provision for General Authorisations (GA). The 2015 DWS Risk Assessment Matrix (RAM) is used to determine the risk of the proposed water use to the receiving aquatic environment in terms of Section 21 (c) and (i). The three risk categories are; low, moderate and high. If the water use is determined to be of a low risk to the watercourse, then a GA may be applicable, subject to consultation with the DWS. Should the risk be determined to be moderate or high then full WULA process will need to be followed.
National	National Environmental Management Act (Act 107 of 1998) NEMA.	NEMA is the overarching legislation with regards to the environment which fundamentally promotes sustainable development. The listed activities related to wetlands that require environmental authorization is as follows: Listing Notice 1 (GNR 327) Activity 12: The development of- (i) infrastructure or structures with a physical footprint of 100 square meters or more; where such development occurs- (a) within a watercourse; (b) if no development setback exists, within 32 meters of a watercourse, measured from the edge of a watercourse;- excluding- (aa) the development of infrastructure or structures within existing ports or harbours that will not increase the development footprint of the port or harbour; (bb) where such development activities are related to the development or a port or harbour, in which case activity 26 in Listing Notice 2 of 2014 applies;

LEVEL	LEGISLATION/POLICY	DESCRIPTION
		(cc) activities listed in activity 14 in Listing Notice 2 of 2014 or activity 14 in Listing Notice 3 of 2014, in which case that activity applies; (dd) where such development occurs within an urban area; (ee) where such development occurs within existing roads, road reserves or railway line reserves; or (ff) the development of temporary infrastructure or structure where such infrastructures will be removed within 6 weeks of the commencement of development and where indigenous vegetation will not be cleared.

3.2 Legislation Applicable to Biodiversity

LEVEL	LEGISLATION/POLICY	DESCRIPTION
International	The Convention of Biological Diversity (Rio de Janeiro, 1992).	The purpose of the Convention on Biological Diversity is to conserve the variability among living organisms at all levels. Primary objectives of this convention are to conserve biodiversity, use biodiversity in a sustainable manner and sharing the benefits of biodiversity fairly and equitably.
National	South African Constitution (Act 108 of 1996).	The Constitution is the supreme law of South Africa and is inclusive of the Bill of Rights. This includes the right to an environment which is not harmful to human health or well-being and to have the environment protected for the benefit of present and future generations through reasonable legislative and other measures.
	National Environmental Management Act (NEMA) (Act 107 of 1998).	NEMA is the overarching legislation with regards to the environment which fundamentally promotes sustainable development. The 'precautionary approach' and 'polluter pays' principles are rooted in NEMA and requires responsibility for impacts to be undertaken throughout the life cycle of a proposed project.
	National Environmental Management: Biodiversity Act (NEMBA) (Act 10 of 2004).	NEMBA ensures the management and conservation of biodiversity in South Africa within the framework of NEMA. The purpose of NEMBA is to protect species and ecosystems as well as to promote the sustainable use of biodiversity resources. NEMBA also addresses aspects such as the protection of threatened ecosystems and necessitates a duty of care in terms of alien invasive species. The South African National Biodiversity Institute (SANBI) was established through this act and is

LEVEL	LEGISLATION/POLICY	DESCRIPTION
		responsible for coordinating and implementing programs relating to biodiversity.
	Conservation of Agricultural Resources Act (Act 43 of 1967).	The aim of this act is prevent the exploitation of South Africa's natural agricultural resources and to ensure the conservation of soil and water resources and natural vegetation. The act has also categorised a large number of invasive alien species. The act also provides obligations to landowners on which these species occur such as the removal of categorised invasive alien invasive species and to prevent the proliferation thereof.
	National Forest Act (Act 84 of 1998)	This act provides a comprehensive mandate for the protection of all natural forests in South Africa. Section 3 of the act stipulates that no development may take place if it impacts on a forest. Only in exceptional circumstances may this be allowed. Section 7 of the act prohibits the cutting, disturbance, destruction or removal of any indigenous tree whether it be living or dead in a forest without a license. Section 15 of the act institutes a similar prohibition on protected tree species listed under the act.
	National Environmental Management: Protected Areas Act (Act 57 of 2003).	This Act provides for the protection and conservation of ecologically important areas which represent South Africa's biodiversity and natural landscapes. The act provides for the sustainable utilisation of protected areas and to promote participation of local communities in the management of protected areas.
	Mountain Catchments Areas Act (Act 62 of 1970)	This act provides for the conservation, use, management and control of land in mountain catchment areas. Land users and land owners within these areas are mandated to manage that land through the prevention of soil erosion, removal or exotic and alien invasive vegetation and fire protection.
	Natural Heritage Resources Act (Act 25 of 1999)	This act promotes good management of natural heritage resources and to enable and encourage communities to nurture and conserve their legacy so that it may be passed on to future generations.
Provincial	Transvaal Nature Conservation Ordinance (Act 12 of 1983)	This act ensures the protection of protected areas, flora and fauna in the Gauteng Province.

LEVEL	LEGISLATION/POLICY	DESCRIPTION
	GDARD Requirements for Biodiversity Assessments Version 2	This guides the format and requirements of the biodiversity assessment.

4 LOCAL SETTING AND CONTEXT

4.1 Climate

The study area lies approximately 1445 m above sea level with a warm and temperate climate. The average annual temperature is in the region of 16.5° C and the annual average rainfall is approximately 659 mm. According to the Koppen-Geiger Climate Classification, the study area falls within the Dry-winter subtropical highland climate (Cwb) where winters are noticeably dry and rainy summers.

4.2 Topography, Drainage and Watercourses

From a southerly to northerly direction, the topography across the study area is relatively undulating with a steady rise from the south to the north. A similar topographic profile is evident from the west to the east of the proposed development area. There is a steady undulating decrease of the topographic slope west to east.

The proposed development area falls within the C22F Quaternary Catchment and the Upper Vaal Water Management Area (WMA). (Figure 4-1). The ephemeral drainage line which falls within the study area and which is approximately 426 m south of the proposed development sites drains south east towards the Vaal River.

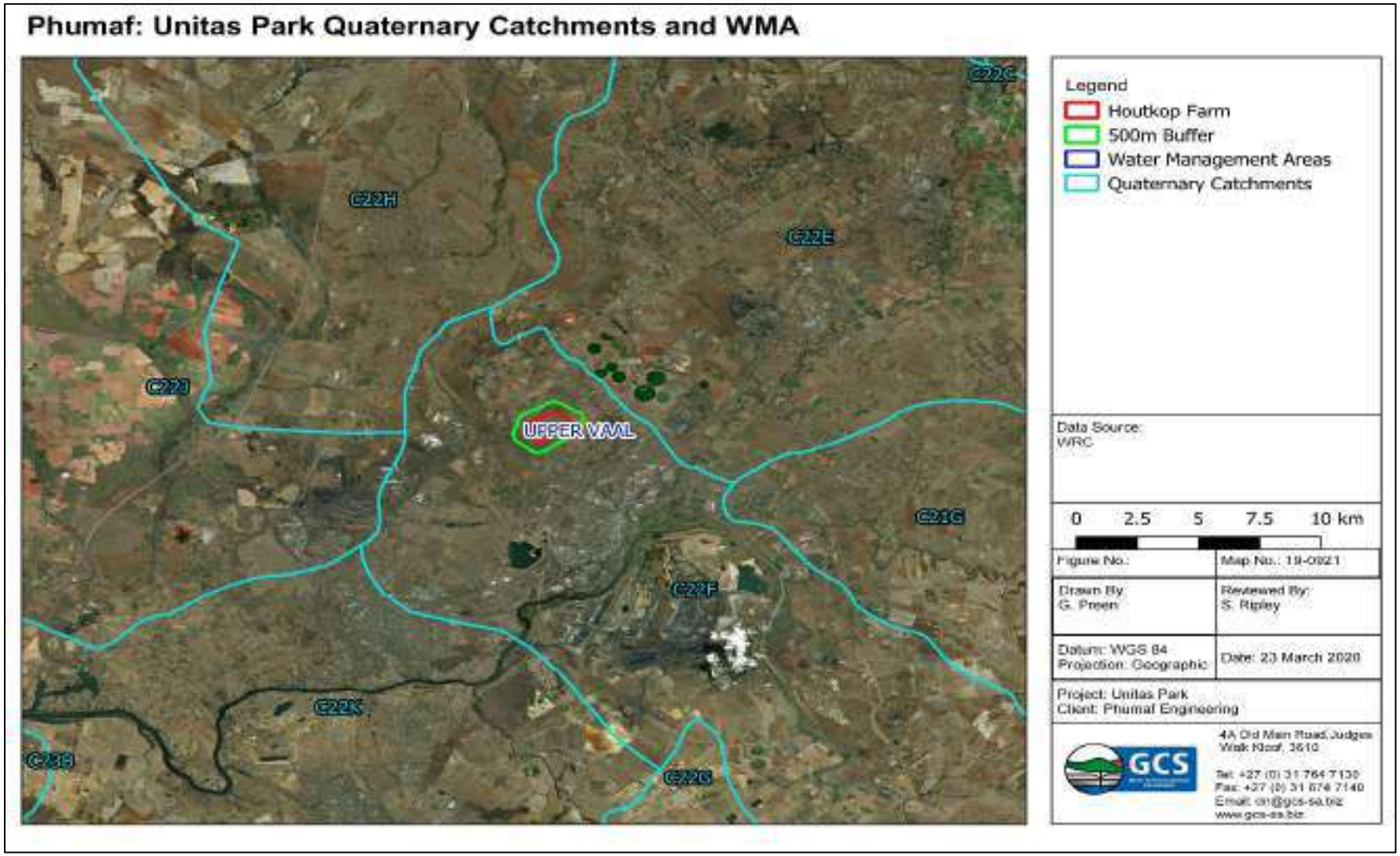

Figure 4-1: Map illustrating the quaternary catchments and WMAs

4.3 Geology and Soils

According to the Environmental Protection Atlas (ENPAT) geology data for the Gauteng Province, the site is underlain by a Quartzite Geology. The associated patterns with the geology in this area are rare upland duplex and margalitic soils and widespread dystrophic and/or mesotrophic red soils. The ENPAT data also indicates that the soil form that overlays this geology is the Hutton Formation.

The Hutton soil formation is characterised by an orthic A-horizon over a red apedal B-horizon. This soil form is generally reddish coloured with a weak structure in which water stagnation does not generally take place.

4.4 Land Cover & Land Use of the Region

For the purpose of this assessment, land cover is loosely categorised into classes that represent natural habitat and categories that contribute to habitat degradation and transformation on a local or regional scale. In terms of the importance for biodiversity, the assumption is that landscapes exhibiting high transformation levels are normally occupied by plant communities and faunal assemblages that do not necessarily reflect the original or pristine status. This is particularly important in the case of conservation important taxa as these plants and animals generally exhibit extremely low tolerance levels towards disturbances. This is one of the main reasons for the threatened status of these species. Changes in the natural environment available to these species are therefore likely to result in severe impacts on these species and, subsequently, their conservation status.

Three important aspects are associated with habitat changes that accompany certain land uses.

- Permanent transformation of natural habitat by land uses such as agriculture, mining and urbanisation results in the permanent decimation of available habitats. These areas will not recover to the original pristine status.
- A second aspect of habitat transformation or degradation is that it affects species directly, namely changes in species presence / absence and – composition. This result from the exodus of species for which habitat conditions have become unfavourable, the decrease in abundance of certain species because of decreased habitat size, or an influx of species that are better adapted to the altered environment. While some, or most, of the new species that occupy an area might be indigenous, they are not necessarily endemic to the area.
- Lastly, a larger threat to the natural biodiversity of a region is represented by the influx of invasive exotic species that can effectively sterilise large tracts of remaining natural habitat.

The proposed development site is located approximately 5.1 kilometers (kms) northwest of the town of Vereeniging, within the Emfuleni Local and Sedibeng District Municipalities, Gauteng, covering an area of approximately 146.54 ha. The Biodiversity GIS (BGIS, 2010) assessment indicates that approximately 28% is currently considered untransformed and remaining natural areas. However, this figure is regarded as an overestimation of the true extent of the remaining natural habitat.

4.5 Flora and Fauna

4.5.1 Mucina & Rutherford Vegetation Units (2006)

According to Mucina and Rutherford (2006) the proposed development area falls within the Soweto Highveld Grassland vegetation unit (Figure 4-2). This vegetation unit has been classified as 'endangered' with almost half already having been impacted or transformed due to cultivation, urban sprawl, mining and building of road infrastructure (Mucina and Rutherford, 2006). Despite the ongoing impacts to this vegetation unit, only 0.2% is protected which is far below the conservation target of 24%. A summary of the Soweto Highveld Grassland vegetation unit is provided in Table 4-1.

Table 4-1: Summary of description of the Soweto Highveld Grassland unit. (Source: Mucina and Rutherford, 2006).

NAME OF VEGETATION UNIT	Soweto Highveld Grassland
CONSERVATION TARGET FROM NSBA	24%
PROTECTED FROM NSBA	0.2%
REMAINING FROM NSBA	52.7%
DESCRITPION OF CONSERVATION STATUS FROM NSBA	Endangered
DESCRIPTION OF THE PROTECTION STATUS FROM NSBA	Hardly Protected
AREA OF THE FULL EXTENT OF THE VEGETATION UNIT (SQUARE KILOMETERS)	14513.32
NAME OF THE BIOME	Grassland Biome

4.5.2 NEMBA Threatened Ecosystems

SANBI were requested by the Department of Environmental Affairs (DEA) in conjunction with provincial conservation authorities to identify threatened ecosystems to be listed.

Threatened ecosystems were identified based on several principles and follows:

- The approach must be explicit and repeatable;

- The approach must be target driven and systematic, especially for threatened ecosystems;
- The approach must follow the same logic as the IUCN approach to listing threatened species, whereby a number of criteria are developed and an ecosystem is listed based on its highest ranking criterion; and
- The identification of ecosystems to be listed must be based on scientifically credible, practical and simple criteria, which must translate into spatially explicit identification of ecosystems.
-

According to the National Threatened Ecosystems database (SANBI, 2011), the study area falls within the vulnerable Soweto Highveld Grassland vegetation unit (Figure 4-2).

4.5.3 Gauteng Conservation Plan/Ecological Support Areas

As per the Gauteng Conservation Plan, the ephemeral drainage line to the south of the study area is of conservation importance due to the following ecological processes (Figure 4-2)

- groundwater dynamics;
- hydrological processes,
- nutrient cycling; and
- wildlife dispersal.

4.6 National Freshwater Ecosystem Priority Areas (NFEPAs)

The NFEPA database highlights areas or priority in terms of conserving South Africa's freshwater ecosystems and supporting the sustainable use of water resources. NFEPAs were identified based on a range of criteria dealing with the maintenance of key ecological processes and the conservation of ecosystem types and species associated with rivers, wetlands and estuaries (Driver *et al*, 2011). Although the NFEPA database is suitable for use at a desktop level for planning and decision-making purposes at a national level, confidence in its accuracy decreases at more local levels of planning. As such, it is important to groundtruth NFEPAs at a local planning level and to potentially refine them with additional local data and knowledge.

Subsequent to a desktop analysis of the NFEPA dataset, it was observed that there is one (1) NFEPA Channelled Valley Bottom Wetland within the study area (Figure 4-2). According to the dataset, this wetland was artificially created and has a wetland condition rating of 'Z3' or 'Heavily to Critically Modified'.

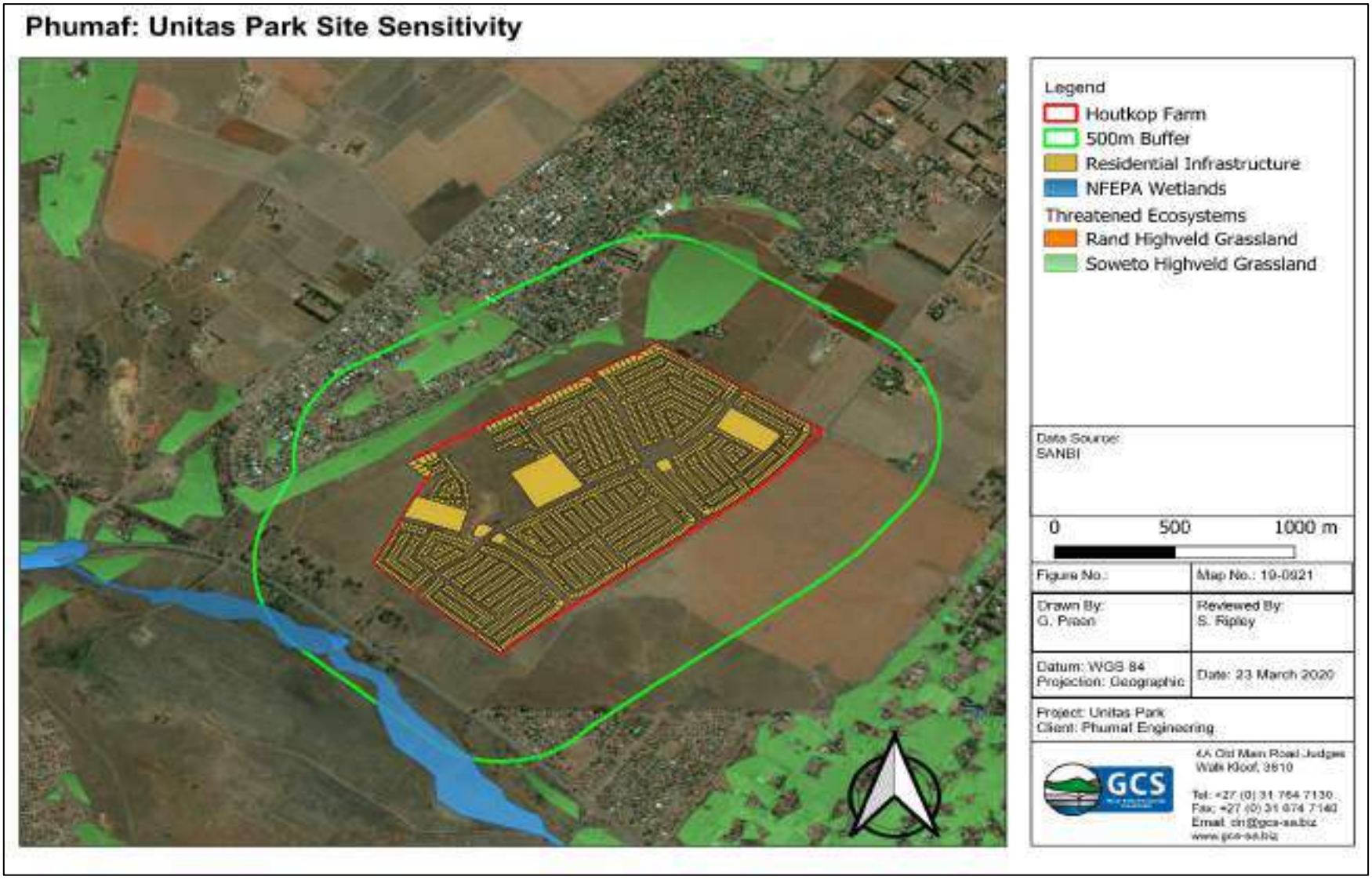

Figure 4-2: Map illustrating sensitive environments.

5 RESULTS AND FINDINGS

Following the desktop and infield assessments the following findings and results were obtained.

5.1 Wetland Assessment

A review of satellite imagery and relevant geospatial data identified one (1) wetland system within the study area (Figure 5-2). The infield assessment confirmed the location and boundaries of the wetland and subsequent screening confirmed that this wetland will be impacted upon by the proposed development (Table 5-1).

The wetland is located within a valley bottom with no clearly defined stream channel or banks. The topography through the wetland system was noted to be gently sloping with water entering mainly from a channel entering the system and from adjacent slopes (Figure 5-1). In accordance with the Classification System (SANBI, 2009), this wetland was classified as an unchanneled valley bottom wetland and will hereafter be referred to as UVB01.

Table 5-1: Wetlands within the study area and potential risk of impact.

HGM Unit	Water Resource Type	Characteristic Potentially Impacted (Yes/No=Y/N)				Risk Rating	Need for further Assessment	Justification
		Habitat	Biota	Water Quality	Flow Regime			
UVB01	Unchanneled Valley-Bottom Wetland	Y	Y	Y	Y	**High Risk**	**Yes**	UVB01 was calculated to be approximately 408 m downslope of the proposed development footprint. The lack of dense vegetation cover between UVB01 and the proposed development site provides minimal buffer area from potential increased runoff and pollutants. This is coupled with a lack of suitable stormwater infrastructure along the R54. Additionally, the direct discharge of effluent into the wetland will present significant impacts. Therefore, it was determined that UVB01 will likely impacted upon by the proposed development.

Figure 5-1: Topographical profile of UVB01 (Source: Google Earth Pro, 2020).

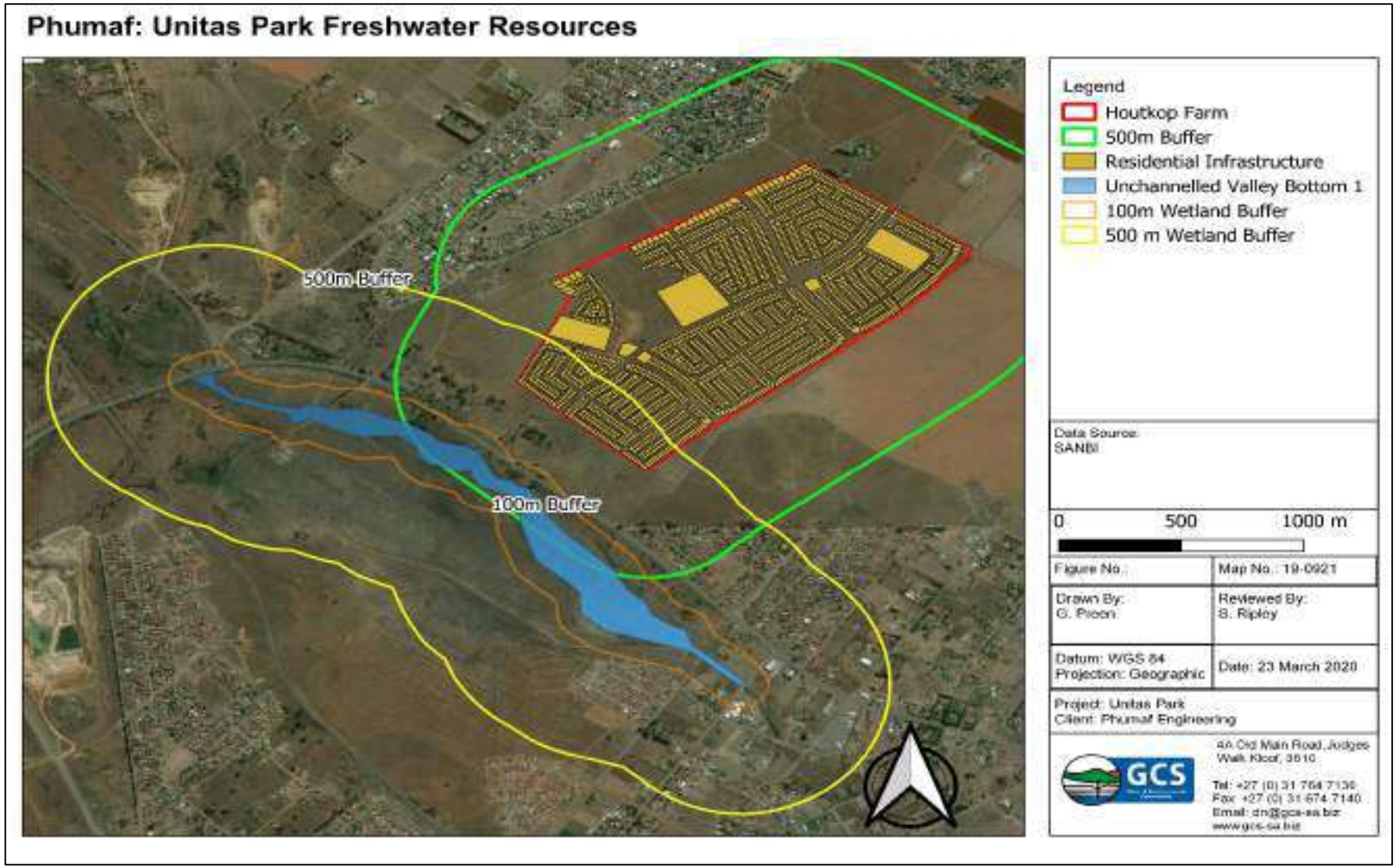

Figure 5-2: Map illustrating the location of UVB01.

5.1.1 Catchment and site-specific impacts

Historically and currently, UVB01 has been impacted upon by several land use changes in the surrounding environment. These changes have altered the topography, hydrology and vegetation of the surrounding area and has thus impacted on the health of UVB01. Each catchment and site-specific impacts have been described in the following sections.

5.1.1.1 Commercial maize cultivation

During the infield assessment, it was observed that the catchment has been highly transformed from its natural vegetative state; that which is consistent with the Soweto Highveld Grassland. The main contributing factor to this is the current level of commercial maize cultivation taking place within the catchment. As a result, indigenous vegetation has been lost with very few indigenous species present in the catchment area.

It is further expected that maize cultivation has had an impact on the hydrology of the wetland as it is reliant on good water supply and utilises large volumes of pesticides and fertilisers which may runoff into the system polluting the water (Matavire, 2015). However, it must be noted that during the infield assessment, no evidence was observed that water is being abstracted from this system for irrigation purposes. Nonetheless, it is expected that nitrates and phosphates have entered the system as a result of the application of pesticides and fertilisers. Wetlands act as periodic or permanent sinks for inorganic sediments, nutrients, organic carbon and toxic substances thus making them very vulnerable to inadequate management of the catchment areas. Wetlands are highly influenced by the surrounding catchment area and the activities taking place within them. Therefore, run-off contaminated by fertilisers and pesticides can significantly increase the nutrient levels of receiving wetlands thus disrupting their ecosystem processes (Walters and Koopman, ND). No formal water quality assessments were carried out.

Erosion and degradation of the study area has also taken place as a result of maize cultivation where the natural vegetation has been removed to make way for cultivation, thus leaving large areas of soil exposed. In addition, the constant tilling of the soil breaks-up soil peds and reduces their cohesiveness. This therefore results in increased surface flow velocities and associated erosion and deposition within the wetland system negatively affecting geomorphology and hydrology. Walters and Koopman (ND) maintain that increased sedimentation within and surrounding the wetland has the potential to diminish habitat diversity and destroy ecological corridors within the landscape. Furthermore, the continual growth and removal of sugarcane from the surrounding area gradually reduces the nutrient composition of the soil thus resulting in slower growth rates of the sugarcane. Therefore, increasing amounts of fertilisers are required to be added to the soil to compensate for this.

5.1.1.2 Road and Residential Infrastructure

During the infield assessment, it was observed that regional road R54 and residential infrastructure is located approximately 84m and 230m upslope of UVB01 respectively. The most obvious impact that the abovementioned infrastructure would have on UVB01, is runoff. There is very little dense vegetation capable of intercepting runoff before it enters the wetland system. It is expected that this will have an impact on the hydrology of UVB01 through increased flow into the systems as well as impacts on the water quality. Additionally, the vegetation of UVB01 may potentially be impacted.

5.1.2 Present Ecological State (PES)

The PES of UVB01 was assessed based on an understanding of both catchment and on-site impacts and the impacts these aspects have on the hydrology, geomorphology and vegetation of the system. WET-Health works by comparing a wetland in its current state with baseline/reference conditions (Macfarlane, *et al* 2007).

A summary of the overall health scores for the wetland system that was assessed is presented in Table 5:2.

Table 5-2: Summary of the WET-Health Scores for the UVB01 wetland system.

WET-Health Scores				
HGM Unit	**Hydrology**	**Geomorphology**	**Vegetation**	**Overall Score**
UVB01	E (7)	1.2 (B)	0.6 (A)	3.5 (C)

5.1.2.1 UVB01

UVB01 is located within a relatively gentle valley bottom receiving water inputs from the adjacent slopes as well as an ephemeral drainage line. The system has experienced significant canalisation at the head and toe areas (Figure 5-3). The surrounding catchment area has been subject to large scale, commercial agriculture which has altered the natural vegetation of the area as well as the surface runoff regime.

The PES of the wetland systems is defined as 'Moderately Modified' (C) which describes a situation in which a moderate change in ecosystem processes and loss of natural habitats has taken please but the natural habitat remains predominantly intact (Table 5-3). The hydrological component has been 'Seriously Modified' (E) due to the canalisation of the stream channel as well as impeding feature such as informal road infrastructure. The geomorphology of the system has been 'moderately modified' (C) as a result of the changes to the runoff regime of the surrounding area. This is due to the large-scale agriculture taking place within the surrounding area. The vegetation within the wetland system was assessed to be 'largely natural' (B) with few dispersed areas of invasive alien plants.

Table 5-3: WET-Health Assessment

WET-HEALTH ASSESSMENT	
HYDROLOGY	The hydrological component of the wetland system has been seriously modified through the canalization and stream channel modification or the system. It was observed that the head and the toe of the system has been impacted by canalisation. Canals tend to reduce diffuse surface flow and retention of water in favour of more concentrated flow. Unchannelled valley bottom wetlands are generally characterised by diffuse surface flow in their natural states. As such, it was determined that canalization and stream channel modifications have had serious impacts on the hydrology of the system.
VEGETATION	The vegetation within the system was observed to be natural and comprised mainly of *Typha capensis*. Impacts to the vegetation were noted to be informal tracks, scattered IAPS (*Arundo donax*) and commercial agriculture.
GEOMORPHOLOGY	The geomorphology was assessed to be largely natural. Impacts to geomorphology included artificial wetland infilling and deposition due to the informal track which dissects the system

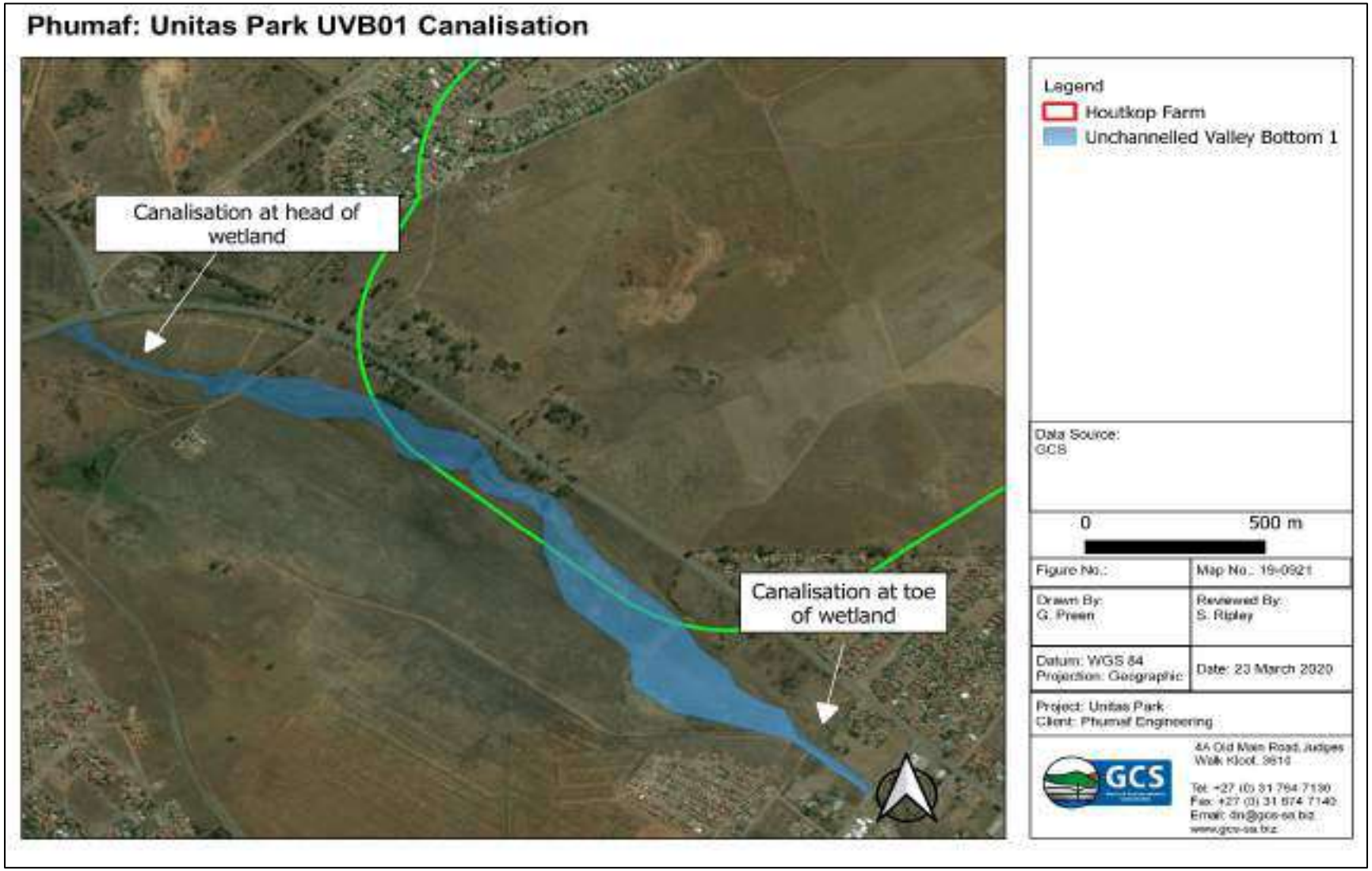

Figure 5-3: Map illustrating the canalisation at the head and toe of the wetland.

5.1.3 Wetland Functional Importance

Wetland benefits can be classified into classified into goods/products (directly harvested from wetlands), functions/services (performed by wetlands) and ecosystem scale attributes. The WET-Ecoservices tool is utilised to assess the goods and services that individual wetlands provide which assists with informed planning and decision-making. The tool provides guidelines for scoring the importance of a wetland in delivering each of the 15 different ecosystem services.

The overall goods and services provided by UVB01 were assessed to be moderate to low (Figure 5-4). The highest service provided by the system is erosion control. This is likely due to the diffuse flow which dominates the system as well as the level of vegetation within the system. Diffuse flow and vegetation allow for the reduction in flow velocity thus mitigating erosivity. The system also scored high for phosphate trapping. Due to the diffuse flow and vegetation, the system is able to trap phosphates originating from the surrounding agricultural practices. The system is not significant in terms of tourism, education or socio-cultural due to the lack of endangered species and the small size of the system. This is likely due to its ability to trap phosphate arising from the surrounding commercial agriculture.

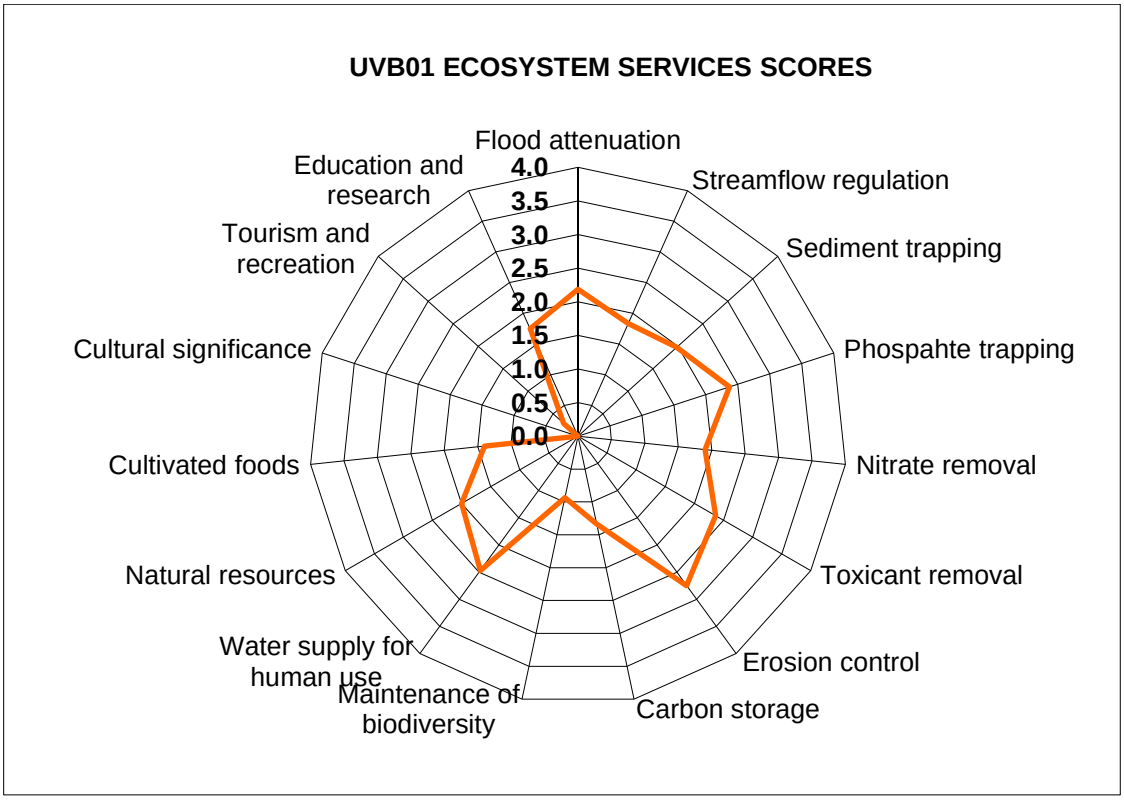

Figure 5-4: Diagram illustrating the extent and variety of ecosystems services provided by UVB01.

5.2 Ecological Assessment

5.2.1 Study area and site-specific impacts

The study area has undergone significant transformation in the form of urban sprawl and commercial agriculture. This has impacted in the natural state of the study area particularly in terms of loss of suitable habitat and biodiversity. Impacts on the biodiversity within the study area have been described below.

5.2.1.1 Commercial agriculture

In general, agriculture is the largest contributor to biodiversity loss with ever expanding impacts due to population growth and food consumption needs. Agriculture necessitates the need to convert natural habitats to intensely managed systems (Dudley and Alexander, 2017). During the infield assessment, it was noted that agriculture is the most significant contributor to the loss of biodiversity and suitable habitat (Figure 5-5). Natural plant species consistent within the Soweto Highveld Grassland have been cleared through tillage leaving only small areas of intact grassland. Cultivated areas retain very low natural vegetation and are considered to be of a low EIS. Other impacts on biodiversity associated with agriculture include drainage, intercropping, rotation, grazing and extensive use of pesticides and fertilizers (McLaughlin and Mieau, 1995).

5.2.1.2 Urban Sprawl

The expansion of urban areas also results in the loss of or fragmentation to biodiversity. Often, natural areas are fragmented into patches which are not big enough to support complex ecological linkages. The infield assessment revealed that urban sprawl has also contributed to the loss of suitable habitat and biodiversity (Figure 5-6).

5.2.1.3 Excavation

It was noted that historical excavation has taken place in the study area. This has resulted in the removal of the topsoil and disturbance of the natural soil profile. Also, the disturbance of the soil has resulted in the proliferation of IAPS (*Acacia mearnsii*, *Acacia dealbata, Datura Stramonium*, *Eucalyptus* sp., *Pinus* sp., *Solanum mauritianum* and *Verbena bonariensis)*.

Figure 5-5: Aerial photograph taking at the northern portion of the site looking south illustrating the expanse of agriculture across the study site.

Figure 5-6: Aerial photograph taking near the southern portion of the site looking east illustrating the level of urban sprawl. The canalised valley bottom wetland is indicated.

5.2.2 Habitat Diversity

The significant transformation of land cover in the study area has resulted in the large-scale loss of suitable habitat for a variety of flora and fauna. It was estimated that 80% of the study area has been transformed from natural habitat due to agriculture and urban sprawl as discussed in the previous subsection. A phytosociological survey was undertaken to identify the dominant floral species (Figure 5-10). During the infield assessment the following habitats were identified:

- Open grassland (Table 5-4) (Figure 5-9),
- Degraded grassland (Table 5-5) (Figure 5-9), and
- Freshwater hydrophytes (Table 5-6) (Figure 5-9).

Transformed areas were also identified and are inclusive of commercial agriculture, formal and informal residential infrastructure.

Several phytosociological classification surveys were carried out to identify the plant species that are representative of the larger area (Figure 5-7 and Figure 5-8).

Small patches of IAPS were observed within the study area. Majority of the species observed were categorized as 1a while only one species observed is categorized as 3 according to the NEMBA. Species categorized as 1b require some control as part of an invasive species control programme. Species under this category must be removed and destroyed. Category 3 species may be retained as long as reasonable steps are taken to prevent their spread such as an invasive management plan.

Figure 5-7: Photograph illustrating the phytosociological classification being undertaken in the open grassland (Red lines indicate the 4 x 4m quadrant).

Figure 5-8: Photograph illustrating the phytosociological classification being undertaken in the degraded grassland (Red lines indicate the quadrant).

Table 5-4: Description of the open grassland.

HABITAT UNIT 1	OPEN GRASSLAND	
DESCRIPTION	There are scattered patches of open grassland surrounding the proposed development. A variety of grass species were identified within the various patches which were between 50 and 150 cm in height.	
PHOTOS		
VEGETATION	Overall vegetation cover is good, however, certain areas where overgrazing has occurred were observed. Given such small areas where grassland is able to flourish, species diversity was fairly high despite the level of transformation which has taken place. Indigenous grass species which were identified during the field assessment are as follows: *Aristida congesta (LC), Chloris virgate (LC), Cymbopogan Validus(LC), Cynodon dactylon (LC), Digitaria longiflora (LC), Eragrostis lehmanniana (LC), Eragrostis plana (LC), Eragrostis Rigidior(LC), Heteropogon Contortis (LC), Melinis repens (LC), Panicum natalense (LC), Themeda triandra (LC), Trachypogan Spicatus (LC), Elionurus muticus (LC), Setaria sphacelate (LC), Sporobolus centrifugus (LC), Sporobolus fimbriatus (LC).*	
INVASION BY EXOTIC SPECIES	Despite the level of transformation of area, the level of proliferation of invasive species was relatively low; approximately 10%. The invasive species observed were as follows: *Cirsium vulgare, Eucalyptus globulus, Ipomoea indica, Melia azedarach, Nerium oleander, Pinus sp.,* and *Verbena Opuntia.*	
NATURALNESS	30 to 40% (Medium-Low)	
EXISTING IMPACTS	The most significant impact to the open grassland is agriculture and urban sprawl. Additional impacts include cattle grazing/trampling and informal dirt tracks.	

Table 5-5: Description of the degraded grassland.

HABITAT UNIT 2	DEGRADED GRASSLAND
DESCRIPTION	One patch of degraded grassland was observed during the field assessment. A few grass species were identified with an average height of approximately 100 to 150 cm.
PHOTOS	
VEGETATION	In contrast to the open grassland areas, the diversity of grass species within the degraded area was fairly low. The grass species identified during the phytosociological survey were as follows: *Aristida congesta (LC), Cynodon dactylon (LC), Eragrostis* rigidior (LC), *Eragrostis lehmanniana (LC), Melinis repens (LC)*and *Themeda triandra (LC).*
INVASION BY EXOTIC SPECIES	Despite the level of transformation of area, the level of proliferation of invasive species was relatively low; approximately 15%. The invasive species observed were as follows: *Cirsium vulgare, Eucalyptus globulus Ipomoea indica, Melia Azedarach, Nerium oleander, Pinus sp., Verbena opuntia.*
NATURALNESS	10% (Very Low)
EXISTING IMPACTS	This area has been subject to historical excavation which has resulted in the removal of topsoil. In turn, this has altered the natural soil profile of the area as well as vegetation dynamics.

Table 5-6: Description of the freshwater hydrophytes.

HABITAT UNIT 3	FRESHWATER HYDROPHYTES
DESCRIPTION	The freshwater hydrophytes were confined to the wetland area to the south of the proposed development area. Two reed species were observed in this area with a height of between 150 to 200 cm.

HABITAT UNIT 3	FRESHWATER HYDROPHYTES	
PHOTOS		
VEGETATION	Only one dominant vegetation species was observed within the wetland system, namely *Typha capensis*. The surrounding grasslands comprised of a mixture of the following: *Aristida congesta (LC), Chloris virgate (LC), Cymbopogan Validus(LC), Cynodon dactylon (LC), Digitaria longiflora (LC), Eragrostis lehmanniana (LC), Eragrostis plana (LC), Eragrostis Rigidior(LC), Heteropogon Contortis (LC), Melinis repens (LC), Panicum natalense (LC), Themeda triandra (LC), Trachypogan Spicatus (LC), Elionurus muticus (LC), Setaria sphacelate (LC), Sporobolus centrifugus (LC), Sporobolus fimbriatus (LC).*	
INVASION BY EXOTIC SPECIES	The alien invasive species which were observed are as follows: *Cirsium vulgare and Verbena.*	
NATURALNESS	80% (High)	
EXISTING IMPACTS	The vegetation in the area has been impacted slightly by exotic species, informal tracks and litter.	

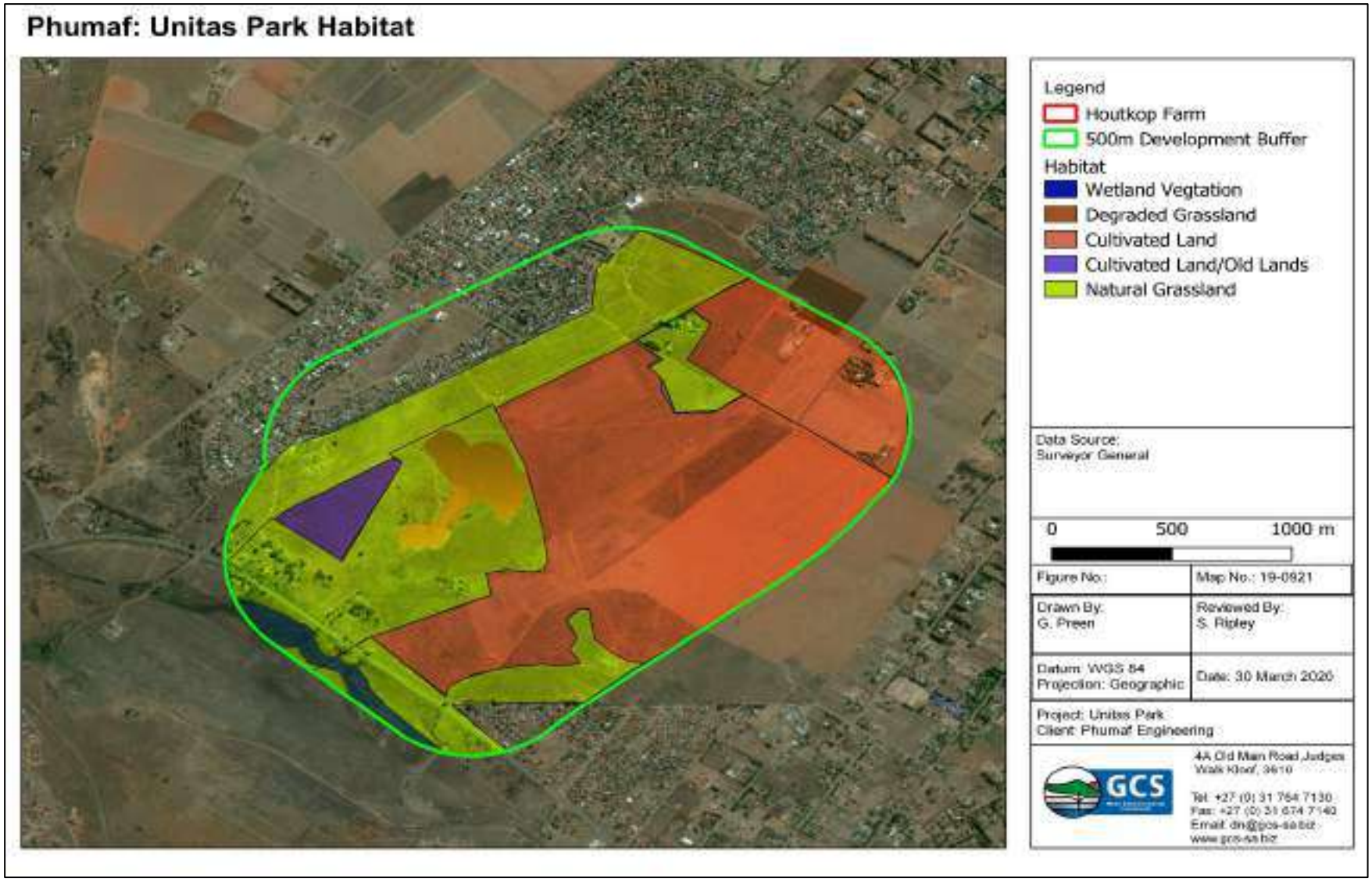

Figure 5-9: Map illustrating the different habitats

Figure 5-10: Map illustrating the floral survey points

5.2.3 Flora of Conservation Concern

Species of conservation concern are species that have a high conservation importance in terms of preserving South Africa's biodiversity and include not only threatened species that have been classified as 'at high risk of extinction in the wild' (Critically Endangered CR, Endangered EN, Vulnerable VU) but also those classified in the categories Near Threatened (NT), Critically Rare, Rare, Declining and Data Deficient. Protected species are listed in international conventions, national acts and provincial ordinances that regulate activities such as hunting, collection and trade of species. If a subpopulation of a species of conservation concern is found to occur on a proposed development site, it would be one indicator that development activities could result in significant loss of biodiversity, bearing in mind that loss of subpopultations of these species will either increase their extinction risk or may in fact contribute to their extinction Figure 5-11.

Following a review of the SANBI red list database, it was found that there are no species of conservation concern within the development area.

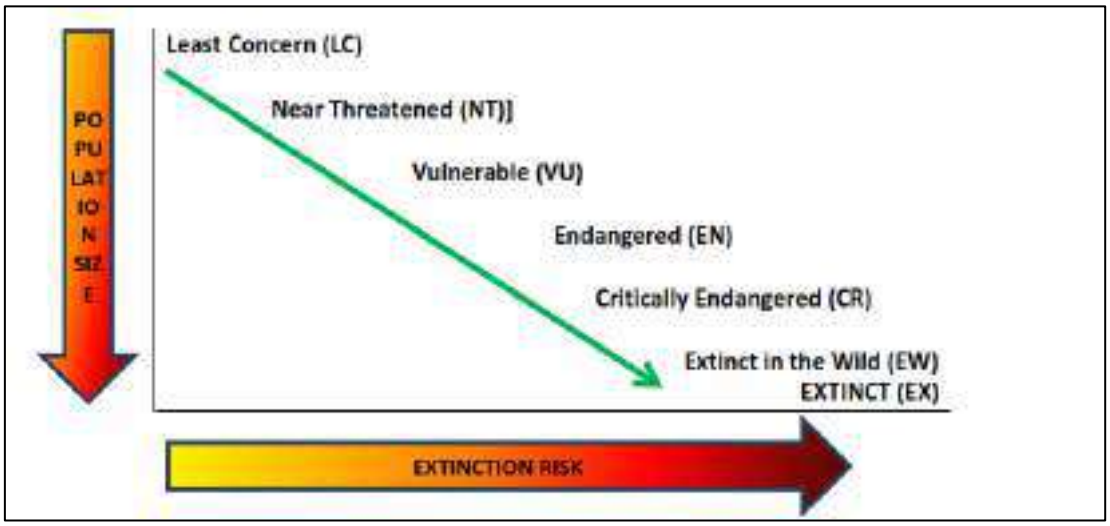

Figure 5-11: Graph illustrating the relationship between population size and extinction risk. (Source: SANBI, 2010).

5.2.4 Mammals

The Red Data list categories were obtained and included in the list. According to the IUCN website, the Red Data categories are described in Table 5:7.

Table 5-7: Description of the red data list categories (Source: IUCN, 2019).

RED DATA LIST CATEGORY	DESCRIPTION
Data Deficient	This occurs when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on distribution and/or population status.

RED DATA LIST CATEGORY	DESCRIPTION
Least Concern	This occurs when a species does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened according to the Red List Criteria.
Vulnerable	These species are considered to face a high risk of extinction in the wild.
Near Threatened	This occurs when a species has been evaluated against the Red List criteria but does not qualify for Critically Endangered or Vulnerable at present but is close to qualifying or is likely to qualify for a threatened category.
Endangered	These species are considered to face a very high risk of extinction in the wild.
Critically Endangered	These species are considered to face an extremely high risk or extinction in the wild.

It was determined that the proposed development site has the potential to support minimal biodiversity due to the impacts of agriculture and urban sprawl on suitable habitat. According to the IUCN and Virtual Museum, there are approximately 81 mammal species which are likely to occur or have been recorded within the proposed development site. The red data status of these species is distributed between Least Concern, Vulnerable, Near Threatened and Critically Endangered (Figure 5-12).

One critically endangered species, namely the *Diceros bicornis* (Black Rhinoceros) has been known to take refuge in the area or areas of similar habitat type. However, this is based on a desktop assessment and is highly unlikely in reality given the current land use practices within the proposed development area. Additionally, seven Near Threatened, three Vulnerable and seventy Least Concern species have been known to occur within the area. The Virtual Museum website indicates that there have been 16 recorded sightings of listed mammals in the area.

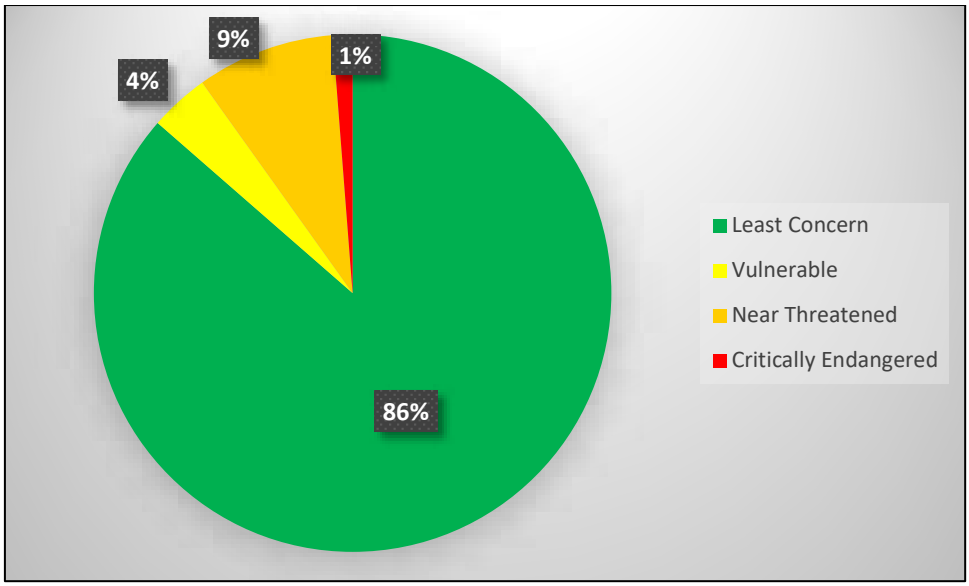

Figure 5-12: Pie chart illustrating the red data status distribution of mammal species.

During the field assessment, 1 mammal was observed, namely the *Lepus saxtilis* (Scrubhare) (Figure 5-13) which has been classed as being of 'Least Concern'. The observation was made in the agricultural fields. According to Chapman *et al* (1990) the scrub hare is attracted to cultivation and garden crops as well as open sandveld, bushveld or forest.

Figure 5-13: Photograph of a Scrub Hare (Source: www.fascinatingafrica.com)

5.2.5 Amphibians

The data sourced pertaining to the amphibian species was obtained from the IUCN and Virtual Museum websites. No amphibian species were observed during the infield assessment likely due to the transformed nature of the site and the surrounding area.

According to the abovementioned websites, there are 20 amphibian species which have occurred or are likely to occur within the study area. Of these 20 species, 1 has been classified as being 'Near Threatened', namely the *Pyxicephalus adspersus* (Giant Bull Frog) (Figure 5-15). The remaining species have all been classed as 'Least Concern' (Figure 5-14). This species inhabits the grasslands and savannahs of Southern Africa. The diet consists mainly of locusts, insects, cockroaches, worms, moths and beetles. However, given the transformed nature of the site coupled with the large-scale use of pesticides, it is expected that there is limited food sources for the Giant Bull Frog. Thus, the likelihood of this species to still be present in the area is negligible.

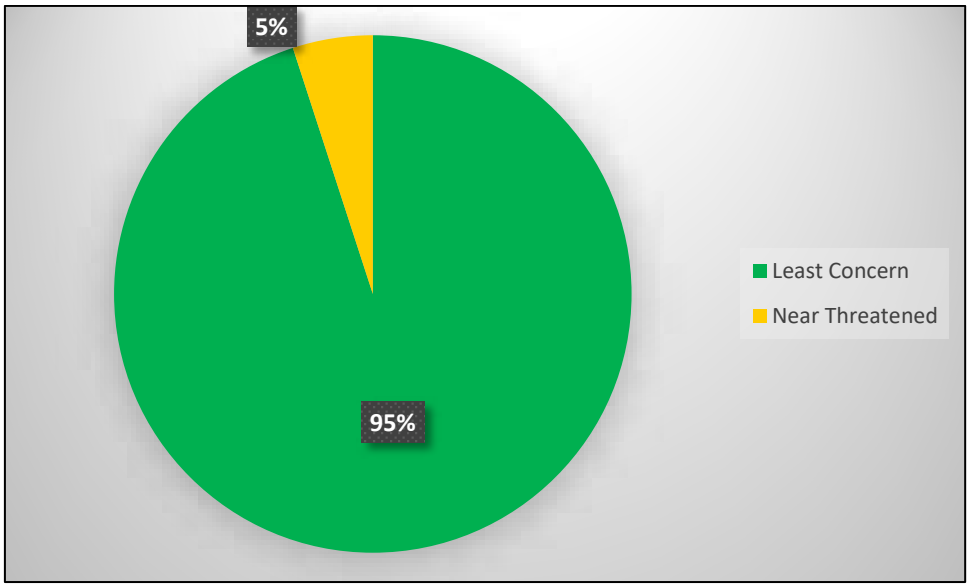

Figure 5-14: Pie chart illustrating the red data status distribution of amphibian species.

Figure 5-15: Photograph of a Giant Bullfrog (Source: www.lafebar.com)

5.2.6 Reptiles

The IUCN and Virtual Museum websites were used to source data relating to the reptile species which are likely to occur or have been recorded in the study area. During the infield, investigation, no reptile species were observed.

There are 32 species which are likely to occur or have occurred within the study area. 31 of these species have been classed as being of 'Least Concern' while 1 species is 'Data Deficient' (Figure 5-16). According to the Virtual Museum website, there have been 22 recorded sightings of the various reptile species which are likely to occur within the study area.

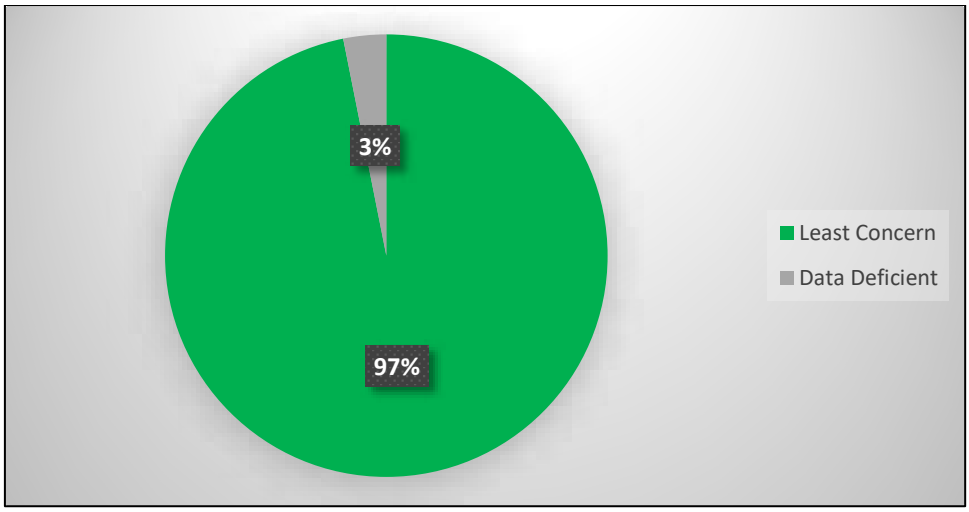

Figure 5-16: Pie chart illustrating the red data status distribution of reptile species.

5.2.7 Dragonflies and Damselflies

Only the Virtual Museum website was used to collect data pertaining to dragonflies and damselflies only as the IUCN website had no data available.

The Virtual Museum website indicates that there are eighteen dragonfly and damselfly species which have been recorded within the study area. Sixteen of these species have been classed as 'Least Concern' while two are 'Data Deficient' (Figure 5-17). The Virtual Museum indicates that there have been forty-five recorded sightings of the various species that are likely to be present in the study area.

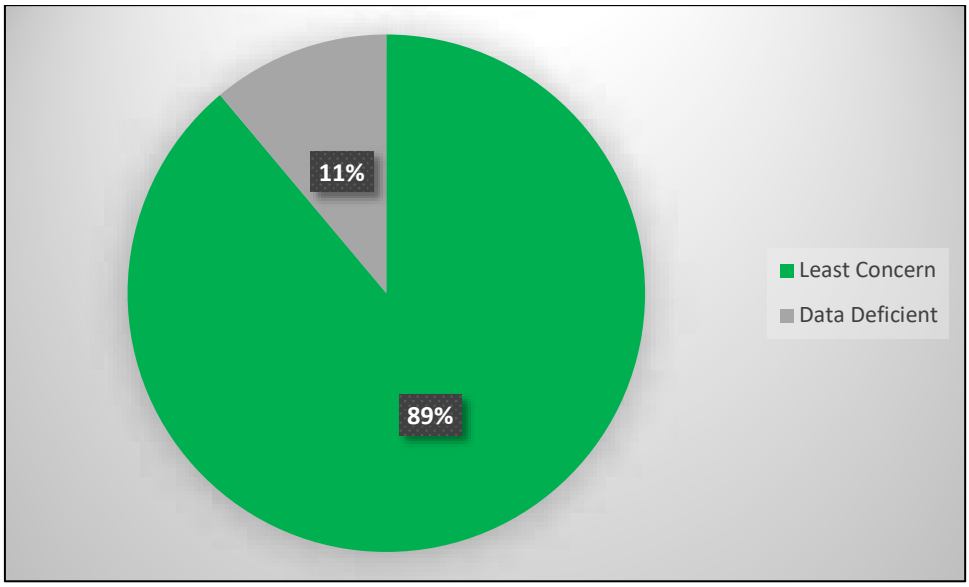

Figure 5-17: Pie chart illustrating the red data status distribution of dragonfly and damselfly species.

5.2.8 Avifauna

The Virtual Museum website was used to source data relating to the avifauna in the area. The IUCN website had no data available.

There are approximately 40 avifauna species which have occurred within the study area. 37 have been classes as being of 'Least Concern' while the remaining 3 are 'Data Deficient' (Figure 5-18). The Virtual Museum also indicated that there have been 95 recorded sightings of the various avifauna species in the study area.

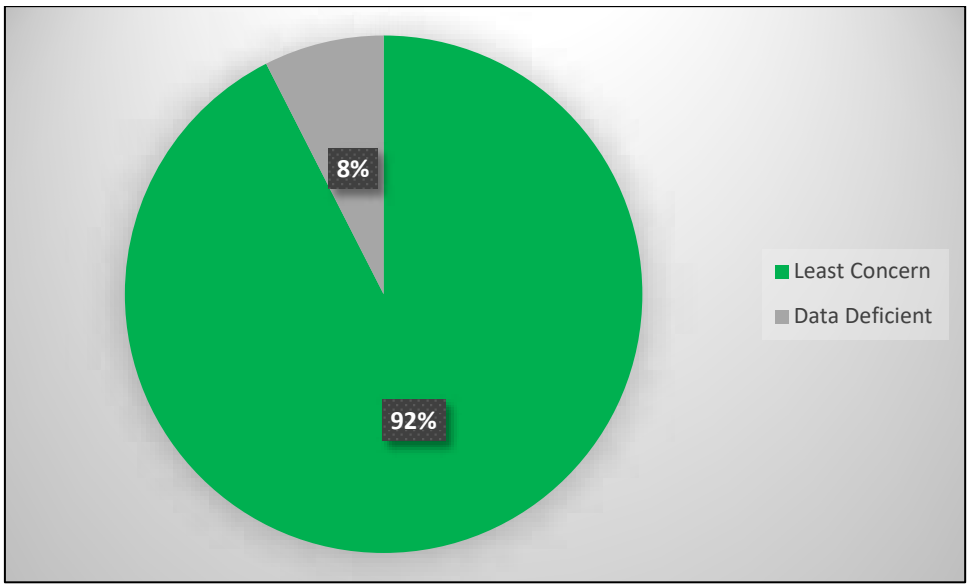

Figure 5-18: Pie chart illustrating the red data status distribution of avifauna species.

During the infield assessment, large flocks of *Streptopelia decipiens* (African Dove) were observed. This species has been classed as being of 'Least Concern'. This species feeds predominantly on grasses, seeds and small fruit. In respect of this species only, it is likely that the maize fields present at the time of the assessment is providing some source of food. The remaining grassland around the maize fields will also be a food source for the African Dove.

6 PRELIMINARY WETLAND IMPORTANCE AND SENSITIVITY

6.1 Wetland and River FEPA's

Following a review of the NFEPA wetland database, it was observed that one (1) NFEPA wetland occurs within the study site and is contained within the larger boundary of UVB01 in the C22F Quaternary Catchment and Upper Vaal WMA. The NFEPA database describes this wetland as a Channelled Valley Bottom wetland, however, following the infield investigation, it was determined that it has now been transformed into an Unchannelled Valley Bottom

wetland. It is presumed that the channelled valley bottom system has been subjected to historical sedimentation due to the disturbance of the soil in the surrounding area. This has likely resulted in the infilling of the once easily identifiable stream channel.

Although the ephemeral drainage line that runs through UVB01 is not considered to be a priority area, the sub-catchment in which it occurs drains into a FEPA River (Figure 6-1). As such, the sub-catchment and the wetland systems occurring within should be considered as ecologically important.

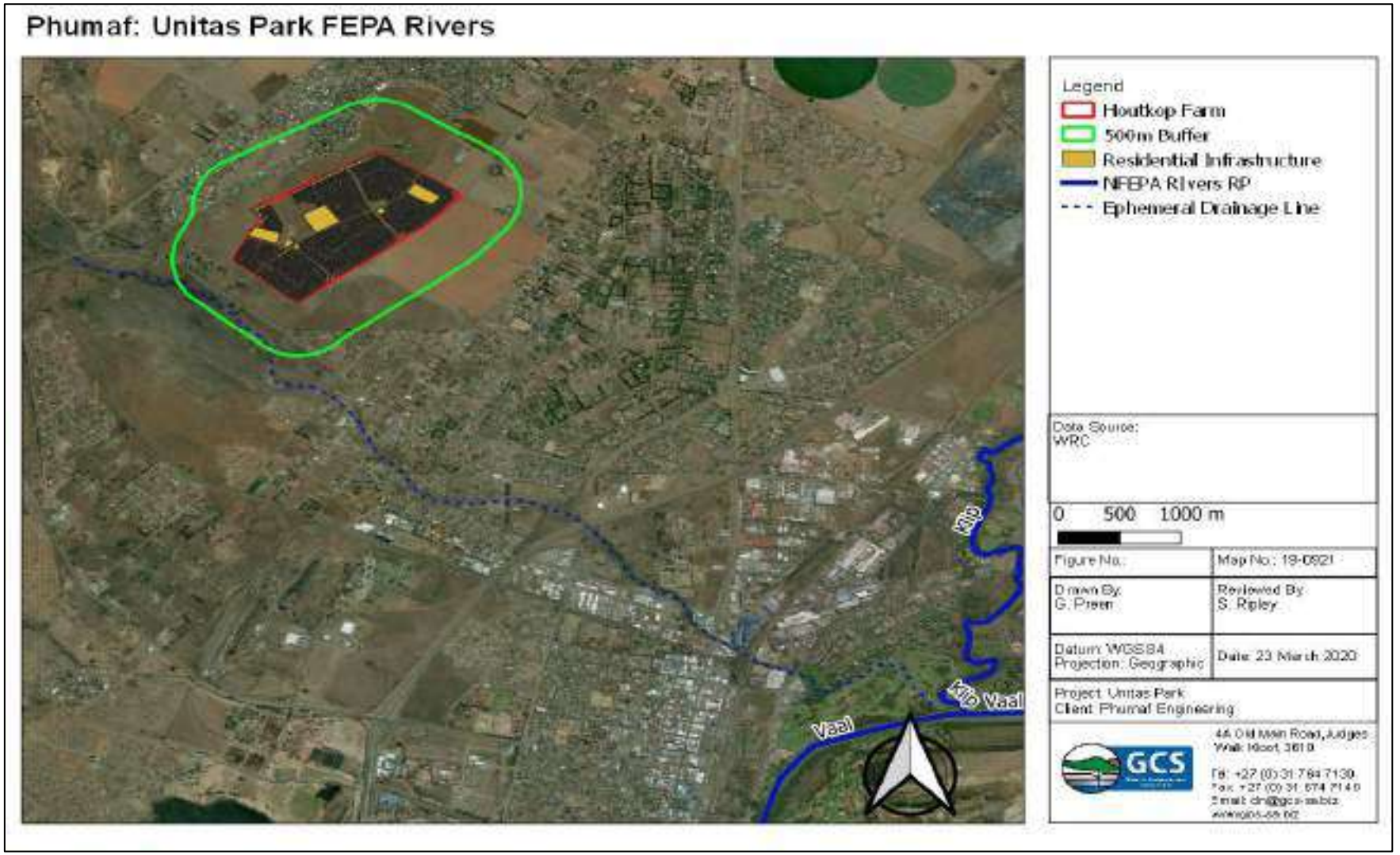

Figure 6-1: Map illustrating the ephemeral drainage line flowing into an FEPA River

7 POTENTIAL PLANNING IMPLICATIONS AND CONSTRAINTS

7.1 NFEPA Constraints and Management Requirements

The proposed development site is located within the sub-catchment of the Vaal FEPA river. In accordance with the NFEPA project, river FEPAs need to be maintained in their current state to achieve biodiversity targets for river ecosystems and threatened or near-threatened fish species. It was noted that the UVB01 provides important ecological links from freshwater resources upstream to freshwater resources downstream and ultimately the Vaal River. Although it is expected that the proposed development will have a minimal impact on UVB01, there is still some risk that remains. Therefore, it is imperative that a suitable buffer/no-go area be established around UVB01. This will ensure that impacts to UVB01 and associated national freshwater conservation goals and targets are avoided. The buffer zone requirements are discussed in subsection 7.3.

7.2 Ecological Importance and Sensitivity Constraints

According to the National Environmental Management: Biodiversity Act (10/2004) (NEMBA), the entire study area falls within a threatened ecosystem due to the presence of the endangered Soweto Highveld Grassland vegetation unit. However, according to the 'Threatened Ecosystem Remaining Extent', there is no naturally occurring grassland within the proposed development site boundary. Despite this, some naturally occurring grassland has been identified just outside the boundaries. It would therefore be important to implement avoidance, mitigation and rehabilitation measures where necessary in an attempt to maintain natural grasslands within the area.

Developing within a threatened ecosystem will require environmental authorisation in terms of NEMA and EIA regulations. The following listed activity may apply:

Listing Notice 3 (GNR 324) Activity 12-

The clearance of an area of 300 square metres or more of indigenous vegetation except where such clearance of indigenous vegetation is required for maintenance purposes undertaken in accordance with a maintenance management plan

- (c)(i) within any critically endangered or endangered ecosystem listed in terms of section 52 of the NEMBA or prior to the publication of such a list, within an area that has been identified as critically endangered in the National Spatial Biodiversity Assessment 2004;
    - (ii) Within Critical Biodiversity Areas or Ecological Support Areas identified in the Gauteng Conservation Plan or bioregional plans.

7.3 Recommended Buffer Zones for Planning Purposes

7.3.1 Background to Buffer Determination

Freshwater resources are coming under increasing pressure due to development and an expanding population. It is imperative that appropriate avoidance and mitigation measures are implemented to prevent further degradation of freshwater resources. In response to this, Macfarlane *et al*. (2016) developed the protocol for the development of geographical buffer zones around freshwater resources in an attempt to protect the resource itself and the goods and services that they provide. A buffer zone refers to a strip of land with a use, function or zoning specifically designed to protect one area of land against the impacts from another (Macfarlane *et al,* 2014). However, buffer zones are limited in their ability to protect freshwater resources from impacts such as hydrological changes caused by stream flow activities as well as point-source discharges. Nonetheless, buffer zones provides several important functions such as:

- Maintaining basic aquatic processes;
- Reducing impacts on water resources from upstream activities and adjoining land uses;
- Providing habitat for aquatic and semi-aquatic species;
- Providing habitat for terrestrial species; and
- A range of ancillary societal benefits.

It is therefore in this regard that a suitable buffer zone has been determined using the wetland buffer zone tool developed by Macfarlane *et al* (2016).

7.3.2 Site Specific Buffers

Following the application of the wetland buffer zone tool, it was determined that a 45 m buffer zone be implemented during the construction phase of the proposed development (Figure 7-1).

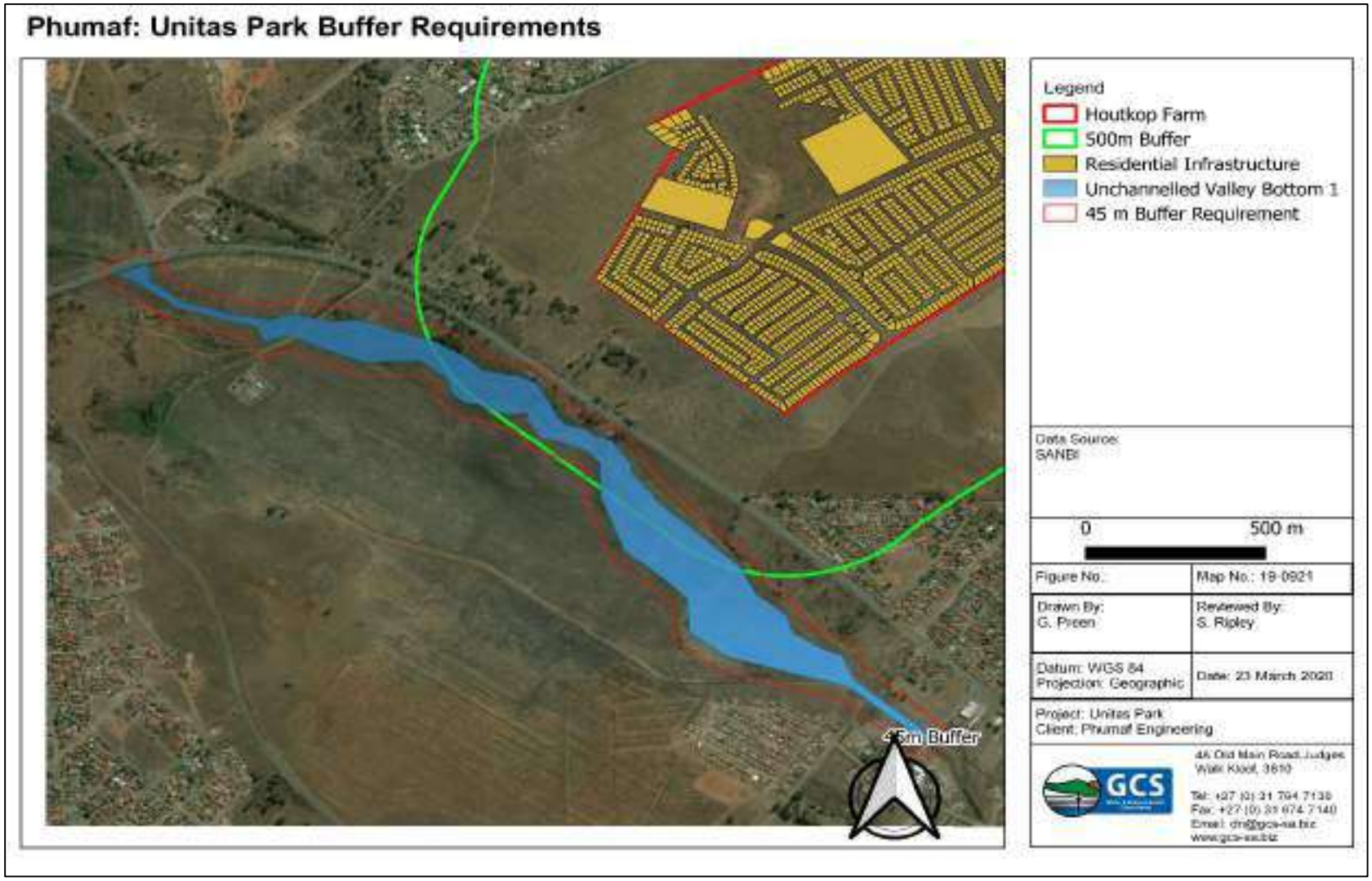

Figure 7-1: Map illustrating the buffer zone requirements

8 POTENTIAL IMPACTS AND RECOMMENDED MITIGATION MEASURES

An understanding of the relationship between the landscape and the dynamic characteristics of ecosystems is vital for the accurate assessment of ecosystem functions and values. The various ecosystems within the landscape are adjusting to disturbances occurring within them and the greater surrounding area. It was necessary to identify potential impacts which may be imparted on the various ecosystems as a result of the proposed development during the construction and operational phase.

8.1 Construction and Operational Phase

Potential impacts that may occur during the construction and operation phase of the proposed development are presented in Table 8-1 and Table 8-2 respectively.

Table 8-1: Potential environmental impacts associated with the construction phase.

POTENTIAL ENVIRONMENTAL IMPACT	APPLICABLE AREA	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
			M	D	S	P	TOTAL	STATUS	SP		M	D	S	P	TOTAL	STATUS	SP
Construction Phase																	
Vegetation																	
Clearing or damage to vegetation	Proposed Development Site	• Site Clearing and the removal of indigenous vegetation • Damage to vegetation through the movement of machinery, vehicles and personnel • Dumping of material outside of designated areas • Generation of pollution and waste • Dust • Proliferation of IAPS	6	4	1	4	44	-	M	• The construction site must be clearly marked and should not exceed the boundaries of the construction site plan. • The unnecessary removal of vegetation outside of the construction site plan is not permitted. • All construction machinery, vehicles and personnel movement must be limited to the existing informal tracks around the site. • No fires are permitted on site. • An IAPS management plan must be compiled by a suitable specialist prior to the commencement of construction activities. This must be implemented throughout the construction and operational phase. This must be monitored by the Environmental Control Officer (ECO). • The open grassland identified and demarcated within this report must be avoided as far as practicable. • A waste management plan must be compiled prior to the commencement of the construction phase. • Suitable waste receptacles must be placed around the site and must be demarcated. Waste receptacles must be wind and scavenger proof. This must be addressed in waste management plan. • Dust control measures such as a water cart must be implemented throughout the construction phase.	2	2	1	3	15	-	L
Introduction of IAPS	Proposed Development Site	• Site clearing and removal of indigenous vegetation • Disturbance of natural soils	8	5	2	4	60	-	M	•The IAPS management plan must be implemented throughout the construction and operational phase and must be monitored by the ECO on a regular basis.	4	4	1	3	27	-	L
Geology & Soils																	
Soil Disturbance	Proposed Development Site	• Earthworks	6	2	1	5	45	-	M	• Soil disturbance must be limited to the construction site plan. Soil disturbance outside of this area is not permitted.	2	2	1	5	25	-	L
Soil Contamination	Proposed Development Site	• Movement of construction vehicles and machinery • Storage of hazardous waste and substances • Maintenance activities • Installation and emptying of temporary ablutions (chemical toilets) • Generation and storage of general waste • Mixing of soil layers during excavation or stockpiling	6	2	1	4	36	-	M	• Restrict movement of construction employees outside of construction areas • Restrict vehicles to travel only on designated roadways • Park construction vehicles in areas lined with concrete or fitted oil traps •Stationary construction vehicles and machinery must have drip trays placed underneath. • Ensure vehicles are in good condition and not leaking fuel or oil when entering the mining areas • Regular vehicle and equipment inspections • Use of bunds during refuelling • Maintenance to be done off site • Suitable spill prevention measures to be in place	2	2	1	2	10	-	L

POTENTIAL ENVIRONMENTAL IMPACT	APPLICABLE AREA	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
			M	D	S	P	TOTAL	STATUS	SP		M	D	S	P	TOTAL	STATUS	SP
Loss of soil productivity & impact on land capability	Proposed Development Site	• Site clearing and the removal of vegetation • Establishment of construction camp & surface infrastructure • Soil and topsoil stockpiling •Dumping of material outside of designated areas • Erosion & compaction leading to loss of soil fertility • Increased stormwater runoff & leaching of soil minerals	6	5	1	4	48	-	M	• Demarcate footprint area clearly & control access • Minimise site clearance to the footprint area only • No unnecessary vegetation clearance outside go the development site plan is permitted • Separate soil layers during excavation to ensure that soil for topsoil for rehabilitation is preserved • Edge effects of construction activities need to be actively managed • Should new road development be necessary, roads should be ripped and rehabilitated at the end of construction activities • All compacted soils should be ripped and profiled at the end of the construction phase. • Implement suitable stormwater management and erosion control measures to minimise erosion • Upon completion of construction activities, no bare areas remain and that indigenous grassland species are reintroduced • Edge effect control needs to be implemented within construction areas, with specific consideration to compaction and erosion control	4	4	1	3	27	-	L
Land Use																	
Permanent change in land use from agricultural to construction	Proposed Development Site	• Construction activities •Movement of construction vehicles and machinery • Activities resulting in an increase in noise pollution • Increased human activity • Site clearing • Site camp establishment and equipment storage • Restriction of access, fencing and securing of site	8	5	2	5	75	-	H	• No mitigation measures possible • Demarcate footprint area clearly	8	5	2	5	75	-	H
Fauna																-	
Habitat Loss	Proposed Development Site	• Vegetation Clearance • Establishment of infrastructure	6	4	1	3	33	-	M	• As per vegetation mitigation measures listed above	4	2	1	2	14	-	L
Disturbance	Proposed Development Site	• Noise • Construction activities - movement of vehicles and personnel and lighting	4	2	1	4	28	-	L	• Demarcate footprint areas clearly • Restrict construction activity to the footprint area only	3	2	1	3	18	-	L
Dust	Proposed Development Site	• Vehicle Movement	4	2	2	3	24	-	L	• Consider surfacing road • Use dust-minimising procedures on access road • Restrict construction activity to the footprint area only • Control vehicle speeds	2	4	1	3	21	-	L
Road Mortalities	Proposed Development Site	• Vehicle Movement	6	2	2	3	30	-	M	• Implement speed control measures (e.g. speed limits, traffic calming measures) •Any instances of road mortalities must be recorded and reported to the ECO.	2	2	2	3	18	-	L
Alien and Invasive Plants	Proposed Development Site	• Soil disturbance during and presence of bare soil areas following construction	6	4	2	4	48	-	M	• Implement alien and invasive plant control and monitoring programme	4	1	2	2	14	-	L
Surface Water & Aquatic Ecosystems																	

POTENTIAL ENVIRONMENTAL IMPACT	APPLICABLE AREA	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
			M	D	S	P	TOTAL	STATUS	SP		M	D	S	P	TOTAL	STATUS	SP
Soil excavation, blasting and earth moving (removal and storage of soil)	Proposed Development Site	• Loss of soils from stock piles • Destabilisation of soils increasing erosion • Erosion and sedimentation of the downslope aquatic systems • Loss / degradation of instream habitat and aquatic biota • Impaired water quality • Loss of ephemeral stream at open cast area	8	4	2	2	28	-	L	• Adhere to the wetland and watercourse buffers • Keep impact footprint as small as possible • Implement the SWMP • Construct cut-off berms downslope of working areas, demarcate footprint areas to be excavated to avoid unnecessary digging • Exposed areas must be ripped and vegetated to increase surface roughness • Create energy dissipation at discharge areas to prevent scouring • Temporary and permanent erosion control methods may include silt fences, retention basins, detention ponds, interceptor ditches, seeding and sodding, riprap of exposed areas, erosion mats, and mulching • Compacted areas must be ripped (perpendicularly) to a depth of 300 mm • A seed mix must be applied to rehabilitated and bare areas • Any gullies or dongas must also be backfilled •Soil management plans should be in place which will include the use of correct stockpiling methods • Berms should be placed around soil stockpiles to secure them •Stockpiles must not exceed 5 m in height.	6	3	1	1	10	-	L
Infrastructure development	Proposed Development Site	• Increased runoff, erosion and sedimentation of the aquatic systems • Change in hydrodynamics of the project area • Loss / degradation of instream habitat and aquatic biota • Impaired water quality • Solid waste production • Loss of ephemeral streams	8	5	2	3	45	-	M	• Adhere to the wetland and watercourse buffers • The proposed infrastructure should be relocated outside of the proposed buffers described in this assessment • Keep impact footprint as small as possible • Implement SWMP • Construct cut-off berms downslope of working areas, demarcate footprint areas to be cleared to avoid unnecessary clearing • Exposed areas must be ripped and vegetated to increase surface roughness • Temporary and permanent erosion control methods may include , gabion walls, mattresses and bars, silt fences, retention basins, detention ponds, interceptor ditches, seeding and sodding, riprap of exposed areas, erosion mats, and mulching	4	5	1	2	20	-	L
Contamination through the storage and handling of chemicals, fuels & other hazardous materials	Proposed Development Site	• Contamination risk if spills occur • Impaired water quality • Change in aquatic fauna communities • Change/deterioration of the ecological status of rivers/streams	6	2	2	3	30	-	M	• No cleaning of vehicles, machines and equipment on site • All hazardous substances to be stored separately in appropriately bunded and demarcated facilities • No servicing of machines, vehicles and equipment on site • Storage of potential contaminants in bunded areas • All contractors must have spill kits available and be trained in the correct use thereof	6	2	1	1	9	-	L
Contamination through inadequate waste management (including ablutions)	Proposed Development Site	• Indiscriminate dumping in aquatic areas • Contaminated stormwater runoff entering aquatic habitats • Impaired water quality. • Change in aquatic fauna communities. Change/deterioration of the ecological status of rivers/streams	6	2	2	3	30	-	M	•Ablution facilities may not be placed within 50 m or the 1:50 year floodline. Whichever is furthest will apply. • Implement a waste management plan • Implement the SWMP • Appropriate sanitary facilities must be provided and all waste to be removed to an appropriate waste facility	6	2	1	2	18	-	L

POTENTIAL ENVIRONMENTAL IMPACT	APPLICABLE AREA	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
			M	D	S	P	TOTAL	STATUS	SP		M	D	S	P	TOTAL	STATUS	SP
Contamination through inadequate stormwater management	Proposed Development Site	• Increased runoff, erosion and sedimentation of the aquatic systems • Change in hydrodynamics of the project area and aquatic systems • Change in aquatic fauna communities. Change/deterioration of the ecological status of rivers/streams	6	4	2	4	48	-	M	• Implement the SWMP	4	4	1	3	27	-	L
Groundwater																	
Poor quality seepage from temporary stockpiles	Proposed Development Site	• Excavation and stockpiling of materials • Runoff from stockpile areas	4	2	2	4	32	-	M	• Cover stockpiles with geomembrane to reduce rainfall infiltration and hence, poor quality percolation into groundwater •Stockpiles should be placed on impermeable surfaces. • Reduce footprint areas to minimise the reaction flow path of rainfall water	4	2	2	3	24	-	L
Contamination through the storage and handling of chemicals, fuels & other hazardous materials	Proposed Development Site	• Contamination risk if spills occur • Impaired water quality	2	2	1	4	20	-	L	• Park construction vehicles in areas lined with concrete or fitted oil traps • Ensure vehicles are in good condition and not leaking fuel or oil when entering the mining areas	2	2	1	2	10	-	L

Table 8-2: Potential environmental impacts associated with the operational phase.

POTENTIAL ENVIRONMENTAL IMPACT	APPLICABLE AREA	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
			M	D	S	P	TOTAL	STATUS	SP		M	D	S	P	TOTAL	STATUS	SP
Operational Phase																	
Vegetation																	
Proliferation of IAPS	Proposed Development Area	• Operation of the proposed development	6	5	2	4	52	-	M	• The IAPS management plan must make provision for the operational phase and must be implemented. The ECO should monitor the site for 6 months following the completion of the proposed development.	4	2	2	2	16	-	L
Geology & Soils																	
Soil contamination	Proposed Development Area	• Oil and hydrocarbon spills from vehicular movement. • Storm water management • Waste management	10	2	2	4	56	-	M	• Implement suitable storm water management measures in the design of the proposed development.	8	1	1	2	20	-	L
Land Use																	
Change in land use from agricultural to residential	Proposed Development Area	• Operation of proposed development.	8	5	2	5	75	-	H	• Unavoidable impact of the proposed development. • Demarcate footprint area clearly	8	5	2	5	75	-	H
Surface Water & Aquatic																	
Increased runoff or stormflow from the site could lead to river bank erosion as well as pollution of downstream water bodies	Receiving surface water bodies	• Increasing impervious areas at the mine site	2	5	2	3	27	-	L	• Implement stormwater management plan	2	5	1	1	8	-	L
Visual																	
Visual impact on surrounding area	Proposed Development Area	• Proposed development infrastructure	8	4	2	4	56	-	M	• Unavoidable impact of the proposed development • Utilise existing vegetation and the natural landscape to naturally screen activities • Alternatively utilise shade cloth to create an artificial buffer • Utilise natural earth colours to best blend in • Detailed lighting plan to minimise light pollution • Highly reflective metals should be avoided to limit reflection and glaze of such structures	8	4	2	2	28	-	L

9 RISK ASSESSMENT MATRIX

The DWS has published General Notice (GN) 509 in Government Gazette no. 40229 under Section 39 of the NWA. The purpose was to streamline the application for and granting of a water use license in terms of Section 21 (c) and (i) water uses. The primary objective of GN 509 was to allow water users to apply for a water use license for Section 21 (c) and (i) under a General Authorisation as opposed to a full water use license.

A risk assessment matrix is used to determine the risk of the proposed activity to the receiving aquatic ecosystem in a post-mitigation state. The three risk categories are low, moderate and high. If the water use is determined to be of a low risk to the aquatic ecosystem, then it may fall under the ambit of a general authorisation subject to consultation with the DWS. However, it is determined to fall within a moderate or high-risk category, a full water use license application will need to be undertaken.

9.1 Risk Identification and Categorization

The first step in undertaking a risk assessment is identifying the specific activities to be assessed and then identifying the risks associated with these activities. In this case, the risks identified for each activity associated with the development and operation of the WWTP is summarized in Table 9-1.

Table 9-1: Summary of risks that were assessed.

Activity	Aspect	Risk
Residential Infrastructure		
C1. Construction of site camp, residential and road infrastructure	Clearing of terrestrial vegetation, reduced surface roughness and and exposure of bare soils to the elements.	C1.1 – Erosion and sedimentation.
		C1.2 – Alien invasive plants
		C1.3 – Water pollution
O1. Operation of the residential development	Hardening of surfaces and increased stormwater runoff	O1.1 – Erosion and sedimentation.
		O1.2 – Increased surface water inputs.
	Vegetation disturbance	O1.3 – Proliferation of IAPS
Waste Water Treatment Plant		
C1. Construction of the WWTP and inlet structure.		C1.1 – Erosion and sedimentation.

	Clearing of terrestrial vegetation, reduced surface roughness and exposure of bare soils to the elements.	C1.2 – Alien invasive plants
		C1.3 – Water pollution
O1. Operation of the facility	Hardening of surfaces, increased stormwater runoff.	O1.1 – Erosion and sedimentation.
	Water discharge.	O1.2 – Increased surface water inputs.
	Contaminated water discharge.	O1.3 – Water pollution
	Accidental, large scale spills.	O1.4 – Water pollution
	Increased pollutant and toxicant inputs.	O1.5 – Reduction in wetland health and function.
	Indirect disturbance through contaminated water inputs.	O1.6 – Deterioration of floral and faunal habitats.

9.2 Risk Assessment Assumptions

The following assumptions are relevant to the risk assessment:

- The risk assessment assumes that all the mitigation measures recommended within this report will be adhered to and effectively implemented. If any of the measures cannot be adhered to, the relevant risks will need to be reassessed.

9.3 RAM Results and Discussion

The risk scores and ratings under a realistic good mitigation/post-mitigation scenario are summarized in Table 9-2.

The results of the RAM indicate that the construction and operation of the residential housing development will have low to negligible impacts on the wetland. This is also the case of the construction of the proposed WWTP. However, the operation of the proposed WWTP will present a medium to high risk of impacting the wetland. The most significant impact to the receiving wetland is the permanent change in ecological health and functioning as a result of the cumulative impacts associated with the proposed WWTP. Alterations to the hydrological regime through increased water inputs and consequent water quality impacts and changes to available habitat were also determined to be of high significance.

Based on RAM, the proposed development of the WWTP and direct effluent discharge into the wetland will have a critical impact. The PES of the wetland will deteriorate significantly owing to the degradation of water quality, changes in the distribution and structure of

aquatic biota and inundation. This will consequently also have implications on the ability of the wetland to provide important ecosystem goods and services.

Table 9-2: Summary of risk scores and ratings.

Risks	Risk Score	Risk Rating
Residential Infrastructure		
C1.1 – Erosion and sedimentation.	48	Low
C1.2 – Alien invasive plants	44	Low
C1.3 – Water pollution	52.25	Low
O1.1 – Erosion and sedimentation.	40	Low
O1.2 – Increased surface water inputs.	49.5	Low
O1.3 – Proliferation of IAPS	50	Low
Waste Water Treatment Plant		
C1.1 – Erosion and sedimentation.	33.75	Low
C1.2 – Alien invasive plants	27	Low
C1.3 – Water pollution	55	Low
O1.1 – Erosion and sedimentation.	42.5	Low
O1.2 – Increased surface water inputs.	165.75	High
O1.3 – Water pollution	168	High
O1.4 – Water pollution	67.5	Medium
O1.5 – Reduction in wetland health and function.	178.5	High
O1.6 – Deterioration of floral and faunal habitats.	171	High

10 HYPOTHETICAL OPERATION PHASE SCENARIO

10.1 Ecosystem Goods and Services – Operation Phase Scenario

In order to fully unpack the potential impacts associated with the discharge of effluent into the wetland, it was deemed prudent to carry out an assessment of the Eco-services in a hypothetical operation phase scenario. The results of the operation phase scenario were compared to the pre-construction phase results and are illustrated in Figure 10-1 and Figure 10-2. The results indicate that the ability of the wetland to provide flood attenuation, natural resources, carbon storage and water supply for human use will be negatively impacted by the proposed discharge.

Increased water inputs into the system and ponding will reduce the ability of the wetland to take up additional water inputs during high energy rainfall events consequently reducing its ability to mitigate the impacts of floods on downstream infrastructure.

Inputs of contaminated water into the system will impact on the ability of the surrounding community to collect and safely use water from the wetland. The suitably of the water for human use will be significantly reduced due to increased populations of pathogens and toxic substances. The use of microbiologically contaminated water for domestic and other purposes is detrimental to human health and society at large (Edokpayi *et al*, 2016). These conditions may also affect livestock and wildlife which utilise the wetland a source of water or habitat. This may also severely impact on human health if the livestock are slaughtered for food. Edokpayi *et al* (2016) found that generally, wastewater from WWTP is rarely treated to acceptable limits due to inadequate investment in wastewater treatment infrastructure, skills shortages and/or poor planning. A study conducted by Saving Water SA in 2011 also showed that less than half of South African WWTP treated water to a safe and acceptable level.

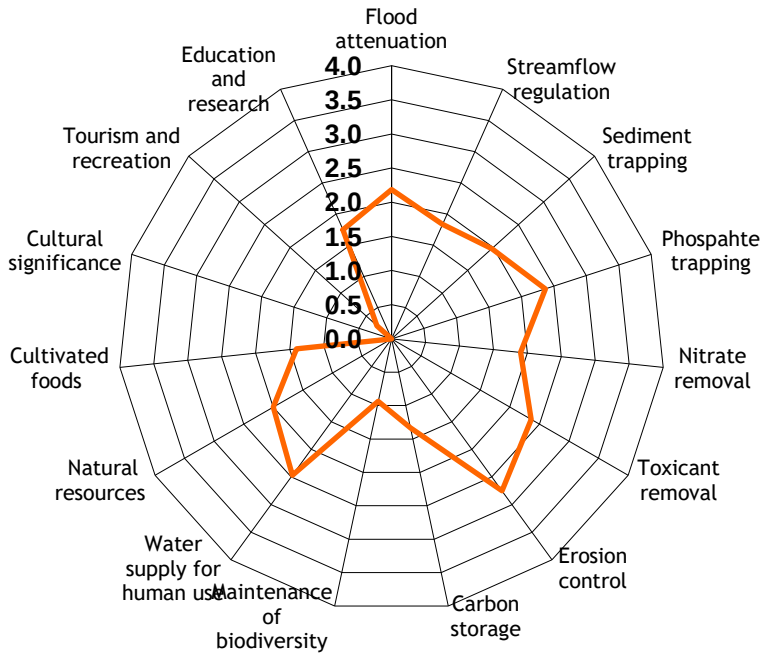

Figure 10-1: Diagram illustrating the extent and variety of ecosystems services provided by UVB01 pre-construction (Source: GCS, 2020).

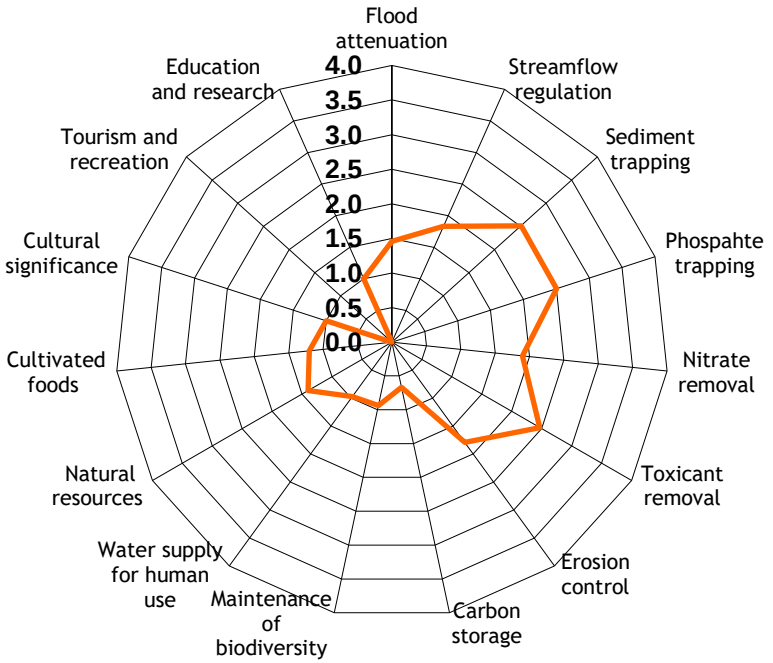

Figure 10-2: Diagram illustrating the extent and variety of ecosystems services provided by UVB01 in an operational phase scenario.

10.2 Present Ecological State – Operation Phase Scenario

The PES of the wetland in an operation phase scenario was assessed and compared to the pre-construction phase results. The results are summarized in Table 10-1 and indicate that the operation of the proposed WWTP will negatively impact on the hydrology, geomorphology and vegetation of the wetland system. Collectively, this will result in a permanent loss in wetland functionality and health. Based on a calculation of the hectare equivalents, the WWTP is expected to result in a loss of 4.89 Ha of functional wetland.

The hydrology of the wetland will be impacted by increased flow inputs and associated alteration to floodpeaks. Increased water inputs will create supersaturated conditions meaning that additional water will not infiltrate and be stored in the wetland but rather flow downstream. This creates concern given the level of impoundment and canalization directly above residential and business infrastructure. As alluded to in the hydrological component of this report, the existing infrastructure will likely not be adequate enough to handle additional water inflows and increased floodpeaks. The residential houses flanking the outlet canal at the toe of the wetland will be at increased risk of damage or destruction as a result of flooding. The proximity of the infrastructure to the canal has been illustrated in Figure 10-3. The water quality will also be measurably impacted through the release of poorly treated effluent which could contaminated downstream water resources with faecal coliforms and result in high nutrient loads. If sewage infrastructure fails or is not regularly maintained and if failures are not repaired in a timeous manner, this could lead to the catastrophic contamination of the surrounding environment and would be costly to rehabilitate if this were to occur.

The geomorphology of the wetland will be significantly impacted through additional and potentially contaminated sediment. Given the slow flow nature of the system at the proposed outlet point, additional sediment will likely smother the system resulting a permanent change in sediment dynamics. The release of large volumes of water into the system will likely result in the erosion of the system if adequate infrastructure is not put in place with suitable flow velocity dissipaters. The increase in sediment into the system may overwhelm the downstream infrastructure during high energy rainfall events resulting in blockages and localized flooding into the surrounding area.

The vegetation of the wetland will also be impacted but to a lesser degree. Vegetation will be impacted by increased sediment deposition, erosion and flooding.

Table 10-1: WET-Health Scores.

WET-Health Scores					
HGM Unit	**Hydrology**	**Geomorphology**	**Vegetation**	**Overall Score**	**Hectare Equivalents**
UVB01 (Pre-construction)	E (7)	1.2 (B)	0.6 (A)	3.5 (C)	21.45
UVB01 (Operational)	7.5 (E)	2.7 (C)	1.0 (B)	4.2 (D)	16.56

Figure 10-3: Aerial photograph illustrating the proximity of infrastructure to the canal.

10.3 Additional Mitigation Measures

Based on the impacts highlighted above, the following mitigation measures have been derived:

- The footprint of the WWTP must be kept to a minimum, to ensure there is no unnecessary intrusion into surrounding habitats.
- Any proposed associated stormwater infrastructure must be positioned at areas where concentrated flows will not result in erosion of the surrounding environment.
- A SWMP, must be composed and implemented. Additionally, it is essential that the site-specific SWMP be strictly adhered to on-site throughout the construction and operation of the WWTP.

- The mitigation of impacts should focus on managing the runoff generated by the concrete surfaces, and introducing it responsibly into the receiving environment. Therefore, the stormwater infrastructure must not be positioned where concentrated flows will enter these systems without efficient energy dissipaters positioned downslope within the flow-path.
- Stockpile areas of raw materials and other construction material must be clearly identified and demarcated prior to materials being brought onto site. None of these areas must be on or near slopes or water resources (within 50 m). All stockpiling areas must be approved by the site ECO before stockpiling occurs.
- All staff are to be trained in on-site activities and their environmental responsibilities clearly outlined before commencing work. All new staff are to be trained before they start work on-site. This should be adequately covered within the site-specific EMPr and should not require input from a freshwater habitat specialist (above what is detailed within this report).
- The contractor must utilise a SWMP (which may form part of the construction method statement) to ensure that all construction activities do not cause, or precipitate, soil erosion which may result in sediment input into the surrounding environment. The designated responsible person on site, as indicated in the stormwater control plan (usually the contractor/ECO) must ensure that no construction work takes place before the stormwater control measures are in place and must include post-construction/operational phase stormwater requirements.
- The drainage plan must ensure no downstream erosion occurs through increased stormwater inputs and that the stormwater system has sufficient capacity for water inputs and drainage. Soft engineering (grassed swales) instead of hard gutters should be used where possible.
- Erosion and sedimentation must be monitored closely and erosion and sedimentation management measures must be implemented. After every heavy rainfall event, the contractor must check the site for erosional damage and rehabilitation in the form of in situ infilling, compaction and revegetation, or the placement of temporary flow-energy dissipaters must occur immediately if damage is found. Energy dissipators should be implemented at the discharge outlet point to prevent erosion of the wetland.
- A construction method statement is required to be compiled by the applicant/contractor for all activities associated with the proposed WWTP. This method statement must include the phases of the WWTP, activities associated with the WWTP and all mitigation measures stipulated within this report, all specialist reports and the project-specific EMPr. The applicant, engineer, contractor and ECO must agree and approve the statement as this will become a binding document to be

implemented on-site. The independent ECO must ensure this document is continuously implemented on-site to ensure no unnecessary disturbance to the surrounding environment.

- A serial plan of construction must be developed:
    - Construction must be immediately followed by rehabilitation;
    - Soil replacement must be conducted in same sequence as excavated;
    - Soil surfaces must not be left open for lengthy periods to prevent erosion.
    - Affected surface vegetation must be removed, appropriately stored then reinstated, immediately post-construction, as close to their original position as possible, to reduce the possibility of longer-term change to the vegetation community. The vegetation must be removed keeping the root systems intact as far as possible.
    - If required vegetation plugs can be sorted from areas adjacent to the construction site, under the supervision of the ECO.
- Removal of vegetation must only be done if necessary for the continuation of the development. Do not allow any disturbance to the adjoining natural vegetation cover or soils. All disturbed areas must be prepared and then re-vegetated to the satisfaction of the ECO as per the relevant method statement and EMPr.
- Where feasible, construction activities should be conducted during the drier months of the year (April – August) to minimise the possibility of erosion, sedimentation and transport of suspended solids associated with disturbed areas and rainfall events.
- Existing access routes must be utilised during construction. All access points, roads and turning areas must be agreed upon by the engineer and ECO prior to commencement of construction. No ad hoc haulage roads or turning areas may be created.
- All potential stormwater contaminants must be bunded in the site camp to prevent run-off into the surrounding environment. A drainage system must be established for the construction camp. The drainage system must be regularly checked to ensure an unobstructed water flow.
- No contaminated runoff or grey water is allowed to be discharged from the construction camp.
- Designated areas for stockpiling of raw materials must be identified before material is brought onto site. All stockpiling areas must be approved by the ECO before stockpiling occurs.
- Care must be taken to avoid the introduction of invasive alien plant species to the site. Alien vegetation re-growth must be controlled throughout the entire site during the construction and rehabilitation periods. This must be done through the utilisation of an alien and invasive plant control plan.

- All exposed surfaces within the construction site must be checked for alien invasive plant species on a monthly basis and any identified alien species must be removed by hand pulling/uprooting and appropriately disposed of. Herbicides should only be utilised where manually removing is not possible. Herbicides utilised are restricted to products which have been certified safe for use by an independent testing authority. The ECO must be consulted before the purchase of any herbicide.
- Water used on site must be from an approved source. Should the water be extracted from a natural source the relevant authorisation must be acquired from DWS before abstraction. Water use on the site must be recorded and monitored.
- The digging of pit latrines is not allowed under any circumstances.
- None of the open areas or the surrounding environment may be used as ablution facilities.
- Portable toilets must be situated outside of the 1:100-year floodline of all rivers, tributaries and wetlands. A maintenance plan for the servicing of these toilets must be drawn up and strictly adhered to, to prevent malfunctioning and neglect resulting in environmental contamination.
- Should any spills of hazardous materials occur on the site or in the storage area, the relevant clean-up specialists must be contacted immediately. Materials that absorb fuel and oil, such as Drizit or earth should be placed over the spill. This contaminated material must be uplifted, placed within impermeable container and disposed of at a registered disposal site.
- In the event of a spillage that cannot be contained, and which poses a serious threat to the local environment, the following Departments must be informed of the incident in accordance with Section 30 of the National Environmental Management Act (Act no. 107 of 1998) within forty-eight (48) hours:
    - The Local Authority;
    - Department of Water and Sanitation;
    - The Department of Environmental Affairs and Development Planning;
    - The Local Fire Department when relevant; and
    - Any other affected departments.
- An incident record must be completed for all spills that do occur on-site. Minor incidents will include small spills of less than 5 litres (L) that do not enter a watercourse, stormwater drains, housekeeping issues and general small non-compliances with the requirements of this report, method statements, EA and/or EMPr. The record of incidents is to be included in the reporting to the authorities. Major incidents must be reported to the authorities, which include spills larger than 5L and all incidents involving contamination of water resources, stormwater or other reportable incidents. Minor incidents: small spills less than 5l that do not enter

stormwater, minor non-compliance with EMPr that does not cause major environmental impact i.e. Housekeeping issues etc. Action: Supervisor and staff on-site to record and address and notify ECO. ECO to advise on remediation measures and to follow up on actions taken to address incident. Records: On-site incident register. Major incidents: Large spills or any spills that enter watercourses, stormwater, contamination of soil, fires, explosions. Action: Report immediately to ECO, action to be taken to prevent further damage and incident to be reported to authorities. ECO to advise on remediation measures and to follow up on actions taken to address incident. Records: On-site incident register and report to authorities as listed above.

- Topsoil must be stored on a level area at least 50 m away from any river, tributary and/or wetland, and outside the 1:100-year flood line. The furthest threshold must be adhered to.
- The harvesting of firewood, medicinal plants, tree bark, flowers or other natural materials is forbidden on the site and from the surrounding environment.
- The Contractor must, as an initial and on-going exercise, implement erosion and sedimentation control measures to the satisfaction of the ECO. Stabilisation of cleared areas to prevent and control erosion and/or sedimentation must be actively managed.
- A designated waste area must be utilised at all times. Bins must be provided and emptied at no less than monthly intervals.
- All solid waste generated during the construction process (including packets, plastic, rubble, cut plant material, waste metals etc.) must be placed in the waste collection area in the construction camp and must not be allowed to blow around the site, be accessible by animals, or be placed in piles adjacent the skips / bins.
- Burying of waste, rubble on site, or dumping on site is prohibited.
- Material Safety Data Sheets (MSDSs) must be readily available on site for all chemicals and hazardous substances to be used on site. Where possible and available, MSDSs should additionally include information on ecological impacts and measures to minimize negative environmental impacts during accidental releases or escapes.
- Hazardous material storage areas must not be within 50 m of any watercourse or within the 1:100-year flood line. The furthest threshold must be adhered to. Hazardous storage areas to be hard surfaced and bunded with an impermeable liner to protect groundwater quality and undercover. The bunded catch pit must have at least 110% the storage capacity of the total stored quantity.
- During the planning phase, a vegetation rehabilitation and invasive alien plant species management plan must be compiled and implemented.

- A surface and groundwater quality monitoring programme must be drawn up to ensure that the quality of treated water is suitable. The wastewater must be continuously monitored during the construction and operation phases.
- The pipeline from the WWTP to the wetland must be encased in concrete or constructure using appropriate technology to prevent leaks or damage during flood events.
- Routine inspections of the infrastructure must be undertaken during the construction and operation phases. If any leaks or system failures are identified, these must be repaired immediately.
- All personnel operating and maintaining the WWTP must be appropriately trained.
- The downstream stormwater infrastructure must be upgraded where possible to compensate for increased flows and floodpeaks.

11 MONITORING REQUIREMENTS

It is recommended that biannual water quality monitoring of the wetland system takes place. It is suggested that one (1) water quality sample be collected at a point upstream of the activity area in order to serve as a control point. One (1) water quality sample would also need to be collected downstream of the activity area to serve as comparison to the control point.

12 REASONED OPINION BY THE SPECIALIST

Appendix 6 of the National Environmental Management Act (Act 107 of 1998): Environmental Impact Assessment Regulations (2014), as amended requires that the specialist conducting a specialist study for submission with an application for authorisation provide a reasoned opinion on whether an authorisation should be granted. In this regard the following key findings were taken into account:

- One unchannelled valley bottom wetland was observed approximately 408m downslope of the proposed development footprint;
- The PES of the wetland was determined to be Moderately Modified (Category C);
- The wetland was assessed to provide moderate to low ecosystem goods and services;
- In terms of the residential development, the results of the RAM indicate a low risk of impact on the wetland; and
- In terms of the WWTP, the results of the RAM indicate a high risk of permanent impact on the wetland.

Therefore, it is the opinion of the specialist that the proposed residential development, on its own, presents no fatal flaws that will prevent the development from being authorized subject to the implementation of the mitigation measures provided in this report.

Based on the results of the RAM, Eco-Services and PES assessments, the proposed direct discharge of effluent from the WWTP into the wetland will impart significant negative impacts not only on the wetland but the surrounding communities who rely on the system for resources and as a source of water. The downstream stormwater infrastructure is likely to be inadequate to effectively handle additional water inputs and increased floodpeaks. This will put the surrounding infrastructure at risk of damage or destruction. Despite the provision of mitigation measures, the results of the RAM indicate that the proposed WWTP will impart a significant and permanent change in wetland health and services. Therefore, it is the opinion of the specialist that alternative methods of disposing of the effluent be implemented.

The option of reducing effluent discharged into the wetland and gradually increasing volumes over time will also impart significant impacts to the wetland and downstream infrastructure. The major concern with this alternative is the impacts to the quality of water and creating a breeding ground for pathogens and bacteria which will likely present significant health risks to the surrounding areas.

The building of a formalized channel within the wetland would impact on the hydrology and geomorphology of the system. Impacts to water quality would also be of significant concern.

The option to pipe and discharge effluent to the Vaal River would present the least impacts to the wetland. However, the impacts associated with this on the Vaal River would need to be assessed by a suitably qualified aquatic specialist and realistic mitigation measures provided.

13 CONCLUSION AND RECOMMENDATIONS

GCS were appointed by Phumaf to undertake a ecological and wetland impact assessment for the proposed development of 7 250 housing units on portion 222 of the farm Houtkop 594. The infield assessment was undertaken on the 04th of March 2020.

13.1 Wetland Assessment

The wetland impact assessment identified one (1) unchanneled valley bottom wetland within the 500m regulated area. Further assessment of the wetland determined the wetland to be moderately modified (Class C) and providing moderate low ecosystem goods and services. The results of the RAM indicated that the proposed residential development poses a low risk of impact on the wetland. However, the proposed construction of a WWTP and direct discharge of effluent into the wetland poses high risk of permanent impact on the wetland. It was determined that the PES of the wetland will reduce to largely modified with a loss of 4.89 Ha of functional wetland. Additionally, the ability of the wetland to provide ecosystem goods and services will be measurably negatively impacted.

Based on the findings of the wetland assessment, the following recommendations have been highlighted for consideration

- The wetland system must be demarcated as a no-go zone;
- Further investigation should take place into piping and discharging the effluent into the Vaal River as this will present the least impacts to the wetland;
- The impacts associated with this on the Vaal River will need to be assessed by an aquatic scientist; and
- The mitigation measures outlined within this report must be implemented.

13.2 Ecological Assessment

The ecological assessment identified 3 habitat types as follows:

- Open grassland;
- Degraded grassland; and
- Freshwater hydrophytes.

The open and degraded grassland were determined to have low to very low naturalness due to the extensive commercial agriculture taking place within the study area. During the infield assessment, no species of conservation concern were observed.

Although the area has the potential to provide habitat for a diverse range of fauna species in a natural state, the degraded nature resulted in very few fauna species being observed. 1

mammal species, namely the *Lepus saxtilis* (Scrub Hare) was observed. Additionally, large flocks of *Streptopelia decipiens* (African Dove) were observed.

Based on the findings of the ecological assessment, the following recommendations have been highlighted for consideration:

- The open grassland must be avoided as far as reasonably practicable;
- Vegetation clearing must be limited to the site plan only. No unnecessary vegetation clearing is permitted;
- An IAPS management plan must be compiled prior to the commencement of the construction phase. This plan must be implemented throughout the construction and operational phase and must be monitored by the ECO;
- Soil disturbance must be limited to the site plan only. Construction machinery may only use the existing pathways. Suitable drip trays must be placed beneath stationary construction machinery;
- No fires are permitted on site;
- Dust control measures must be implemented;
- Erosion control measures must be implemented throughout the site. Stockpiles may not exceed 5 m in heights and must be covered using an impermeable material;
- Suitable waste receptacles must be placed around the site which are both scavenger and wind proof.

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APPENDIX 1 AMPHIBIAN SPECIES LIST

SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS	NUMBER OF RECORDS	DATE LAST RECORDED
Amietia delalandii	Delalande's River Frog	Least Concern	1	28 November 1998
Amietia fuscigula	Cape River Frog	Least Concern	1	26 February 1981
Amietia poyntoni	Poynton's River Frog	Least Concern		
Breviceps adspersus	Common Rain Frog	Least Concern		
Cacosternum boettgeri	Common Caco	Least Concern	4	10 November 2014
Chiromantis xerampelina	Southern Foam Nest Frog	Least Concern	1	28 September 2017
Kassina senegalensis	Bubbling Kassina	Least Concern	2	13 January 2000
Phrynobatrachus natalensis	Natal Dwarf Puddle Frog	Least Concern		
Pyxicephalus adspersus	Giant Bull Frog	Near Threatened	5	24 January 2017
Schismaderma carens	Red Toad	Least Concern	1	28 November 1998
Sclerophrys capensis	Raucous Toad	Least Concern	2	09 January 2014
Sclerophrys garmani	Olive Toad	Least Concern	1	24 December 2001
Sclerophrys gutturalis	Guttural Toad	Least Concern	6	24 December 2001
Sclerophrys poweri	Power's Toad	Least Concern		
Semnodactylus wealii	Weale's Running Frog	Least Concern		
Strongylopus fasciatus	Striped Stream Frog	Least Concern		
Tomopterna cryptotis	Tremelo Sand Frog	Least Concern	1	26 February 1981
Tomopterna natalensis	Natal Sand Frog	Least Concern	1	28 November 1998
Tomopterna tandyi	Tandy's Sand Frog	Least Concern		
Xenopus laevis	Common Platanna	Least Concern	4	28 November 1998

APPENDIX 2 AVIFAUNA SPECIES LIST

SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS	NUMBER OF RECORDS	DATE LAST RECORDED
Actizera lucida	Rayed blue	Least Concern (SABCA 2013)	2	22 February 2009
Afrogegenes hottentota	Marsh hottentot skipper	Least Concern (SABCA 2013)	1	01 March 2008
Afrogegenes sp.	Hottentots		1	01 March 2008
Azanus jesous	Topaz babul blue	Least Concern (SABCA 2013)	2	27 January 2019
Azanus moriqua	Black-bordered babul blue	Least Concern (SABCA 2013)	1	01 March 2008
Belenois aurota	Brown-veined white	Least Concern (SABCA 2013)	3	22 February 2009
Byblia ilithyia	Spotted joker	Least Concern (SABCA 2013)	1	01 March 2008
Cacyreus marshalli	Common geranium bronze	Least Concern (SABCA 2013)	1	30 January 2016
Catopsilia florella	African migrant	Least Concern (SABCA 2013)	4	22 February 2009
Chilades trochylus	Grass jewel	Least Concern (SABCA 2013)	2	29 January 2017
Coeliades forestan forestan	Striped policeman	Least Concern (SABCA 2013)	2	01 March 2008
Colias electo electo	African clouded yellow	Least Concern (SABCA 2013)	1	01 March 2008
Danaus chrysippus orientis	African monarch, Plain tiger	Least Concern (SABCA 2013)	5	22 February 2009
Daphnis nerii	Oleander Hawk-Moth	Not listed	1	02 April 2014
Eicochrysops messapus mahallakoaena	Cupreous blue	Least Concern (SABCA 2013)	1	01 March 2008
Eretis umbra umbra	Small marbled elf	Least Concern (SABCA 2013)	3	22 February 2009
Eurema brigitta brigitta	Broad-bordered grass yellow	Least Concern (SABCA 2013)	5	29 January 2017
Gomalia elma elma	Green-marbled skipper	Least Concern (SABCA 2013)	1	01 March 2008
Hypolimnas misippus	Common diadem	Least Concern (SABCA 2013)	4	22 February 2009
Junonia hierta cebrene	Yellow pansy	Least Concern (SABCA 2013)	3	22 February 2009
Junonia oenone oenone	Blue pansy	Least Concern (SABCA 2013)	1	01 March 2008
Junonia orithya madagascariensis	Eyed pansy	Least Concern (SABCA 2013)	6	28 April 2019
Lepidochrysops ortygia	Koppie blue	Least Concern (SABCA 2013)	4	14 January 1993
Lepidochrysops patricia	Patricia blue	Least Concern (SABCA 2013)	2	08 January 2009
Leptotes pirithous pirithous	Common zebra blue	Least Concern (SABCA 2013)	1	01 March 2008
Metisella meninx	Marsh sylph	Least Concern (SABCA 2013)	4	04 March 2009
Papilio demodocus demodocus	Citrus swallowtail	Least Concern (SABCA 2013)	1	01 March 2008
Pontia helice helice	Common meadow white	Least Concern (SABCA 2013)	1	08 January 2009
Pseudolarentia megalaria		Not Threatened (NT) [not an IUCN category]	1	28 April 2019
Rhodometra sacraria		Not Threatened (NT) [not an IUCN category]	1	17 March 2017
Spialia asterodia	Star sandman	Least Concern (SABCA 2013)	4	22 February 2009
Spialia dromus	Forest sandman	Least Concern (SABCA 2013)	4	01 March 2008

SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS	NUMBER OF RECORDS	DATE LAST RECORDED
Spialia mafa mafa	Mafa sandman	Least Concern (SABCA 2013)	4	22 February 2009
Stygionympha wichgrafi wichgrafi	Wichgraf's hillside brown	Least Concern (SABCA 2013)	2	01 March 2008
Tarucus sybaris sybaris	Dotted blue	Least Concern (SABCA 2013)	1	01 March 2008
Telchinia rahira rahira	Marsh acraea	Least Concern (SABCA 2013)	5	01 January 2018
Utetheisa pulchella	Crimson-Speckled Moth	Not listed	1	19 March 2017
Vanessa cardui	Painted lady	Least Concern (SABCA 2013)	3	08 January 2009
Zizeeria knysna knysna	African grass blue	Least Concern (SABCA 2013)	3	27 January 2019
Zizula hylax	Tiny grass blue	Least Concern (SABCA 2013)	2	22 February 2009

APPENDIX 3 DRAGONFLIES AND DAMSELFLIES

SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS	NUMBER OF RECORDS	DATE LAST RECORDED
Anax imperator	Blue Emperor	LC	3	10 November 2019
Pinheyschna subpupillata	Stream Hawker	LC	1	15 December 2005
Africallagma sp.	African bluets		1	01 January 2018
Africallagma glaucum	Swamp Bluet	LC	6	10 November 2019
Azuragrion nigridorsum	Sailing Bluet	LC	1	10 January 2016
Ischnura senegalensis	Tropical Bluetail	LC	5	10 November 2019
Proischnura rotundipennis	Round-winged Bluet	LC	1	15 December 2005
Pseudagrion massaicum	Masai Sprite	LC	2	10 November 2019
Pseudagrion salisburyense	Slate Sprite	LC	2	26 February 2017
Crocothemis erythraea	Broad Scarlet	LC	5	10 November 2019
Diplacodes lefebvrii	Black Percher	LC	6	28 April 2019
Diplacodes luminans	Barbet Percher	LC	2	14 January 2018
Pantala flavescens	Wandering Glider	LC	1	27 January 2019
Rhyothemis semihyalina	Phantom Flutterer	LC	3	18 February 2018
Sympetrum fonscolombii	Red-veined Darter or Nomad	LC	3	10 November 2019
Tholymis tillarga	Twister	LC	1	12 March 2016
Trithemis sp.			1	14 January 2018
Trithemis furva	Navy Dropwing	LC	1	14 January 2018

APPENDIX 4 MAMMAL SPECIES LIST

SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS	NUMBER OF RECORDS	DATE LAST RECORDED
Aethomys ineptus	Tete Veld Rat	Least Concern		
Alcelaphus buselaphus	Hartbesst Antelope	Least Concern		
Antidorcas marsupialis	Springbok	Least Concern		
Aonyx capensis	African Clawless Otter	Near Threatened		
Atelerix frontalis	South African Hedgehog	Least Concern		
Atilax paludinosus	Marsh Mongoose	Least Concern		
Canis mesomelas	Black-backed Jackal	Least Concern	1	16 April 2019
Caracal caracal	Caracal	Least Concern		
Ceratotherium simum	White Rhinoceros	Near Threatened		
Chaerephon pumilus	Little Free-tailed Bat	Least Concern	2	
Connochaetes gnou	Black Wildebeest	Least Concern		
Connochaetes taurinus	Blue Wildebeest	Least Concern		
Crocidura cyanea	Reddish-Gray Musk Shrew	Least Concern		
Crocidura maquassiensis	Makwassie Musk Shrew	Least Concern		
Cynictis penicillata	Yellow Mongoose	Least Concern	1	16 December 2011
Damaliscus pygargus	Bontebok	Least Concern	1	16 April 2019
Desmodillus auricularis	Cape Short-Eared Gerbil	Least Concern		
Diceros bicornis	Black Rhinocerus	Critically Endangered		
Eidolon helvum	Straw-Coloured Fruit Bat	Near Threatened		
Elephantulus brachyrhynchus	Short-Snouted Elephant Shrew	Least Concern		
Elephantulus myurus	Eastern Rock Elephant Shrew	Least Concern		
Eptesicus hottentotus	Long-Tailed House Bat	Least Concern		
Equus quagga	Plains Zebra	Least Concern	2	16 October 2014
Felis nigripes	Black-Footed Cat	Vulnerable		
Felis silvestris	Wildcat	Least Concern		
Genetta genetta	Common Genet	Least Concern		
Gerbilliscus brantsii	Highveld Gerbil	Least Concern		
Gerbilliscus leucogaster	Bushveld Gerbil	Least Concern		
Herpestes sanguineus	Slender Mongoose	Least Concern		
Hydrictis maculicollis	Spotted-Necked Otter	Near Threatened		
Hystrix africaeaustralis	Cape Porcupine	Least Concern		
Ichneumia albicauda	White-Tailed Mongoose	Least Concern		

SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS	NUMBER OF RECORDS	DATE LAST RECORDED
Ictonyx striatus	Striped Polecat	Least Concern		
Kobus ellipsiprymnus	Waterbuck	Least Concern	1	16 April 2019
Leptailurus serval	Serval	Least Concern		
Lepus victoriae	African Savanna Hare	Least Concern		
Mastomys coucha	Southern Multimammate Mouse	Least Concern		
Mellivora capensis	Honey Badger	Least Concern		
Micaelamys namaquensis	Namaqua Rock Rat	Least Concern		
Mungos mungo	Banded Mongoose	Least Concern		
Mus musculus	House Mouse	Least Concern		
Myotis tricolor	Cape Hairy Bat	Least Concern		
Myotis welwitschii	Welwitsch's Bat	Least Concern		
Mystromys albicaudatus	White-Tailed Rat	Vulnerable		
Neoromicia capensis	Cape Serotine	Least Concern		
Neoromicia zuluensis	Zulu Serotine	Least Concern		
Nycteris thebaica	Egyptian Slit-Faced Bat	Least Concern		
Orycteropus afer	Aardvark	Least Concern		
Otomys angoniensis	Angoni Vlei Rat	Least Concern		
Otomys auratus	Vlei Rat	Near Threatened		
Ourebia ourebi	Oribi Antelope	Least Concern		
Panthera pardus	Leopard	Vulnerable		
Papio ursinus	Chacma Baboon	Least Concern		
Parahyaena brunnea	Brown Hyena	Near Threatened		
Pedetes capensis	South African Springhare	Least Concern		
Pelea capreolus	Grey Rhebok	Near Threatened		
Phacochoerus africanus	Common Warthog	Least Concern		
Poecilogale albinucha	African Striped Weasel	Least Concern		
Procavia capensis	Rock Hyrax	Least Concern		
Proteles cristata	Aardwolf	Least Concern		
Raphicerus campestris	Steenbok	Least Concern		
Rattus rattus	Roof Rat	Least Concern	1	06 May 1994
Rhabdomys dilectus	Mesic Four Striped Grass Rat	Least Concern		
Rhabdomys pumilio	Xeric Four-striped Grass Rat	Least Concern	1	07 May 2019
Rhinolophus clivosus	Geoffroy's Horseshoe Bat	Least Concern		

SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS	NUMBER OF RECORDS	DATE LAST RECORDED
Rhinolophus darlingi	Darling's Horseshoe Bat	Least Concern		
Saccostomus campestris	South African Pouched Mouse	Least Concern		
Sauromys petrophilus	Robert's Flat-Headed Bat	Least Concern		
Scotophilus dinganii	African Yellow Bat	Least Concern		
Steatomys krebsii	Kreb's Fat Mouse	Least Concern		
Steatomys pratensis	Fat Mouse	Least Concern		
Suncus varilla	Lesser Dwarf Shrew	Least Concern		
Suricata suricatta	Meerkat	Least Concern		
Sylvicapra grimmia	Common Duiker	Least Concern		
Syncerus caffer	African Buffalo	Least Concern	1	16 April 2019
Tadarida aegyptiaca	Egyptian Free-tailed Bat	Least Concern	1	01 July 1989
Taurotragus oryx	Common Eland	Least Concern	1	16 April 2019
Tragelaphus angasii	Nyala	Least Concern	2	11 May 2014
Tragelaphus oryx	Common Eland	Least Concern		
Vulpes chama	Cape Fox	Least Concern		
Xerus inauris	South African Ground Squirrel	Least Concern	1	03 November 2014

APPENDIX 5 REPTILE SPECIES LIST

SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS	NUMBER OF RECORDS	DATE OF LAST RECORD
Acontias gracilicauda	Thin-tailed Legless Skink	Least Concern		
Afrotyphlops bibronii	Bibron's Blind Snake	Least Concern		
Agama atra	Southern Rock Agama	Least Concern		
Aparallactus capensis	Black-headed Centipede-eater	Least Concern	1	28 July 2019
Boaedon capensis	Brown House Snake	Least Concern	1	28 January 2011
Causus rhombeatus	Rhombic Night Adder	Least Concern		
Chamaeleo dilepis	Common Flap-neck Chameleon	Least Concern		
Chamaesaura aenea	Transvaal Grass Lizard	Least Concern		
Cordylus vittifer	Common Girdled Lizard	Least Concern	3	14 August 2014
Crotaphopeltis hotamboeia	Red-lipped Snake	Least Concern		
Dasypeltis scabra	Common Egg Eater	Least Concern	1	26 February 1981
Gerrhosaurus flavigularis	Yellow-throated Plated Lizard	Least Concern		
Hemachatus haemachatus	Rinkhals	Least Concern	2	18 January 2015
Hemidactylus mabouia	Common Tropical House Gecko	Least Concern		
Homoroselaps dorsalis	Striped Harlequin Snake	Least Concern		
Homoroselaps lacteus	Spotted Harlequin Snake	Least Concern		
Lamprophis aurora	Aurora House Snake	Least Concern	4	18 January 2015
Pachydactylus capensis	Cape Gecko	Least Concern	1	14 August 2014
Panaspis wahlbergi	Wahlberg's Snake-eyed Skink	Least Concern		
Pelomedusa galeata	South African Marsh Terrapin	Not evaluated	1	03 October 2012
Philothamnus semivariegatus	Spotted Bush Snake	Least Concern		
Prosymna ambigua	East African Shovelsnout Snake	Least Concern		
Prosymna sundevallii	Sundevall's Shovel Snout	Least Concern		
Psammophis crucifer	Cross-Marked Grass Snake	Least Concern		
Psammophis subtaeniatus	Western Yellow-Bellied Sand Snake	Least Concern	2	07 May 2019
Psammophylax rhombeatus	Spotted Grass Snake	Least Concern		
Psammophylax tritaeniatus	Striped Skaapsteker	Least Concern		
Pseudocordylus melanotus	Common Crag Lizard	Least Concern	3	26 February 1981
Rhinotyphlops lalandei	Delalande's Beaked Blind Snake	Least Concern	2	10 November 2014
Trachylepis capensis	Cape Skink	Least Concern		
Trachylepis punctatissima	Speckled Rock Skink	Least Concern	1	26 February 1981
Trachylepis varia sensu lato	Common Variable Skink Complex	Least Concern		

APPENDIX 6 FLORA SPECIES

SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS
Aristida congesta	Tassel Three-Awn	Least Concern
Chloris virgata	Feather Fingergrass	Least Concern
Cymbopogan validus	Giant Turpentine Grass	Least Concern
Cynodon dactylon	Bermuda Grass	Least Concern
Digitaria longiflora	False Couch Grass	Least Concern
Elionurus muticus	Wire Grass	Least Concern
Eragrostis lehmanniana	Lehmann Lovegrass	Least Concern
Eragrostis plana	Fan Love Grass	Least Concern
Eragrostis Rigidior	Curly Leaf Grass	Least Concern
Heteropogon Contortis	Spear Grass	Least Concern
Melinis repens	Rose Natal Grass	Least Concern
Panicum natalense	Natal Buffalo Grass	Least Concern
Setaria sphacelate	South African Pigeon Grass	Least Concern
Sporobolus centrifugus	Spike Dropseed Grass	Least Concern
Sporobolus fimbriatus	Perennial Dropseed	Least Concern
Themeda triandra	Red Grass	Least Concern
Trachypogan Spicatus	Giant Spear Grass	Least Concern
Typha capensis	Bulrush	Least Concern
Invasive Alien Species		
Cirsium vulgare	Spear Thistle	Category 1b
Eucalyptus globulus	Blue Gum	Category 1b
Ipomoea indica	Blue Morning Glory	Category 1b
Melia Azedarach	Syringa Tree	Category 1b
Nerium oleander	Oleander	Category 1b
Pinus sp	Pine Species	Category 3
Verbena Opuntia	Prickly Pear	Category 1b

ANNEXURE 7 WETLAND RISK ASSESSMENT MATRIX RESIDENTIAL INFRASTRUCTURE

Phase	Activity	Aspect	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph+Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection		Likelihood	Significance	Risk Rating
Construction Phase	Construction of the site camp, residential and road infrastructure	Clearing of terrestrial vegetation, reduced surface roughness and exposure of bare soils the elements.	O1.1 - Erosion and sedimentation	2	2	2	2	**2**	2	2	6	1	1	5	1		**8**	**48**	L
			O1.2 – Alien invasive plants	1	2	2	1	**1.5**	2	2	5.5	1	1	5	1		**8**	**44**	L
			O1.3 - Water pollution from construction vehicles	1	2	2	2	**1.75**	2	1	4.75	2	2	5	2		**11**	**52.25**	L
Operational Phase	Operation of the residential development	Hardening of surfaces and increased stormwater runoff	O1.1 - Erosion and sedimentation	2	2	2	2	**2**	1	2	5	1	1	5	1		**8**	**40**	L
			O1.2 - Increased surface water inputs.	2	2	1	1	**1.5**	2	2	5.5	2	1	5	1		**9**	**49.5**	

		Disturbance of vegetation	O1.3 Proliferation of IAPS.	1	2	3	2	**2**	1	2	5	2	2	5	1		**10**	**50**

ANNEXURE 8 WETLAND RISK ASSESSMENT MATRIX WWTP

No.	Phases	Activity	Aspect	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph+Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection		Likelihood	Significance	Risk Rating
1	Construction Phase	Construction of the WWTP and inlet structure.	Clearing of terrestrial vegetation, reduced surface roughness and exposure of bare soils the elements.	O1.1 - Erosion and sedimentation	2	2	2	1	**1.75**	1	1	3.75	1	2	5	1		**9**	**33.75**	L
				O1.2 – Alien invasive plants	1	1	1	1	**1**	1	1	3	1	1	5	2		**9**	**27**	L
				O1.3 - Water pollution	1	3	1	1	**1.5**	1	3	5.5	1	2	5	2		**10**	**55**	L
	Operational Phase	Operation of the WWTP	Hardening of surfaces and increased stormwater runoff	O1.1 - Erosion and sedimentation	1	1	2	1	**1.25**	1	2	4.25	2	2	5	1		**10**	**42.5**	L
			Water discharge	O1.2 - Increased surface water inputs.	4	3	2	2	**2.75**	3	4	9.75	5	5	5	2		**17**	**165.75**	H

			Contaminated water discharge	O 1.3 - Water pollution	4	5	2	3	**3.5**	3	4	10.5	5	5	5	1		**16**	**168**	H
			Accidential, large scale spills.	O1.4 - Water pollution	4	4	4	2	**3.5**	3	1	7.5	1	2	5	1		**9**	**67.5**	M
			Increased pollutant and toxicant inputs	O1.5 - Reduction in wetland health and function.	4	5	3	2	**3.5**	3	4	10.5	5	4	5	3		**17**	**178.5**	H
			Indirect disturbance through contaminated water inputs.	O1.6 - Deterioration of floral and faunal habitats.	4	4	3	3	**3.5**	2	4	9.5	5	5	5	3		**18**	**171**	H

APPENDIX B5

Heritage Impact Assessment

HERITAGE IMPACT ASSESSMENT

(REQUIRED UNDER SECTION 38 (8) OF THE NHRA (No. 25 OF 1999)

FOR THE PROPOSED UNITAS PARK EXT 16 TOWNSHIP DEVELOPMENT LOCATED IN UNITAS PARK, GAUTENG PROVINCE.

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Amendments on Document

Date	Report Reference Number	Description of Amendment

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The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken and HCAC reserves the right to modify aspects of the report including the recommendations if and when new information becomes available from ongoing research or further work in this field or pertaining to this investigation.

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REPORT OUTLINE

Appendix 6 of GNR 326 EIA Regulations (7 April 2017) as amended provides the requirements for specialist reports undertaken as part of the environmental authorisation process. In line with this, Table 1 provides an overview of Appendix 6 together with information on how these requirements have been met.

Table 1. Specialist Report Requirements.

Requirement from Appendix 6 of GNR 326 EIA Regulations (7 April 2017)	Chapter
(a) Details of - (i) the specialist who prepared the report; and (ii) the expertise of that specialist to compile a specialist report including a curriculum vitae	Section a Section 12
(b) Declaration that the specialist is independent in a form as may be specified by the competent authority	*Declaration of Independence*
(c) Indication of the scope of, and the purpose for which, the report was prepared	Section 1
(cA)an indication of the quality and age of base data used for the specialist report	Section 1, 3.4 and 7.1.
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	9
(d) Duration, Date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 3.4
(e) Description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 3
(f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternative;	Section 8 and 9
(g) Identification of any areas to be avoided, including buffers	Section 9
(h) Map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	Section 8
(I) Description of any assumptions made and any uncertainties or gaps in knowledge	Section 3.7
(j) a description of the findings and potential implications of such findings on the impact of the proposed activity including identified alternatives on the environment or activities;	Section 9
(k) Mitigation measures for inclusion in the EMPr	Section 9 and 10
(l) Conditions for inclusion in the environmental authorisation	Section 9 and 10
(m) Monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 9 and 10
(n) Reasoned opinion - (i) as to whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and (ii) if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Section 10.2
(o) Description of any consultation process that was undertaken during the course of preparing the specialist report	Section 6
(p) A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Refer to BA Report
(q) Any other information requested by the competent authority	Section 10

Executive Summary

HCAC was appointed to conduct a Heritage Impact Assessment of the proposed Unitas Park Ext 16 township development located between Sebokeng and Vereeniging in Gauteng Province. The aim of the assessment is to understand the heritage character of the study area as well as the impact of the proposed development on non-renewable heritage resources that might occur in the impact area. The study area was assessed both on desktop level and by a non-intrusive pedestrian field survey. The study area is approximately 149 hectares in extent and is mostly cultivated hampering access throughout the study area. The field survey was conducted as a non-intrusive pedestrian survey to cover the extent of the study area as the development lay out was not available at the time of the survey.

The field survey recorded scatters of Stone Age artefacts (Feature 1,2,4,5 and 6), a stone cairn of unknown purpose (Feature 3), and a party demolished homestead (Feature 7). An independent paleontological study (Bamford 2020) concluded that the proposed site lies on soils overlying deep deposits of siltstones, mudstones, shales and possible coal seams of the Vryheid Formation (Ecca Group, Karoo Supergroup) of middle Permian age. Such rocks can potentially preserve fossils of the *Glossopteris* flora however the potentially fossiliferous rocks are more than 50m below the surface so will not be impacted upon by an urban development but a Fossil Chance Find Protocol is recommended.

The impact of the proposed project on heritage resources is considered to be low and it is recommended that the proposed project can commence on the condition that the following recommendations are implemented as part of the EMPr and based on approval from SAHRA:

- Feature 1, 2, 4, 5 and 6 must be monitored during construction to determine if *in-situ* subsurface layers are present.
- It is recommended that Feature 3 should be monitored during earthworks in the area.
- No mitigation is required for Feature 7, unless it is proven that the site is older than 60 years,

In addition to the site-specific recommendations outlined above the following applies:

- Confirmation of any grave sites in the study area as part of the social consultation process
- Graves should ideally be retained *in-situ* in open spaces
- Implementation of a chance find procedure (archaeological and paleontological) for the project as outlined in Section 10.1

.

Declaration of Independence

Specialist Name	Jaco van der Walt
Declaration of Independence	I declare, as a specialist appointed in terms of the National Environmental Management Act (Act No 108 of 1998) and the associated 2014 Environmental Impact Assessment (EIA) Regulations, that I: - I act as the independent specialist in this application; - I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant; - I declare that there are no circumstances that may compromise my objectivity in performing such work; - I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity; - I will comply with the Act, Regulations and all other applicable legislation; - I have no, and will not engage in, conflicting interests in the undertaking of the activity; - I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority; - All the particulars furnished by me in this form are true and correct; and - I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.
Signature	
Date	14/03/2020

a) Expertise of the specialist

Jaco van der Walt has been practising as a CRM archaeologist for 15 years. He obtained an MA degree in Archaeology from the University of the Witwatersrand focussing on the Iron Age in 2012 and is a PhD candidate at the University of Johannesburg focussing on Stone Age Archaeology with specific interest in the Middle Stone Age (MSA) and Later Stone Age (LSA). Jaco is an accredited member of ASAPA (#159) and have conducted more than 500 impact assessments in Limpopo, Mpumalanga, North West, Free State, Gauteng, KZN as well as he Northern and Eastern Cape Provinces in South Africa.

Jaco has worked on various international projects in Zimbabwe, Botswana, Mozambique, Lesotho, DRC Zambia and Tanzania. Through this he has a sound understanding of the IFC Performance Standard requirements, with specific reference to Performance Standard 8 – Cultural Heritage.

TABLE OF CONTENTS

Contents

REPORT OUTLINE 1
EXECUTIVE SUMMARY 2
DECLARATION OF INDEPENDENCE 3
a) Expertise of the specialist 3
ABBREVIATIONS 7
GLOSSARY 7
1 INTRODUCTION AND TERMS OF REFERENCE: 8
1.1 Terms of Reference 8
2 LEGISLATIVE REQUIREMENTS 13
3 METHODOLOGY 14
3.1 Literature Review 14
3.2 Genealogical Society and Google Earth Monuments 14
3.3 Stakeholder Engagement and Public consultation 14
3.4 Site Investigation 15
3.5 Site Significance and Field Rating 17
3.6 . Impact Assessment Methodology 18
3.7 Limitations and Constraints of the study 19
4 DESCRIPTION OF SOCIO-ECONOMIC ENVIRONMENT 19
5 DESCRIPTION OF THE PHYSICAL ENVIRONMENT: 20
6 RESULTS OF PUBLIC CONSULTATION AND STAKEHOLDER ENGAGEMENT: 22
7.1. Literature Review 23
7.1.1. Genealogical Society and Google Earth Monuments 23
7.2. Archaeology of the greater study area 24
Historical information 25
Anglo Boer War 25
7.2.1. Cultural Landscape 26
8. FINDINGS OF THE SURVEY 27
9. POTENTIAL IMPACT 32
9.1. Pre-Construction phase: 32
9.2. Construction Phase 32
9.3. Operation Phase: 32
9.4. Cumulative Impacts 34
10. RECOMMENDATIONS AND CONCLUSION 35
10.1. Chance Find Procedure 36
10.2. Reasoned Opinion 37
10.3. Potential risk 37
11. REFERENCES 38

LIST OF FIGURES

Figure 1. Regional setting (1: 250 000 topographical map). 10
Figure 2: Local setting (1:50 000 topographical map). 11
Figure 3. Satellite image indicating the study area (Google Earth 2020). 12
Figure 4: Track logs of the survey in green. Large parts of the study area are cultivated and therefore inaccessible – no track logs are available in these areas. 16
Figure 5. North Eastern border. 20
Figure 6. South Eastern border 20
Figure 7. North Western Border. 21
Figure 8. South Western Border. 21
Figure 9. North Eastern portion of the study area. 21
Figure 10. North Eastern portion of the study area. 21
Figure 11. General site conditions – South Western portion of the study area. 22
Figure 12. General site conditions – South Western portion of the study area. 22
Figure 13. Quarry. 22
Figure 14. Quarry. 22
Figure 15. 2010 Google Image of the study area. 26
Figure 16. 2017 Google Image of the study area. 27
Figure 17. Site distribution map. 29
Figure 18. Large foundation slabs. 30
Figure 19. Large foundation slabs. 30
Figure 20. Range of artefacts exposed by ploughing. 30
Figure 21. Quartzite Core. 30
Figure 22. Fresh removal visible on pebble, possibly from machinery. 31
Figure 23. Ploughed area in the vicinity of Feature 1 exposing artefacts. 31
Figure 24. Lower density of artefacts and natural stones within ploughed material at Feature 2. 31
Figure 25. Packed stone feature at Feature 3. 31
Figure 26. Feature 7 Homestead. 32
Figure 27. Feature 7 Homestead. 32

LIST OF TABLES

Table 1. Specialist Report Requirements. 1
Table 2: Project Description 9
Table 3: Infrastructure and project activities 9
Table 4: Site Investigation Details 15
Table 5. Recorded features 28
Table 6. Impact of the project on heritage resources. 33
Table 7. Cumulative Impact of the project. 34

ABBREVIATIONS

AIA: Archaeological Impact Assessment
ASAPA: Association of South African Professional Archaeologists
BA: Basic Assessment
BGG Burial Ground and Graves
BIA: Basic Impact Assessment
CFPs: Chance Find Procedures
CMP: Conservation Management Plan
CRR: Comments and Response Report
CRM: Cultural Resource Management
DEA: Department of Environmental Affairs
EA: Environmental Authorisation
EAP: Environmental Assessment Practitioner
ECO: Environmental Control Officer
EIA: Environmental Impact Assessment*
EIA: Early Iron Age*
EIA Practitioner: Environmental Impact Assessment Practitioner
EMP: Environmental Management Programme
ESA: Early Stone Age
ESIA: Environmental and Social Impact Assessment
GIS Geographical Information System
GPS: Global Positioning System
GRP Grave Relocation Plan
HIA: Heritage Impact Assessment
LIA: Late Iron Age
LSA: Late Stone Age
MEC: Member of the Executive Council
MIA: Middle Iron Age
MPRDA: Mineral and Petroleum Resources Development Act
MSA: Middle Stone Age
NEMA National Environmental Management Act, 1998 (Act No. 107 of 1998)
NHRA National Heritage Resources Act, 1999 (Act No. 25 of 1999)
NID Notification of Intent to Develop
NoK Next-of-Kin
PRHA: Provincial Heritage Resource Agency
SADC: Southern African Development Community
SAHRA: South African Heritage Resources Agency

**Although EIA refers to both Environmental Impact Assessment and the Early Iron Age both are internationally accepted abbreviations and must be read and interpreted in the context it is used.*

GLOSSARY

Archaeological site (remains of human activity over 100 years old)
Early Stone Age (~ 2.6 million to 250 000 years ago)
Middle Stone Age (~ 250 000 to 40-25 000 years ago)
Later Stone Age (~ 40-25 000, to recently, 100 years ago)
The Iron Age (~ AD 400 to 1840)
Historic (~ AD 1840 to 1950)
Historic building (over 60 years old)

1 Introduction and Terms of Reference:

Heritage Contracts and Archaeological Consulting CC (**HCAC)** has been contracted by GCS Water and Environmental Consultants to conduct a heritage impact assessment of the proposed Unitas Ext 16 township development located within Unitas Park, north of Vereeniging, Gauteng Province (Figure 1 – 3).

The aim of the study is to survey the proposed development footprint to identify cultural heritage sites, document, and assess their importance within local, provincial and national context. It serves to assess the impact of the proposed project on non-renewable heritage resources, and to submit appropriate recommendations with regard to the responsible cultural resources management measures that might be required to assist the developer in managing the discovered heritage resources in a responsible manner. It is also conducted to protect, preserve, and develop such resources within the framework provided by the National Heritage Resources Act of 1999 (Act No 25 of 1999). The report outlines the approach and methodology utilized before and during the survey, which includes: Phase 1, review of relevant literature; Phase 2, the physical surveying of the area on foot and by vehicle; Phase 3, reporting the outcome of the study.

During the survey, Middle Stone Age artefact scatters, a stone cairn of unknown purpose and a dilapidated homestead were identified. General site conditions and features on sites were recorded by means of photographs, GPS locations, and site descriptions. Possible impacts were identified and mitigation measures are proposed in the following report. SAHRA as a decision-making authority under section 38(1) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) require all documents, complied in support of this application to be submitted to SAHRA.

1.1 Terms of Reference

Field study

Conduct a field study to: (a) locate, identify, record, photograph and describe sites of archaeological, historical or cultural interest; b) record GPS points of sites/areas identified as significant areas; c) determine the levels of significance of the various types of heritage resources affected by the proposed development.

Reporting

Report on the identification of anticipated and cumulative impacts the operational units of the proposed project activity may have on the identified heritage resources for all 3 phases of the project; i.e., construction, operation and decommissioning phases. Consider alternatives, should any significant sites be impacted adversely by the proposed project. Ensure that all studies and results comply with the relevant legislation, SAHRA minimum standards and the code of ethics and guidelines of ASAPA.

To assist the developer in managing the discovered heritage resources in a responsible manner, and to protect, preserve, and develop them within the framework provided by the National Heritage Resources Act of 1999 (Act No 25 of 1999).

Table 2: Project Description

Size of property	149 hectares
Magisterial District	Emfuleni Municipality
1: 50 000 map sheet number	2627 DB
Central co-ordinate of the development	26°37'30.50"S 27°54'12.72"E

Table 3: Infrastructure and project activities

Type of development	Township Development
Project size	Approximately 149 hectares
Project Components	The Gauteng Rapid Land Release Programme aims to fast track the release of serviced stands from state-owned land to qualifying beneficiaries. Phumaf Holdings was appointed to assist the Department of Human Settlements with all pre-planning, planning work, design and construction management to enable the release of the identified stands

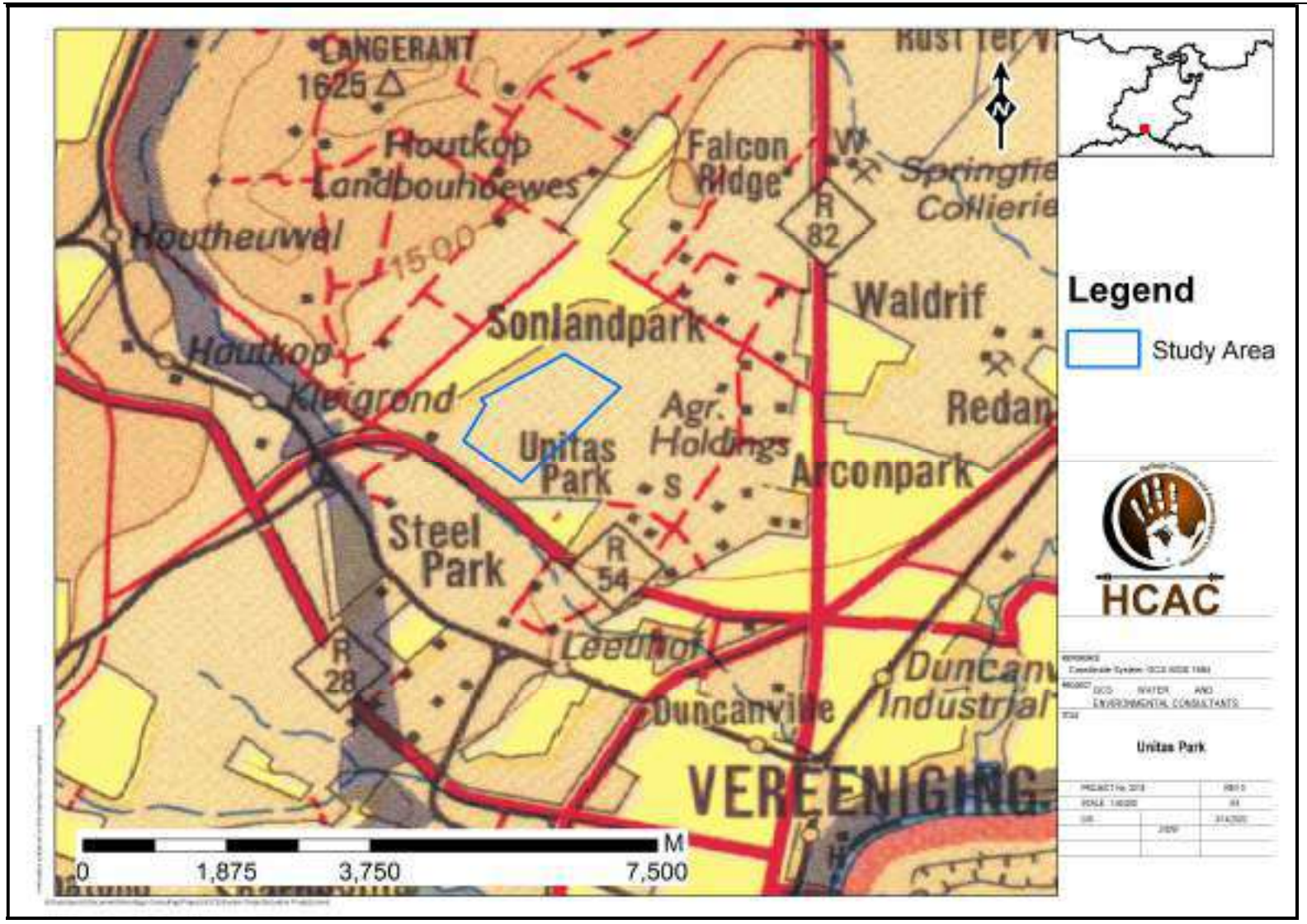

Figure 1. Regional setting (1: 250 000 topographical map).

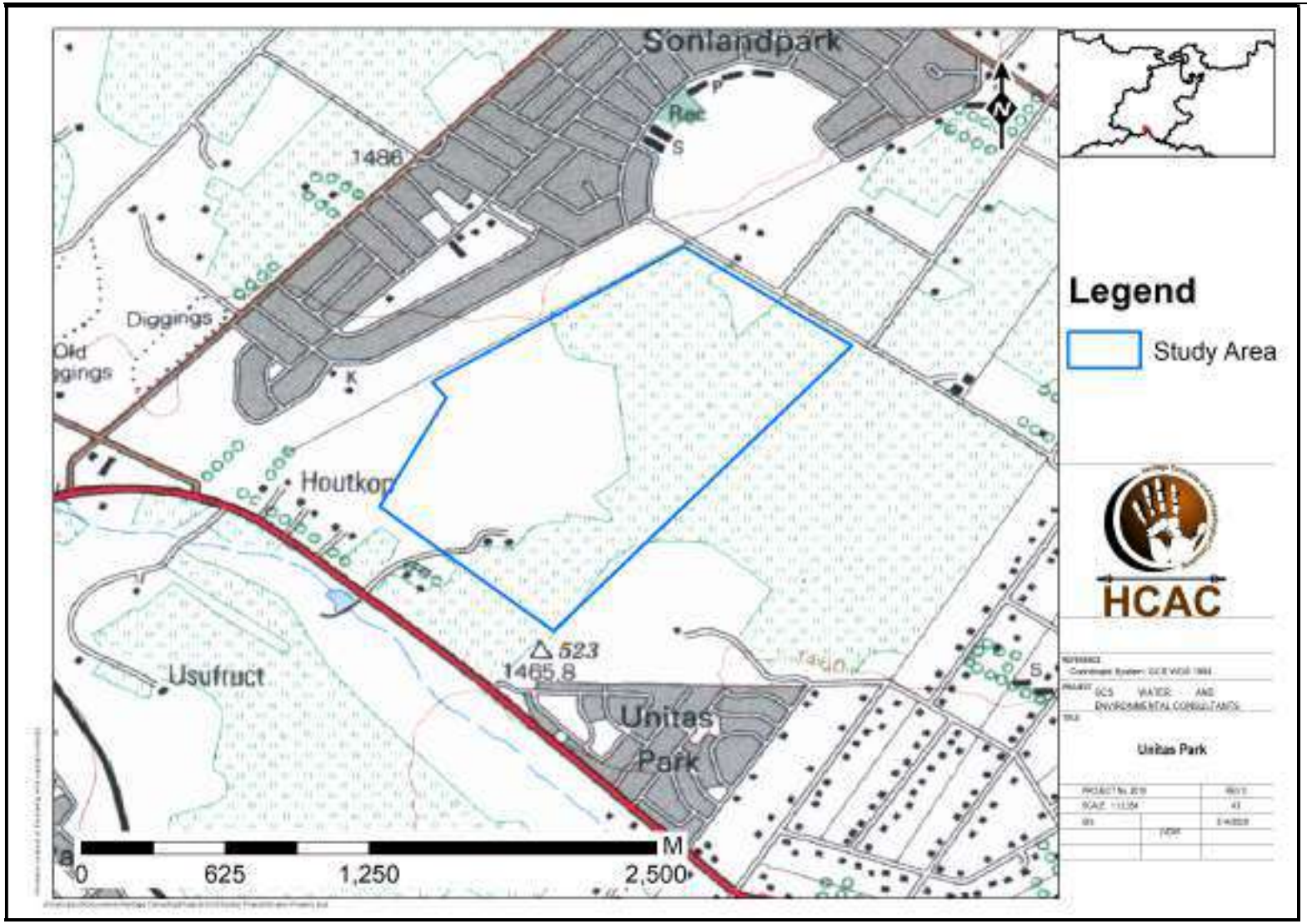

Figure 2: Local setting (1:50 000 topographical map).

Figure 3. Satellite image indicating the study area (Google Earth 2020).

2 Legislative Requirements

The HIA is required under the following legislation:

- National Heritage Resources Act (NHRA), Act No. 25 of 1999)
- National Environmental Management Act (NEMA), Act No. 107 of 1998 - Section 23(2)(b)
- Mineral and Petroleum Resources Development Act (MPRDA), Act No. 28 of 2002 - Section 39(3)(b)(iii)

A Phase 1 HIA is a pre-requisite for development in South Africa as prescribed by SAHRA and stipulated by legislation. The overall purpose of heritage specialist input is to:

- Identify any heritage resources, which may be affected;
- Assess the nature and degree of significance of such resources;
- Establish heritage informants/constraints to guide the development process through establishing thresholds of impact significance;
- Assess the negative and positive impact of the development on these resources; and
- Make recommendations for the appropriate heritage management of these impacts.

The HIA should be submitted to the PHRA if established in the province or to SAHRA. SAHRA will ultimately be responsible for the professional evaluation of Phase 1 AIA reports upon which review comments will be issued. 'Best practice' requires Phase 1 AIA reports and additional development information, as per the impact assessment report and/or EMPr, to be submitted in duplicate to SAHRA after completion of the study. SAHRA accepts Phase 1 AIA reports authored by professional archaeologists, accredited with ASAPA or with a proven ability to do archaeological work.

Minimum accreditation requirements include an Honours degree in archaeology or related discipline and 3 years post-university CRM experience (field supervisor level). Minimum standards for reports, site documentation and descriptions are set by ASAPA in collaboration with SAHRA. ASAPA is based in South Africa, representing professional archaeology in the SADC region. ASAPA is primarily involved in the overseeing of ethical practice and standards regarding the archaeological profession. Membership is based on proposal and secondment by other professional members.

Phase 1 AIA's are primarily concerned with the location and identification of heritage sites situated within a proposed development area. Identified sites should be assessed according to their significance. Relevant conservation or Phase 2 mitigation recommendations should be made. Recommendations are subject to evaluation by SAHRA.

Conservation or Phase 2 mitigation recommendations, as approved by SAHRA, are to be used as guidelines in the developer's decision-making process.

Phase 2 archaeological projects are primarily based on salvage/mitigation excavations preceding development destruction or impact on a site. Phase 2 excavations can only be conducted with a permit, issued by SAHRA to the appointed archaeologist. Permit conditions are prescribed by SAHRA and includes (as minimum requirements) reporting back strategies to SAHRA and deposition of excavated material at an accredited repository.

In the event of a site conservation option being preferred by the developer, a site management plan, prepared by a professional archaeologist and approved by SAHRA, will suffice as minimum requirement.

After mitigation of a site, a destruction permit must be applied for with SAHRA by the applicant before development may proceed.

Human remains older than 60 years are protected by the National Heritage Resources Act, with reference to Section 36. Graves older than 60 years, but younger than 100 years fall under Section 36 of Act 25 of 1999 (National Heritage Resources Act), as well as the Human Tissues Act (Act 65 of 1983), and are the jurisdiction of SAHRA. The procedure for Consultation Regarding Burial Grounds and Graves (Section 36[5]) of Act 25 of 1999) is applicable to graves older than 60 years that are situated outside a formal cemetery administrated by a local authority. Graves in this age category, located inside a formal cemetery administrated by a local authority, require the same authorisation as set out for graves younger than 60 years, in addition to SAHRA authorisation. If the grave is not situated inside a formal cemetery, but is to be relocated to one, permission from the local authority is required and all regulations, laws and by-laws, set by the cemetery authority, must be adhered to.

Human remains that are less than 60 years old are protected under Section 2(1) of the Removal of Graves and Dead Bodies Ordinance (Ordinance No. 7 of 1925), as well as the Human Tissues Act (Act 65 of 1983), and are the jurisdiction of the National Department of Health and the relevant Provincial Department of Health and must be submitted for final approval to the office of the relevant Provincial Premier. This function is usually delegated to the Provincial MEC for Local Government and Planning; or in some cases, the MEC for Housing and Welfare. Authorisation for exhumation and reinternment must also be obtained from the relevant local or regional council where the grave is situated, as well as the relevant local or regional council to where the grave is being relocated. All local and regional provisions, laws and by-laws must also be adhered to. To handle and transport human remains, the institution conducting the relocation should be authorised under Section 24 of Act 65 of 1983 (Human Tissues Act).

3 METHODOLOGY

3.1 Literature Review

A brief survey of available literature was conducted to extract data and information on the area in question to provide general heritage context into which the development would be set. This literature search included published material, unpublished commercial reports and online material, including reports sourced from the South African Heritage Resources Information System (SAHRIS).

3.2 Genealogical Society and Google Earth Monuments

Google Earth and 1:50 000 maps of the area were utilised to identify possible places where sites of heritage significance might be located; these locations were marked and visited during the field work phase. The database of the Genealogical Society was consulted to collect data on any known graves in the area.

3.3 Stakeholder Engagement and Public consultation

Stakeholder engagement is a key component of any BAR process, it involves stakeholders interested in, or affected by the proposed development. Stakeholders are provided with an opportunity to raise issues of concern (for the purposes of this report only heritage related issues will be included). The aim of the public consultation process was to capture and address any issues raised by community members and other stakeholders during key stakeholder and public meetings. The process involved:

- Placement of advertisements and site notices
- Stakeholder notification (through the dissemination of information and meeting invitations);
- Stakeholder meetings undertaken with I&APs;
- Authority Consultation
- The compilation of a Basic Assessment Report (BAR).

Please refer to section 6 for more detail.

3.4 Site Investigation

Conduct a field study to: a) systematically survey the proposed project area to locate, identify, record, photograph and describe sites of archaeological, historical or cultural interest; b) record GPS points of sites/areas identified as significant areas; c) determine the levels of significance of the various types of heritage resources recorded in the project area.

Table 4: Site Investigation Details

	Site Investigation
Date	27 February 2020
Season	Summer- Visibility on site was moderate with some areas having an overgrowth of tall grass that made ground visibility low. A large portion of the study area is situated within an existing maize field and therefore inaccessible. The area was sufficiently covered (Figure 4) to understand the heritage character of the study area.

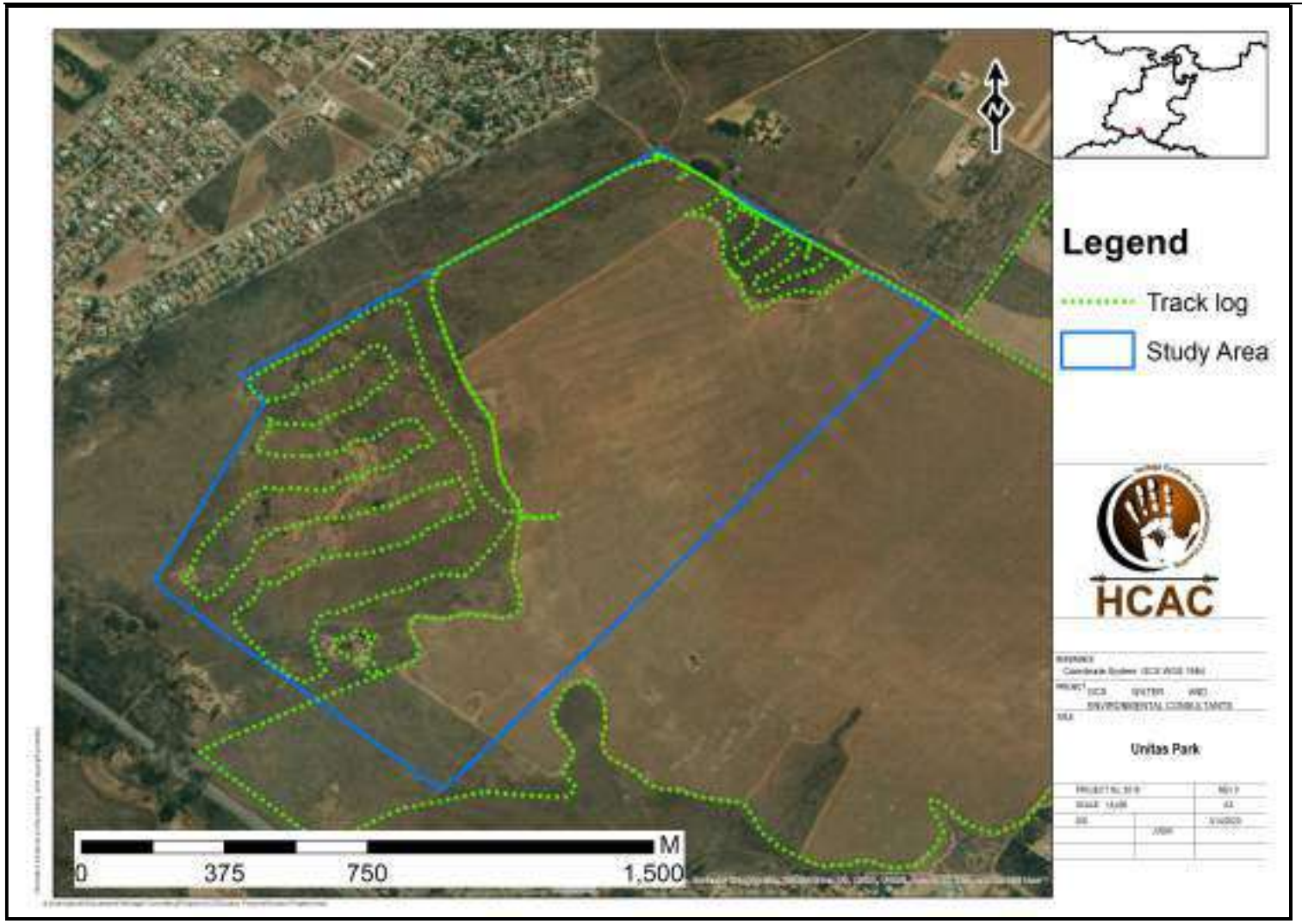

Figure 4: Track logs of the survey in green. Large parts of the study area are cultivated and therefore inaccessible – no track logs are available in these areas.

3.5 Site Significance and Field Rating

Section 3 of the NHRA distinguishes nine criteria for places and objects to qualify as 'part of the national estate' if they have cultural significance or other special value. These criteria are:

- Its importance in/to the community, or pattern of South Africa's history;
- Its possession of uncommon, rare or endangered aspects of South Africa's natural or cultural heritage;
- Its potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage;
- Its importance in demonstrating the principal characteristics of a particular class of South Africa's natural or cultural places or objects;
- Its importance in exhibiting particular aesthetic characteristics valued by a community or cultural group;
- Its importance in demonstrating a high degree of creative or technical achievement at a particular period;
- Its strong or special association with a particular community or cultural group for social, cultural or spiritual reasons;
- Its strong or special association with the life or work of a person, group or organisation of importance in the history of South Africa;
- Sites of significance relating to the history of slavery in South Africa.

The presence and distribution of heritage resources define a 'heritage landscape'. In this landscape, every site is relevant. In addition, because heritage resources are non-renewable, heritage surveys need to investigate an entire project area, or a representative sample, depending on the nature of the project. In the case of the proposed project the local extent of its impact necessitates a representative sample and only the footprint of the areas demarcated for development were surveyed. In all initial investigations, however, the specialists are responsible only for the identification of resources visible on the surface. This section describes the evaluation criteria used for determining the significance of archaeological and heritage sites. The following criteria were used to establish site significance with cognisance of Section 3 of the NHRA:

- The unique nature of a site;
- The integrity of the archaeological/cultural heritage deposits;
- The wider historic, archaeological and geographic context of the site;
- The location of the site in relation to other similar sites or features;
- The depth of the archaeological deposit (when it can be determined/is known);
- The preservation condition of the sites; and
- Potential to answer present research questions.

In addition to this criteria field ratings prescribed by SAHRA (2006), and acknowledged by ASAPA for the SADC region, were used for the purpose of this report. The recommendations for each site should be read in conjunction with section 10 of this report.

FIELD RATING	*GRADE*	*SIGNIFICANCE*	*RECOMMENDED MITIGATION*
National Significance (NS)	Grade 1	-	Conservation; national site nomination
Provincial Significance (PS)	Grade 2	-	Conservation; provincial site nomination
Local Significance (LS)	Grade 3A	High significance	Conservation; mitigation not advised
Local Significance (LS)	Grade 3B	High significance	Mitigation (part of site should be retained)
Generally Protected A (GP. A)	-	High/medium significance	Mitigation before destruction
Generally Protected B (GP. B)	-	Medium significance	Recording before destruction
Generally Protected C (GP.C)	-	Low significance	Destruction

3.6. Impact Assessment Methodology

The criteria below are used to establish the impact rating on sites:

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):
- The **duration**, wherein it will be indicated whether:
  - the lifetime of the impact will be of a very short duration (0-1 years), assigned a score of 1;
  - the lifetime of the impact will be of a short duration (2-5 years), assigned a score of 2;
  - medium-term (5-15 years), assigned a score of 3;
  - long term (> 15 years), assigned a score of 4; or
  - permanent, assigned a score of 5;
  - The **magnitude**, quantified on a scale from 0-10 where; 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
  - The **probability of occurrence**, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1-5 where; 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
  - The **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
  - the **status**, which will be described as either positive, negative or neutral.
  - the degree to which the impact can be reversed.
  - the degree to which the impact may cause irreplaceable loss of resources.
  - the *degree* to which the impact can be mitigated.

The **significance** is calculated by combining the criteria in the following formula:
S=(E+D+M) P
S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e., where this impact would not have a direct influence on the decision to develop in the area),
- 30-60 points: Medium (i.e., where the impact could influence the decision to develop in the area unless it is effectively mitigated),
- 60 points: High (i.e., where the impact must have an influence on the decision process to develop in the area).

3.7 Limitations and Constraints of the study

The authors acknowledge that the brief literature review is not exhaustive on the literature of the area. The possibility exists that some features or artefacts may not have been discovered/recorded during the survey. Similarly, the possible occurrence of graves and other cultural material cannot be excluded. This report only deals with the footprint area of the proposed development and consisted of non-intrusive surface surveys. This study did not assess the impact on medicinal plants and intangible heritage as it is assumed that these components would have been highlighted through the public consultation process if relevant. It is possible that new information could come to light in future, which might change the results of this Impact Assessment. Large portions of the development are currently under cultivation and was mostly inaccessible.

4 Description of Socio-Economic Environment

Stats SÁ provides the following information: According to Census 2011, Emfuleni Local Municipality has a total population of 721 663, of which 85,4% are black African, 12% are white, 1,2% are coloured, and 1,0% are Indian/Asian. Of those 20 years and older, 3,6 % completed primary school, 36,7% have some secondary education, 32,4% completed matric, and 12,9% have some form of higher education. The percentage with no form of schooling is 4,0%. Of the population, 202 543 people are economically active (employed or unemployed but looking for work) and, of these, 34,7% are unemployed. Of the 85 594 economically active youth (15–35 years) in the area, 45% are unemployed.

5 Description of the Physical Environment:

Unitas Park Extension 16 is located within Unitas Park, to the north east of the R54. Sebokeng is located to the north west of the study area, with Vereeniging to the south. The R59 runs from Vereeniging to Meyerton in the north west of the site. The study area is mainly used for the growing of maize which makes a large portion of the site inaccessible. Two portions were accessed by using the gravel roads that provides access around the maize field (Figure 5 – 8). The first area is situated along the north-eastern border of the study area and is mostly surrounded by maize fields apart from the border along the road (Figure 9 and 10). A 2 to 3-meter-wide section of topsoil has been ploughed along the interface edge of the open field and the maize field. The second portion that was accessible is situated in the North-western section of the study area (Figure 11 and 12). This portion is characterised by a large open field that is also bordered by the maize field to the south. The northern extent of this portion has been extensively dug out as part of an old quarry (Figure 13 and 14). The extent of the digging works is visible on google earth imagery of the study area (Figure 3 and 15)

Vegetation in the area is described as Soweto Highveld Grassland (Mucina *et al* 2006). The site shows very little of the original prevailing vegetation types as it has been altered over an extended period of time. Land use surrounding the study area consist of township development cultivation activities. The study area is flat without any major topographical features like pans or ridges.

Figure 5. North Eastern border.

Figure 6. South Eastern border.

Figure 7. North Western Border.

Figure 8. South Western Border.

Figure 9. North Eastern portion of the study area.

Figure 10. North Eastern portion of the study area.

Figure 11. General site conditions – South Western portion of the study area.

Figure 12. General site conditions – South Western portion of the study area.

Figure 13. Quarry.

Figure 14. Quarry.

6 Results of Public Consultation and Stakeholder Engagement:

Adjacent landowners and the public at large were informed of the proposed activity as part of the BA process and no formal consultation was conducted by the heritage team. Site notices and advertisements notifying interested and affected parties were placed at strategic points and in local newspapers as part of the process conducted by GCS.

7. **Literature / Background Study:**

7.1. Literature Review

CRM assessments conducted in the general vicinity help to contextualise the study area. The following assessments conducted in the immediate vicinity that were consulted is listed below:

Author	Year	Project	Findings
Pistorius, J.C.C.	2007	A Phase I Heritage Impact Assessment Study for Water and Sewage Pipeline Corridors Near Vanderbijlpark In the Gauteng Province of South Africa	Graves, stone and historical structures.
Coetzee, F. P.	2008	Cultural Heritage Survey of the proposed urban development on Portions 156 & 203 of the Farm Houtkop 594 IQ, Emfuleni Local Municipality, Sedibeng District, Gauteng	Structures and cemeteries
Magoma, M.	2014	Phase 1 Archaeological Impact Assessment Specialist Study Report for The Proposed New Meteor Substation and Associated 88kv Powerlines in Sebokeng Township of Emfuleni Local Municipality Within Sedibeng District Municipality. Gauteng Province.	Graves, structures and places of worship.

7.1.1. Genealogical Society and Google Earth Monuments

Google Earth and 1:50 000 maps of the area were utilised to identify possible places where archaeological and historical sites might be located. The database of the Genealogical Society of South Africa indicated no known grave sites within the study area.

7.2. Archaeology of the greater study area

The Stone Age

South Africa has a long and complex Stone Age sequence of more than 2 million years. The broad sequence includes the Later Stone Age, the Middle Stone Age and the Earlier Stone Age. Each of these phases contain sub-phases or industrial complexes, and within these we can expect regional variation regarding characteristics and time ranges. The three main phases can be divided as follows;

∗ Later Stone Age; associated with Khoi and San societies and their immediate predecessors. Recently to ~30 thousand years ago

∗ Middle Stone Age; associated with Homo sapiens and archaic modern humans. 30-300 thousand years ago.

∗ Earlier Stone Age (ESA); associated with early Homo groups such as Homo habilis and Homo erectus. 400 000-> 2 million years ago.

Several Stone Age sites are on record near Vereeniging and Meyerton, dating to the ESA and more specifically the Acheulean Industry (van Riet Lowe, 1937, 1952; van Riet Lowe & van der Elst, 1949; van der Elst 1950; Mason, 1962). This ESA sequence is collectively known as the 'Three Rivers Sites' or the 'Vereeniging Sites' (Kuman, 2007). With several locales (e.g., Klip River Quarry, Henley-on-Klip and Meyerton Townlands) located in the greater area. Most of the artefacts are made from dolerites and andesites as well quartzites at the Henley-on-Klip and Meyerton Townlands site.

The Henley-on-Klip site was identified in a road cutting, between Meyerton and Heidelberg (van Riet Lowe & van der Elst, 1949). The Meyerton Townlands site was exposed during pipeline trenching by the Rand Water Board who exposed gravels associated with the Klip River (le Roux and le Roux 1959). MSA and LSA assemblages are on record for the general area (van der Elst, 1950). Huffman (2008) identified an LSA site in the general area.

The Iron Age

The Iron Age as a whole represents the spread of Bantu speaking people and includes both the pre-Historic and Historic periods. It can be divided into three distinct periods:

- The Early Iron Age: Most of the first millennium AD.
- The Middle Iron Age: 10th to 13th centuries AD
- The Late Iron Age: 14th century to colonial period.

Iron Age sites have been identified in an AIA produced by Huffman (2008) for the Mountain View development on Farm Nooitgedacht 176 IR, Gauteng. Stone walling and ceramic residues were identified at several localities near Perdeberg hill, located on Farm Nooitgedacht. Some ceramics were associated with the "Uitkomst facies" (AD 1800).

Extensive Stone walled sites are recorded at Klipriviers Berg Nature reserve belonging to the Late Iron Age period. A large body of research is available on this area. These sites (Taylor's Type N, Mason's Class 2 & 5) are now collectively referred to as Klipriviersberg (Huffman 2007). These settlements are complex in that aggregated settlements are common, the outer wall sometimes includes scallops to mark back courtyards, there are more small stock kraals, and straight walls separate households in the residential zone. These sites date to the 18th and 19th centuries and was built by people in the Fokeng cluster.

In this area the Klipriviersberg walling would have ended at about AD 1823, when Mzilikazi entered the area (Rasmussen 1978). This settlement type may have lasted longer in other areas because of the positive interaction between Fokeng and Mzilikazi.

Historical information

J. S. Bergh's historical atlas of the four northern provinces of South Africa is a very useful source for the writing of local and regional history. The Difaqane (Sotho), or Mfekane ("the crushing" in Nguni) was a time of bloody upheavals in Natal and on the Highveld, which occurred around the early 1820's until the late 1830's. (Bergh 1999: 10) It came about in response to heightened competition for land and trade, and caused population groups like gun-carrying Griquas and Shaka's Zulus to attack other tribes. (Bergh 1999: 14; 116-119) It seems that, in 1827, Mzilikazi's Ndebele started moving through the area where Johannesburg is located today. This group went on raids to various other areas in order to expand their area of influence. (Bergh 1999: 11)

During the time of the Difaqane, a northwards migration of white settlers from the Cape was also taking place. Some travellers, missionaries and adventurers had gone on expeditions to the northern areas in South Africa, some already as early as the 1720's.

It was however only by the late 1820's that a mass-movement of Dutch speaking people in the Cape Colony started advancing into the northern areas. This was due to feelings of mounting dissatisfaction caused by economical and other circumstances in the Cape. This movement later became known as the Great Trek. This migration resulted in a massive increase in the extent of that proportion of modern South Africa dominated by people of European descent. (Ross 2002: 39) By 1939 to 1940, farm boundaries were drawn up in an area that includes the present-day Johannesburg and Krugersdorp. (Bergh 1999: 15).

Anglo Boer War

The Anglo-Boer War, which took place between 1899 and 1902 in South Africa, was one of the most turbulent times in South Africa's history. Even before the outbreak of war in October 1899 British politicians, including Sir Alfred Milner and Mr. Chamberlain, had declared that should Britain's differences with the Z.A.R. result in violence, it would mean the end of republican independence. This decision was not immediately publicized, and subsequently republican leaders based their assessment of British intentions on the more moderate public utterances of British leaders. Consequently, in March 1900, they asked Lord Salisbury to agree to peace on the basis of the status quo ante bellum. Salisbury's reply was; however, a clear statement of British war aims. (Du Preez 1977)

An Anglo Boer War battle known as the Battle of Doornkop took place in the area on 29 May 1900. The British were advancing toward Johannesburg led by General John French. De La Rey and his men held the Klipriviersberg Ridge for the first two days but on the third day the Boers were outflanked by French's cavalry to the West, where General Sarel Oosthuizen's commando was forced to withdraw. This opened the road to Johannesburg and the British took the city peacefully on 30 May 1900 (Bikholtz 2013). Huffman (2008) recorded several sangers dating to the Boer war close to the study area on a ridge.

During the Anglo-Boer War the first blockhouses were built on the orders of the British Commander-in-Chief, Field Marshal Lord Roberts in 1900. The main aim of the blockhouses was to protect the railway lines, which were the main supply route for the British army. These blockhouses were two-storey stone buildings. The Witkop blockhouse is situated on the R59, near the Engen garage (traveling south from Johannesburg). It is one of only fifty remaining blockhouses in the country (http://www.sedibeng.gov.za/2010/2010_attractions.html) .

7.2.1. Cultural Landscape

Unitas Park Ext 16 is located within Unitas Park, to the north east of the R54. The R82 runs north-south approximately 2.3km to the east of the site. The N1 is about 11km to the north west of the site. Sebokeng lies to the north west of the site, with Vereeniging to the south. The R59 runs from Vereeniging to Meyerton in the north west of the site. The site is currently vacant, with immediate adjacent land portions also being vacant. There is evidence of a wetland or some surface water on the site, as well as to the south east of the site (Figure 15 and 16). The general area used to consist of commercial farms with their main focus on the production of crops and the raising of live-stock. Most of these farms were later sub-divided into small holdings and erven and are now densely built-up residential areas and do not have significant cultural landscape elements.

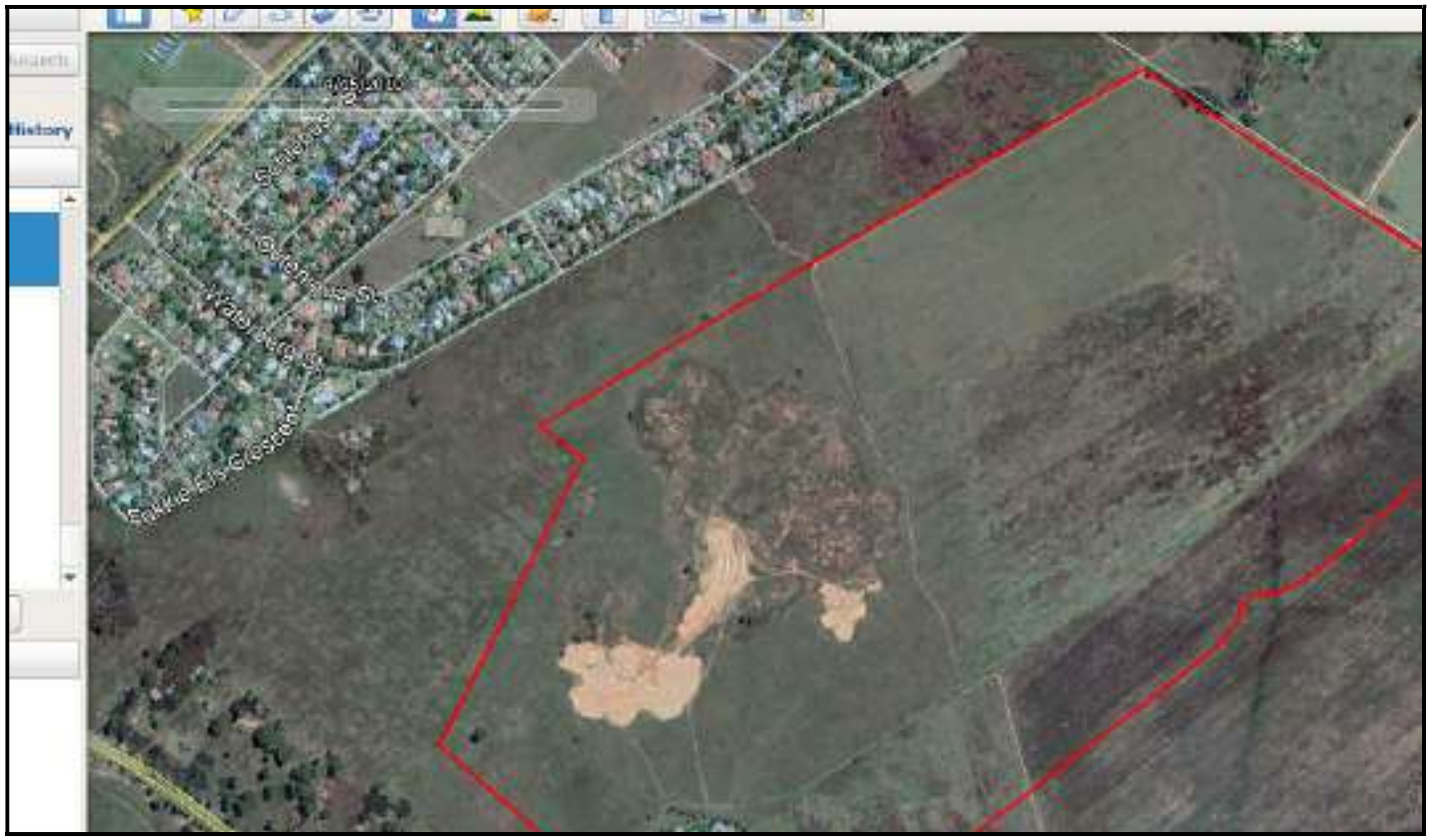

Figure 15. 2010 Google Image of the study area.

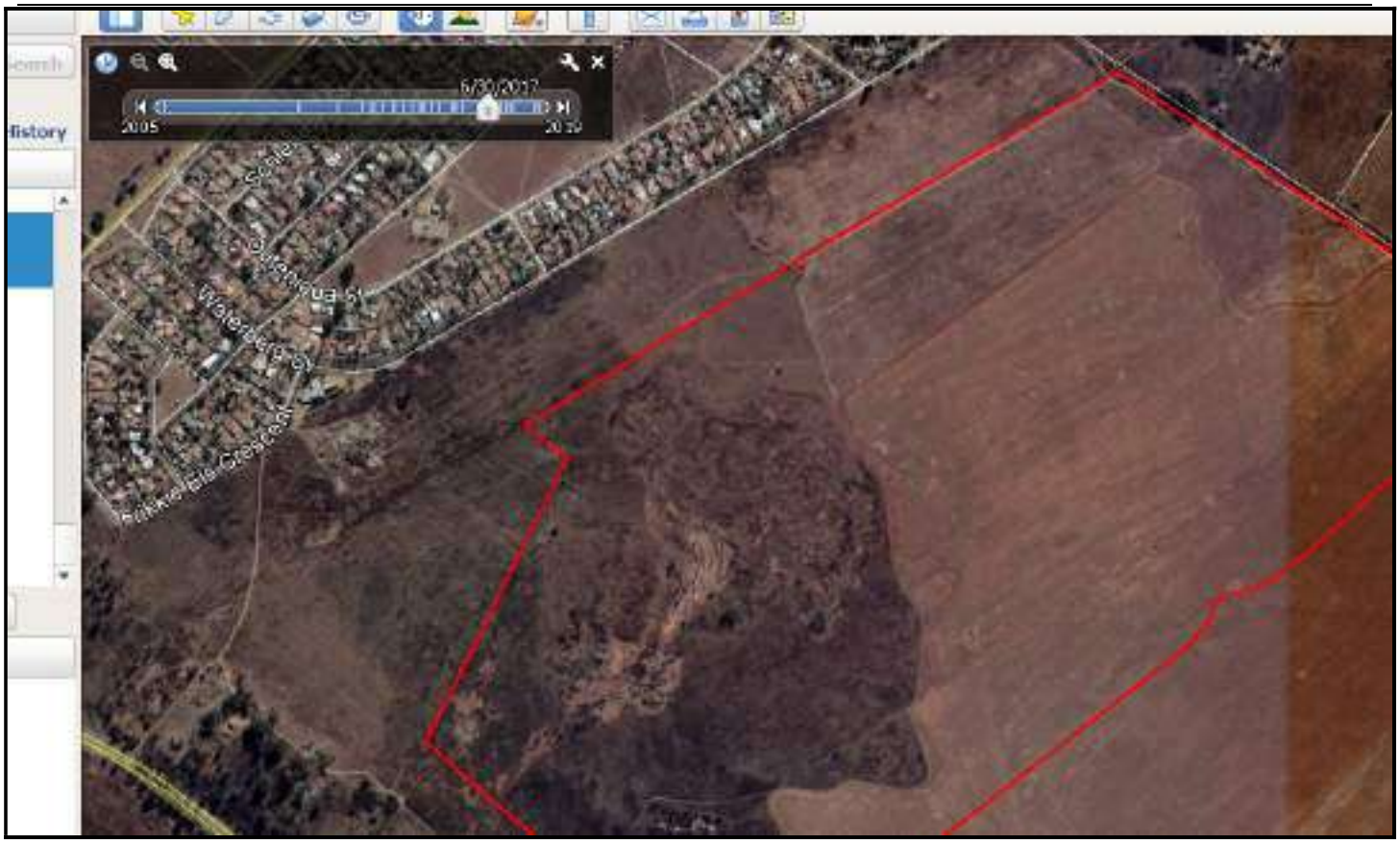

Figure 16. 2017 Google Image of the study area.

8. Findings of the Survey

It is important to note that only the development footprint was assessed as indicated in Figure 1 - 4. The study area is mainly used for the growing of maize which makes a large portion of the study area inaccessible. These cultivation activities would have impacted on surface indicators of heritage resources in the study area. Two portions were accessed by using the gravel roads that provides access around the maize field.

Large foundation blocks are located at the Northern border of the study area (Figure 18 and 19) and could possibly be attributed to infrastructure such as raised pipeline foundations etc. During the survey Stone Age artefacts, a demolished ruin and a stone cairn of unknown purpose were recorded (Table 5 & Figure 17) and is briefly explained below. Recorded Features were given the Pre-Fix F and numbered numerically.

Table 5. Recorded features

Label	Latitude	Longitude	Description	Heritage Significance	Field Rating	Recommendation
F1	26°37'15.09"S	27°54'29.19"E	Low density scatter of MSA artefacts: Mixture of raw materials- chert, fine grain quartzite. Artefacts consist of blades, miscellaneous flakes and cores.	Low	GP C	Area should be monitored during construction.
F2	26°37'10.95"S	27°54'28.12"E	Low density scatter of MSA Artefacts.	Low	GP C	Area should be monitored during construction.
F3	26°37'9.41"S	27°54'30.08"E	Stacked pile of stones.	If confirmed to be a grave – high social significance	GP A	The area should be monitored during construction.
F4	26°37'9.97"S	27°54'30.82"E	MSA Core Fine grained quartzite	Low	GP C	Area should be monitored during construction.
F5	26°37'14.06"S	27°54'30.07"E	MSA flake Fine grained quartzite	Low	GP C	Area should be monitored during construction.
F6	26°37'12.83"S	27°54'31.84"E	MSA flake Fine grained quartzite	Low	GP C	Area should be monitored during construction.
F7	26°37'45.54"S	27°53'58.19"E	Dilapidated Homestead	Low	GP C	Unless proven to be older than 60 years no further action is required.

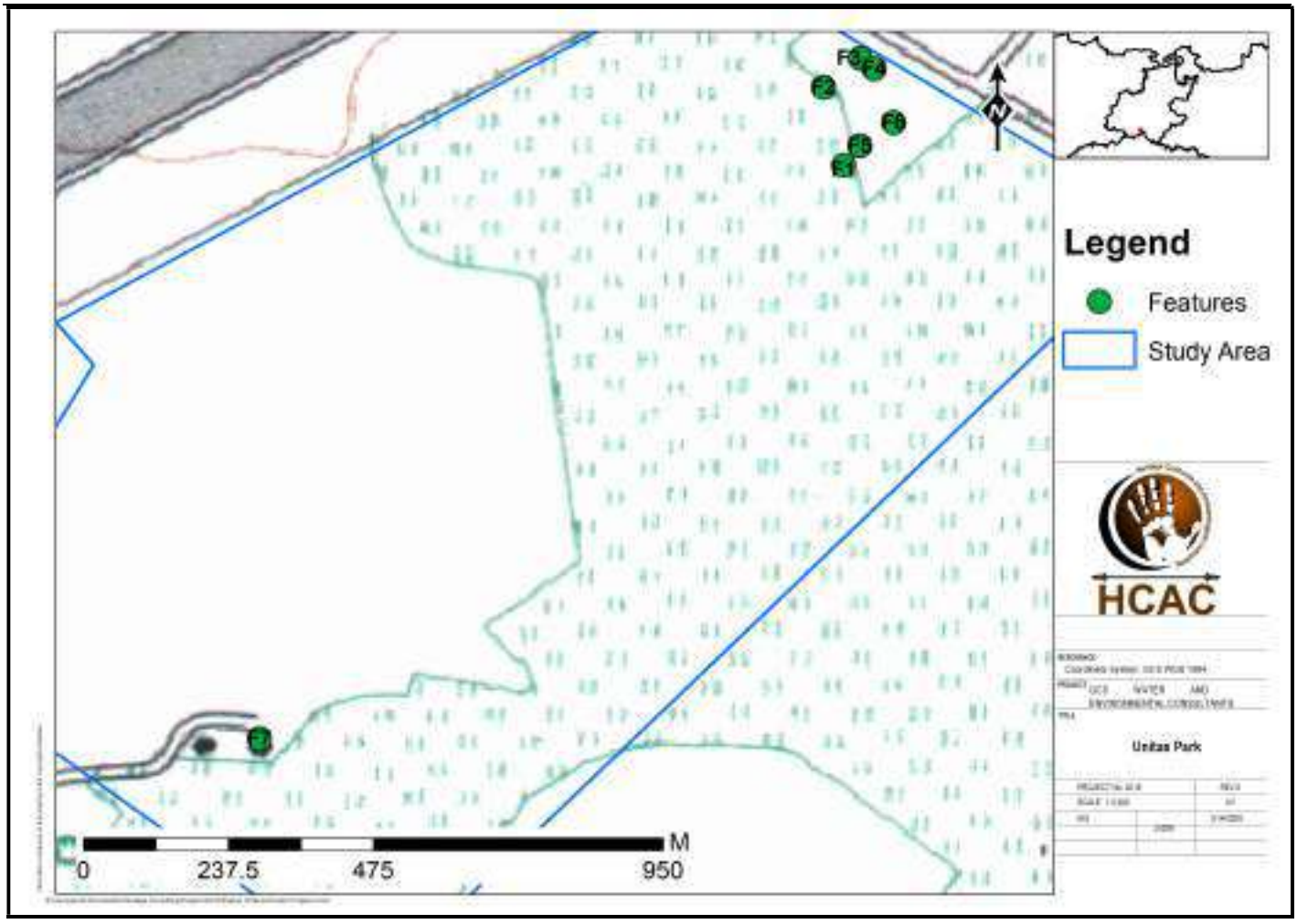

Figure 17. Site distribution map.

A low density (less than 2 artefacts per m²) scatter of Middle Stone Age artefacts was exposed by ploughing in the northern section of the study area. Raw material suitable for knapping is mantled by quaternary sands and has been exposed by ploughing activities (Figure 20 – 24). This low-density scatter was recorded as Feature 1, 2, 4, 5 and 6 but is interpreted as one site. The use of large machinery can result in pseudo tools (Van der Walt & Bradfield 2018) and fresh flakes can be seen on some of the cobbles (Figure 22) as a result of ploughing.

Feature 3 consists of a stone packed feature (Figure 25) of unknown purpose but could probably be the result of clearing for agricultural activities. Although unlikely the feature could also represent a grave.

The remains of partly demolished homestead are found in the southern portion of the study area and recorded as Feature 7 (Figure 26 and 27). The areas around the homestead is dominated by tall grass hampering visibility and the possibility of additional features in this area cannot be excluded. The structures' potential to contribute to aesthetic, historic, scientific and social aspects are non-existent and it is therefore of no heritage significance. Based on architectural elements the structure does not seem to be older than 60 years and is therefore not protected by the NHRA.

An independent paleontological assessment was conducted by Prof Marion Bamford and concluded that the proposed site lies on the soils overlying deep deposits of siltstones, mudstones, shales and possible coal seams of the Vryheid Formation (Ecca Group, Karoo Supergroup) of middle Permian age. Such rocks can potentially preserve fossils of the *Glossopteris* flora however the potentially fossiliferous rocks are more than 50 m below the surface so will not be impacted upon by an urban development. Based on the geological record and literature it is recommended that no palaeontological site visit is required unless the geologist or responsible person on during excavations finds fossils. The study included a Fossil Chance Find Protocol.

Figure 18. Large foundation slabs.

Figure 19. Large foundation slabs.

Figure 20. Range of artefacts exposed by ploughing.

Figure 21. Quartzite Core.

Figure 22. Fresh removal visible on pebble, possibly from machinery. .

Figure 23. Ploughed area in the vicinity of Feature 1 exposing artefacts.

Figure 24. Lower density of artefacts and natural stones within ploughed material at Feature 2**.**

Figure 25. Packed stone feature at Feature 3.

Figure 26. Feature 7 Homestead.

Figure 27. Feature 7 Homestead.

9. Potential Impact

The development lay out plan was not available at the time of the survey and writing of the report and it is assumed that all sites will be directly impacted on by the development. The Stone Age scatters (Features 1,2,4,5 and 6) is out of context, impacted on by the ploughing activities and of low heritage significance and based on the considerations in Table 6 without mitigation the impact of the development on the identified features is expected to be low to medium and with mitigation low. The Stone packed feature could represent a grave, if this is confirmed and the grave is impacted on without mitigation the impact will be high. Feature 7 is a dilapidated homestead of low heritage significance and the impact on this feature is low.

9.1. Pre-Construction phase:

The area will be upgraded and it is assumed that this phase will entail groundworks. Impacts include destruction or partial destruction of non-renewable heritage resources.

9.2. Construction Phase

During this phase, the impacts and effects are similar in nature but more extensive than the pre-construction phase. These activities can have a negative and irreversible impact on heritage sites. Impacts include destruction or partial destruction of non-renewable heritage resources.

9.3. Operation Phase:

No impact is envisaged during this phase.

Table 6. Impact of the project on heritage resources.

Nature: During the construction phase activities resulting in disturbance of surfaces and/or sub-surfaces may destroy, damage, alter, or remove from its original position archaeological and paleontological material or objects as well as graves (if present).		
	Without mitigation	**With mitigation (Preservation/ excavation of site)**
Extent	Local (3)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (4)	Low (3)
Probability	Probable (3)	Probable (3)
Significance	**36 (Medium)**	**30 (Low)**
Status (positive or negative)	Negative	Negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	No resources were recorded	No resources were recorded.
Can impacts be mitigated?	Yes	Yes

Mitigation:

To mitigate the impact of the proposed project on the recorded heritage resources the following recommendations apply as a condition of authorisation (part of the EMPr) and based on approval from SAHRA.

- Feature 1, 2, 4, 5 and 6 must be monitored during construction to determine if *in-situ* subsurface layers are present.
- It is recommended that Feature 3 should be monitored during earthworks in the area.
- No mitigation is required for Feature 7, unless it is proven that the site is older than 60 years,

In addition to the site-specific recommendations outlined above the following applies:

- Confirmation of any grave sites in the study area as part of the social consultation process
- Graves should ideally be retained *in-situ* in open spaces
- Implementation of a chance find procedure for the project as outlined in Section 10.1

Residual Impacts:

Although surface sites can be avoided or mitigated, there is a chance that completely buried sites would still be impacted but this cannot be quantified.

9.4. Cumulative Impacts

Table 7. Cumulative Impact of the project.

Cumulative impacts occur from the combination of effects of various impacts on heritage resources. The importance of identifying and assessing cumulative impacts is that the whole is greater than the sum of its parts. The area is of low heritage sensitivity and the possibility of unearthing subsurface heritage resources is small.

Nature: During the construction phase activities resulting in disturbance of surfaces and/or sub-surfaces may destroy, damage, alter, or remove from its original position archaeological and paleontological material or objects as well as graves (if present).		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local (1)	Local (1)
Duration	Permanent (5)	Permanent (5)
Magnitude	Minor (2)	Minor (2)
Probability	Probable (3)	Improbable (2)
Significance	**24 (Low)**	**16 (Low)**
Status (positive or negative)	Negative	Negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	No resources were recorded	No resources were recorded.
Can impacts be mitigated?	Yes.	Unknown
Confidence in findings	High	High

10. Recommendations and conclusion

The study area is mainly used for the growing of maize which makes a large portion of the study area inaccessible. The south western portion of the study area has been extensively dug out as part of an old quarry and these activities would have impacted on surface indicators of heritage resources in the study area. Large cement foundation blocks are located in the northern portion of the study area and could possibly be attributed to infrastructure such as raised pipeline foundations etc.

The field survey recorded scatters of Stone Age artefacts (Feature 1,2,4,5 and 6), a stone cairn of unknown purpose (Feature 3), and a party demolished homestead (Feature 7). An independent paleontological study (Bamford 2020) concluded that the proposed site lies on the soils overlying deep deposits of siltstones, mudstones, shales and possible coal seams of the Vryheid Formation (Ecca Group, Karoo Supergroup) of middle Permian age. Such rocks can potentially preserve fossils of the *Glossopteris* flora however the potentially fossiliferous rocks are more than 50m below the surface so will not be impacted upon by an urban development. Based on the geological record and literature it is recommended that no palaeontological site visit is required unless the geologist or responsible person on during excavations finds fossils. The study included a Fossil Chance Find Protocol.

The impact of the proposed project on heritage resources is considered to be low and it is recommended that the proposed project can commence on the condition that the following recommendations are implemented as part of the EMPr and based on approval from SAHRA:

- Feature 1, 2, 4, 5 and 6 must be monitored during construction to determine if *in-situ* subsurface layers are present.
- It is recommended that Feature 3 should be monitored during earthworks in the area.
- No mitigation is required for Feature 7, unless it is proven that the site is older than 60 years,

In addition to the site-specific recommendations outlined above the following applies:

- Confirmation of any grave sites in the study area as part of the social consultation process
- Graves should ideally be retained *in-situ* in open spaces
- Implementation of a chance find procedure (archaeological and paleontological) for the project as outlined in Section 10.1

10.1. Chance Find Procedure

The possibility of the occurrence of subsurface finds or previously unknown sites cannot be excluded. Therefore, if during construction any possible finds such as stone tool scatters, artefacts or bone and fossil remains are made, the operations must be stopped and a qualified archaeologist must be contacted for an assessment of the find and therefor chance find procedures should be put in place for the project. A short summary of chance find procedures is discussed below.

This procedure applies to the developer's permanent employees, its subsidiaries, contractors and subcontractors, and service providers. The aim of this procedure is to establish monitoring and reporting procedures to ensure compliance with this policy and its associated procedures. Construction crews must be properly inducted to ensure they are fully aware of the procedures regarding chance finds as discussed below.

- If during the pre-construction phase, construction, operations or closure phases of this project, any person employed by the developer, one of its subsidiaries, contractors and subcontractors, or service provider, finds any artefact of cultural significance or heritage site, this person must cease work at the site of the find and report this find to their immediate supervisor, and through their supervisor to the senior on-site manager.
- It is the responsibility of the senior on-site Manager to make an initial assessment of the extent of the find, and confirm the extent of the work stoppage in that area.
- The senior on-site Manager will inform the ECO of the chance find and its immediate impact on operations. The ECO will then contact a professional archaeologist for an assessment of the finds who will notify the SAHRA.

Monitoring Programme for Palaeontology – to commence once the excavations activities begin.

1. The following procedure is only required if fossils are seen on the surface and when drilling/excavations commence.
2. When excavations begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (stromatolites, microbially induced sedimentary structures) should be put aside in a suitably protected place. This way the project activities will not be interrupted.
3. Photographs of similar structures are provided here for the developer to assist in recognizing the microfossils.
4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
5. If there is any possible fossil material found by the developer/environmental officer then the qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible.
6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.
7. If no good fossil material is recovered then no site inspections by the palaeontologist will not be necessary. A final report by the palaeontologist must be sent to SAHRA once the project has been completed and only if there are fossils.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

10.2. Reasoned Opinion

The impact of the proposed project on heritage resources is considered low and no further pre-construction mitigation in terms of archaeological resources is required based on approval from SAHRA. Furthermore, the socio-economic benefits also outweigh the possible impacts of the development if the correct mitigation measures (i.e. chance find procedure) are included in the EMPr.

10.3. Potential risk

Potential risks to the proposed project are the occurrence of unknown and unmarked graves. The possibility exists that the study area could contain graves of which surface indicators have been destroyed or obscured by vegetation and subsurface material could be uncovered during earth works. These risks can be mitigated to an acceptable level with monitoring and the implementation of a chance find procedure as outlined in Section 10.1.

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Appendix A - Curriculum Vitae of Specialist

Jaco van der Walt
Archaeologist

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Education:

Particulars of degrees/diplomas and/or other qualifications:

Name of University or Institution:		University of Pretoria
Degree obtained	**:**	BA Heritage Tourism & Archaeology
Year of graduation	**:**	2001
Name of University or Institution:		University of the Witwatersrand
Degree obtained	**:**	BA Hons Archaeology
Year of graduation	**:**	2002
Name of University or Institution	**:**	University of the Witwatersrand
Degree Obtained	**:**	MA (Archaeology)
Year of Graduation	:	2012
Name of University or Institution	**:**	University of Johannesburg
Degree	**:**	PhD
Year	:	Currently Enrolled

EMPLOYMENT HISTORY:

2011 – Present:	**Owner – HCAC (Heritage Contracts and Archaeological Consulting CC)**.
2007 – 2010 :	**CRM Archaeologist,** Managed the Heritage Contracts Unit at the University of the Witwatersrand.
2005 - 2007:	**CRM Archaeologist**, Director of Matakoma Heritage Consultants
2004:	**Technical Assistant**, Department of Anatomy University of Pretoria
2003:	**Archaeologist**, Mapungubwe World Heritage Site
2001 - 2002:	**CRM Archaeologists,** For R & R Cultural Resource Consultants, Polokwane
2000:	**Museum Assistant**, Fort Klapperkop.

Countries of work experience include:

Republic of South Africa, Botswana, Zimbabwe, Mozambique, Tanzania, The Democratic Republic of the Congo, Lesotho and Zambia.

SELECTED PROJECTS INCLUDE:

Archaeological Impact Assessments (Phase 1)

Heritage Impact Assessment Proposed Discharge Of Treated Mine Water Via The Wonderfontein Spruit Receiving Water Body Specialist as part of team conducting an Archaeological Assessment for the Mmamabula mining project and power supply, Botswana

Archaeological Impact Assessment Mmamethlake Landfill

Archaeological Impact Assessment Libangeni Landfill

Linear Developments

Archaeological Impact Assessment Link Northern Waterline Project At The Suikerbosrand Nature Reserve

Archaeological Impact Assessment Medupi – Spitskop Power Line,

Archaeological Impact Assessment Nelspruit Road Development

Renewable Energy developments

Archaeological Impact Assessment Karoshoek Solar Project

Grave Relocation Projects

Relocation of graves and site monitoring at Chloorkop as well as permit application and liaison with local authorities and social processes with local stakeholders, Gauteng Province.

Relocation of the grave of Rifle Man Maritz as well as permit application and liaison with local authorities and social processes with local stakeholders, Ndumo, Kwa Zulu Natal.

Relocation of the Magolwane graves for the office of the premier, Kwa Zulu Natal

Relocation of the OSuthu Royal Graves office of the premier, Kwa Zulu Natal

Phase 2 Mitigation Projects

Field Director for the Archaeological Mitigation For Booysendal Platinum Mine, Steelpoort, Limpopo Province. Principle investigator Prof. T. Huffman

Monitoring of heritage sites affected by the ARUP Transnet Multipurpose Pipeline under directorship of Gavin Anderson.

Field Director for the Phase 2 mapping of a late Iron Age site located on the farm Kameelbult, Zeerust, North West Province. Under directorship of Prof T. Huffman.

Field Director for the Phase 2 surface sampling of Stone Age sites effected by the Medupi – Spitskop Power Line, Limpopo Province

Heritage management projects

Platreef Mitigation project – mitigation of heritage sites and compilation of conservation management plan.

MEMBERSHIP OF PROFESSIONAL ASSOCIATIONS:

- Association of Southern African Professional Archaeologists. Member number 159

  Accreditation:
  - Field Director Iron Age Archaeology
  - Field Supervisor Colonial Period Archaeology, Stone Age Archaeology and Grave Relocation
- Accredited CRM Archaeologist with SAHRA
- Accredited CRM Archaeologist with AMAFA
- Co-opted council member for the CRM Section of the Association of Southern African Association Professional Archaeologists (2011 – 2012)

PUBLICATIONS AND PRESENTATIONS

- A Culture Historical Interpretation, Aimed at Site Visitors, of the Exposed Eastern Profile of K8 on the Southern terrace at Mapungubwe.
  - J van der Walt, A Meyer, WC Nienaber
  - Poster presented at Faculty day, Faculty of Medicine University of Pretoria 2003
- 'n Reddingsondersoek na Anglo-Boereoorlog-ammunisie, gevind by Ifafi, Noordwes-Provinsie. South-African Journal for Cultural History 16(1) June 2002, with A. van Vollenhoven as co-writer.
- Fieldwork Report: Mapungubwe Stabilization Project.
  - WC Nienaber, M Hutten, S Gaigher, J van der Walt
  - Paper read at the Southern African Association of Archaeologists Biennial Conference 2004
- A War Uncovered: Human Remains from Thabantšho Hill (South Africa), 10 May 1864.
  - M. Steyn, WS Boshoff, WC Nienaber, J van der Walt
  - Paper read at the 12th Congress of the Pan-African Archaeological Association for Prehistory and Related Studies 2005
- Field Report on the mitigation measures conducted on the farm Bokfontein, Brits, North West Province .
  - J van der Walt, P Birkholtz, W. Fourie
  - Paper read at the Southern African Association of Archaeologists Biennial Conference 2007
- Field report on the mitigation measures employed at Early Farmer sites threatened by development in the Greater Sekhukhune area, Limpopo Province. J van der Walt
  - Paper read at the Southern African Association of Archaeologists Biennial Conference 2008

- Ceramic analysis of an Early Iron Age Site with vitrified dung, Limpopo Province South Africa.
    - J van der Walt. Poster presented at SAFA, Frankfurt Germany 2008

- Bantu Speaker Rock Engravings in the Schoemanskloof Valley, Lydenburg District, Mpumalanga (*In Prep)*
    - J van der Walt and J.P Celliers
- Sterkspruit: Micro-layout of late Iron Age stone walling, Lydenburg, Mpumalanga. W. Fourie and J van der Walt. A Poster presented at the Southern African Association of Archaeologists Biennial Conference 2011
- Detailed mapping of LIA stone-walled settlements' in Lydenburg, Mpumalanga. J van der Walt and J.P Celliers
    - Paper read at the Southern African Association of Archaeologists Biennial Conference 2011
- Bantu-Speaker Rock engravings in the Schoemanskloof Valley, Lydenburg District, Mpumalanga. J.P Celliers and J van der Walt
    - Paper read at the Southern African Association of Archaeologists Biennial Conference 2011
- Pleistocene hominin land use on the western trans-Vaal Highveld ecoregion, South Africa, Jaco van der Walt.
    - J van der Walt. Poster presented at SAFA, Toulouse, France. Biennial Conference 2016

REFERENCES:

1. Prof Marlize Lombard Senior Lecturer, University of Johannesburg, South Africa
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2. Prof TN Huffman Department of Archaeology Tel: (011) 717 6040
   University of the Witwatersrand
3. Alex Schoeman University of the Witwatersrand
   E-mail:Alex.Schoeman@wits.ac.za

APPENDIX B6

Palaeontological Impact Assessment

Palaeontological Impact Assessment for the proposed development in Unitas Park Ext 16, Gauteng Province

Desktop Study (Phase 1)

For

Heritage Contracts and Archaeological Consulting

09 March 2020

Prof Marion Bamford
Palaeobotanist
P Bag 652, WITS 2050
Johannesburg, South Africa
Marion.bamford@wits.ac.za

Expertise of Specialist

The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 31 years research; 3years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Heritage Contracts and Archaeological Consulting (HCAC), Modimolle, South Africa. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision making process for the Project.

Specialist: Prof Marion Bamford

Signature:

Executive Summary

A palaeontological Impact Assessment was requested for the proposed development in Unitas Park Ext 16, Gauteng Province in order to comply with the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA). The site was indicated as very highly sensitive on the SAHRIS map so a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development.

The proposed site lies on the soils overlying deep deposits of siltstones, mudstones, shales and possible coal seams of the Vryheid Formation (Ecca Group, Karoo Supergroup) of middle Permian age. Such rocks can potentially preserve fossils of the *Glossopteris* flora however the potentially fossiliferous rocks are more than 50m below the surface so will not be impacted upon by an urban development.

SAHRA requires a Fossil Chance Find Protocol it is added here. Based on the geological record and literature it is recommended that no palaeontological site visit is required unless the geologist or responsible person on during excavations finds fossils.

Table of Contents

Expertise of Specialist 1

Declaration of Independence 1

1. Background 4

2. Methods and Terms of Reference 6

3i. Project location and geological context 6

3ii. Palaeontological context 8

4. Impact assessment 9

5. Assumptions and uncertainties 11

6. Recommendation 11

7. References 11

8. Chance Find Protocol 12

Appendix A (examples of fossils) 13

Appendix B (short CV of specialist) 15

1. Background

The Gauteng Rapid Land Release Programme aims to fast track the release of serviced stands from state-owned land to qualifying beneficiaries. Phumaf Holdings was appointed to assist the Department of Human Settlements with all pre-planning, planning work, design and construction management to enable the release of the identified stands. GCS Water and Environment has been contracted by Phumaf Holdings to undertake the environmental authorization processes required for the stands in order for compliance to the National Environmental Management Act NEMA (Act 107 of 1998, as amended).

Unitas Park ext 16 is located within Unitas Park, to the north east of the R54 (Houtkop Road). The R82 is runs north-south approximately 2.3km to the east of the site. The N1 is about 11km to the north west of the site. Sebokeng lies to the north west of the site, with Vereeniging to the south. The R59 is runs from Vereeniging to Meyerton in the north west of the site. The site is currently vacant, with immediate adjacent land portions also being vacant. There is evidence of a wetland or some surface water on the site, as well as to the south east of the site. A drainage line appears to run from the site towards Houtkop Road to the south west, where the surface water drains under the road and continues to flow into a National Freshwater Ecosystem Protection Area (NFEPA). The buffer of the NFEPA includes a portion of the south west of the site. The site is approximately 149 hectares in extent. Refer to the maps below for the location and regional locality map, indicating the surrounding residential allotment townships. Unitas Park is within the 2010 urban edge.

A Palaeontological Impact Assessment was requested for the above project. To comply with the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development and is reported herein.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (amended 2017).

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
ai	Details of the specialist who prepared the report	Appendix B
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
b	A declaration that the person is independent in a form as may be specified by the competent authority	Page 1
c	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
ci	An indication of the quality and age of the base data used for the specialist report: SAHRIS palaeosensitivity map accessed – date of this report	Yes

cii	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5
d	The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
e	A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2
f	The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 4
g	An identification of any areas to be avoided, including buffers	N/A
h	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5
j	A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 4
k	Any mitigation measures for inclusion in the EMPr	Appendix A
l	Any conditions for inclusion in the environmental authorisation	N/A
m	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	N/A
nii	If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	N/A
o	A description of any consultation process that was undertaken during the course of carrying out the study	N/A
p	A summary and copies if any comments that were received during any consultation process	N/A
q	Any other information requested by the competent authority.	N/A

Figure 1: Google Earth map of the proposed development of the vacant land in Unitas Park Ext 16, northern Vereeniging, with the section indicated with the red block. Map supplied by HCAC.

2. Methods and Terms of Reference

The Terms of Reference (ToR) for this study were to undertake a PIA and provide feasible management measures to comply with the requirements of SAHRA.
The methods employed to address the ToR included:

1. Consultation of geological maps, literature, palaeontological databases, published and unpublished records to determine the likelihood of fossils occurring in the affected areas. Sources included records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases;
2. Where necessary, site visits by a qualified palaeontologist to locate any fossils and assess their importance (*not applicable to this assessment*);
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*not applicable to this assessment*); and
4. Determination of fossils' representivity or scientific importance to decide if the fossils can be destroyed or a representative sample collected (*not applicable to this assessment*).

3. Geology and Palaeontology

i. Project location and geological context

Figure 2: Geological map of the area around Unitas Park in Vereeniging. The location of the proposed project is indicated within the yellow rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2626 West Rand.

Table 2: Explanation of symbols for the geological map and approximate ages (Barbolini et al., 2016; Eriksson et al., 2006, 2012; Johnson et al., 2006). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Qs	Quaternary sands	Alluvium, sand, calcrete	ca 2.5 Ma to Present
Qw	Quaternary sands	Aeolian dands	Ca 2.5 Ma to Present
Pv	Vryheid Fm, Ecca Group, Karoo SG	Sandstone, shale, coal	Middle Ecca, early Permian, ca 270 Ma
Vdi	Diabase	Intrusive volcanic rocks	Post Transvaal SG
Vh	Hekpoort Fm, Pretoria Group, Transvaal SG	Andesite, agglomerate, tuff	Ca 2224 Ma
Vt	Timeball Hill Fm, Pretoria Group, Transvaal SG	Quartzite, mudrock, diamictite	< 2420 Ma
Vmd	Malmani Subgroup, Chuniespoort Group, Transvaal SG	Dolomite, chert	Ca 2500 – 2460 Ma

The site lies in the southern part of the Transvaal Basin, in one of three late Archaean to early Proterozoic basins that together form the Transvaal Supergroup. In the Transvaal Basin the Pretoria Group overlies the Chuniespoort Group. There are three major cycles of infilling of the basin and the Malmani Subgroup is within the first or lower cycle and the Timeball Hill Formation within the second cycle (Eriksson et al., 2012) so although the sediments are adjacent to each other there is quite a lot of time separating them. The sediments of the Karoo Supergroup overlie the ancient rocks unconformably at this northern margin of the Karoo Basin. To the east and northeast, in the Karoo Basin proper, the Vryheid Formation is well stratified and contains thick coal seams that are exploited commercially for coal. In southern Gauteng, however, the deposits are thin and poorly preserved.

The Vryheid Formation is in the middle Ecca Group and represents the infilling of the Karoo Basin from north and south highlands. The palaeoclimate of that time would have been warm and humid.

To the west are considerably younger deposits of Quaternary Kalahari sands comprising Aeolian sands, fluvial sands, alluvium and soils but they are not in the development footprint.

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 3. The whole area is on Vryheid Formation sandstones and shales, and surrounded by much older rocks to the north and west. Vereeniging is not in the prime coal mining area. There are only two coal mines in the Vereeniging-Sasolburg Coalfield and the coal seams are about 200m below the surface (Snyman, 1998; p 175-177). The coal is overlain by two thick layers of dolerite (non-fossiliferous) and the uppermost sandstone layer is about 50m below the surface (ibid). There is a small chance that the sandstone could preserve fossil plants but generally sandstone is too coarse to preserve any useful information or detail. The surface sands and soils range from 5-10m thick in this area (Snyman, 1998), and they are too young and disturbed by vegetation, roots and humans (farming, urban developments) to preserve any Vryheid or more recent fossils.

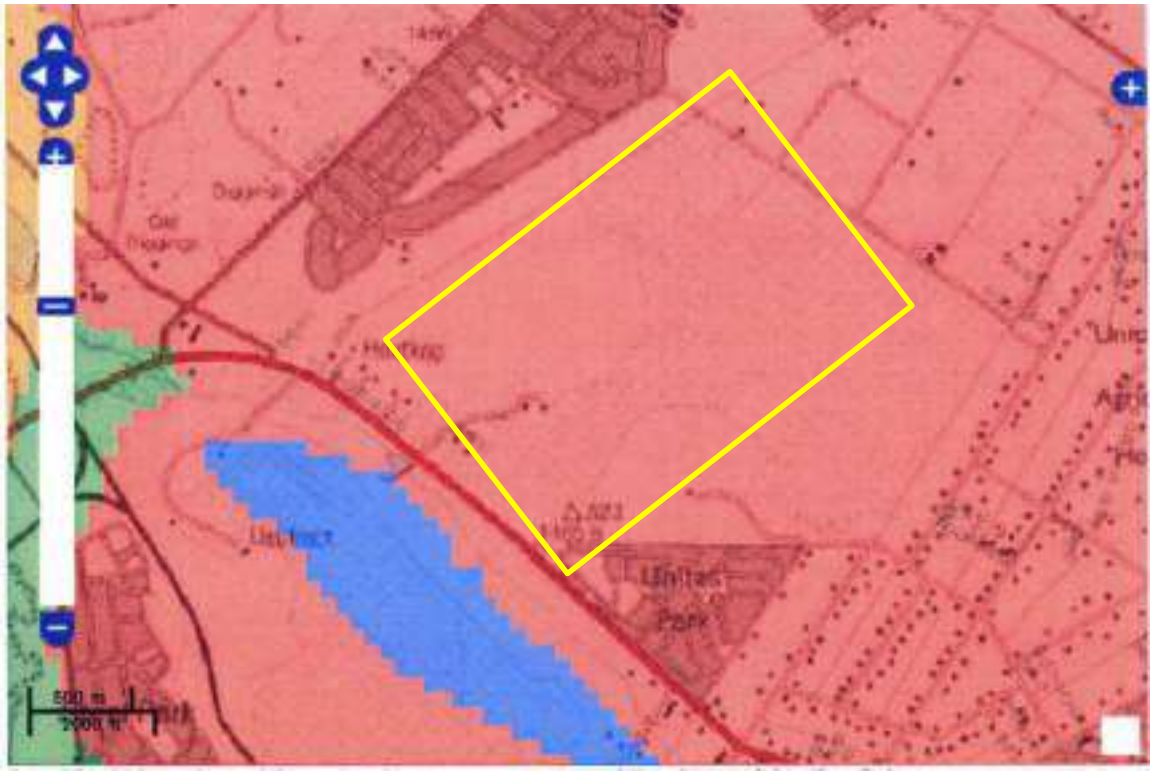

Figure 3: SAHRIS palaeosensitivity map for the proposed development in Unitas Park Ext 16 shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

From the SAHRIS map above (Figure 3) the area is indicated as very highly sensitive (red) so a desktop PIA has been completed.

As explained above, in this area the coal seams and associated potentially fossiliferous rocks are far below the surface. The vacant lot has evidence of earlier agriculture and more recently of human impact that can be clearly seen from the Google Earth imagery.

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 3:

TABLE 3A: CRITERIA FOR ASSESSING IMPACTS

PART A: DEFINITION AND CRITERIA		
Criteria for ranking of the SEVERITY/NATURE of environmental impacts	**H**	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.

	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	**L**	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	**L**	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national
PROBABILITY (of exposure to impacts)	**H**	Definite/ Continuous
	M	Possible/ frequent
	L	Unlikely/ seldom

TABLE 3B: IMPACT ASSESSMENT

PART B: ASSESSMENT		
SEVERITY/NATURE	**H**	-
	M	-
	L	The Vryheid Fm could preserve fossils but not in the overlying soils and sands. Cores for coal mines indicate that the coals are more than 200m below the surface. The impact would be very unlikely.
	L+	-
	M+	-
	H+	-
DURATION	**L**	-
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	**L**	Since only the possible fossils within the area would be fossil plants from the *Glossopteris* flora in the shales, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	**-**
	L	It is extremely unlikely that any fossils would be found in the overlying soils and sands. Coal seams are far below the surface. No fossils have been reported from here. Nonetheless, a Fossil Chance Find protocol is added here.

Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. The geological structures suggest that the rocks are the correct age and type to preserve fossils of the Glossopteris flora, in the Vryheid Formation. However, the reports from coalmines in the area indicated that the coal seams and associated fine-grained sediments, are far below the surface. The project for residential housing and associated amenities is not likely to penetrate more than 5-10 m below the land surface. The area is already highly disturbed from previous agricultural activities and current human urban impact. a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is extremely low.

5. Assumptions and uncertainties

Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the sandstones, shales, coal, dolomites, cherts, basalts and lavas of the early Proterozoic Transvaal Supergroup and Palaeozoic Karoo Supergroup, are typical for the country and do NOT contain fossils in the first instance and could contain fossils in the second instance. None has been reported from this area. Borehole cores for the coalmines indicate that the coal seams are far below the surface. The surface is already highly disturbed from previous agricultural activities and current human urban impact.

6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the overlying soils and sands of the Vryheid Formation. Dolerite does not preserve fossils and the uppermost potentially fossiliferous layer is more than 50 m below the surface so would not be affected by any urban development.

A Fossil Chance Find Protocol is included here for the very small chance that the excavations might reveal some fossil plants. There would be no fossils in the surface soils.

7. References

Barbolini, N., Bamford, M.K., Rubidge, B., 2016. Radiometric dating demonstrates that Permian spore-pollen zones of Australia and South Africa are diachronous. Gondwana Research 37, 241-251.

Eriksson, P.G., Altermann, W., Hartzer, F.J., 2006. The Transvaal Supergroup and its pre-cursors. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. pp 237-260.

Eriksson, P.G., Bartman, R., Catuneanu, O., Mazumder, R., Lenhardt, N., 2012. A case study of microbial mats-related features in coastal epeiric sandstones from the Palaeoproterozoic Pretoria Group, Transvaal Supergroup, Kaapvaal craton, South Africa; the effect of preservation (reflecting sequence stratigraphic models) on the relationship between mat features and inferred palaeoenvironment. Sedimentary Geology 263, 67-75.

Plumstead, E.P., 1969. Three thousand million years of plant life in Africa. Geological Society of southern Africa, Annexure to Volume LXXII. 72pp + 25 plates.

Snyman, C.P., 1998. Coal. In: Wilson, M.G.C., and Anhaeusser, C.P., (Eds), The Mineral Resources of South Africa: Handbook, Council for Geosciences 16, 136-205.

8. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavations for foundations and amenities begin.

1. The following procedure is only required if fossils are seen on the surface and when drilling/excavations commence.
2. When excavations begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (leaf impressions, wood, coal) should be put aside in a suitably protected place. This way the project activities will not be interrupted.
3. Photographs of similar structures are provided here for the developer to assist in recognizing the microfossils (for example see Figure 4, 5).
4. Photographs of the putative fossils from the site can be sent to the palaeontologist for a preliminary assessment.
5. If there is any possible fossil material found by the developer/environmental officer then the qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible.
6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site, a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.
7. If no good fossil material is recovered then no site inspections by the palaeontologist will be necessary. A final report by the palaeontologist must be sent to SAHRA once the project has been completed and only if there are fossils.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

Appendix A – Examples of fossils from the Vryheid Formation

Figure 4: Examples of fossil plants of the Glossopteris flora that could be associated with the coal seams.

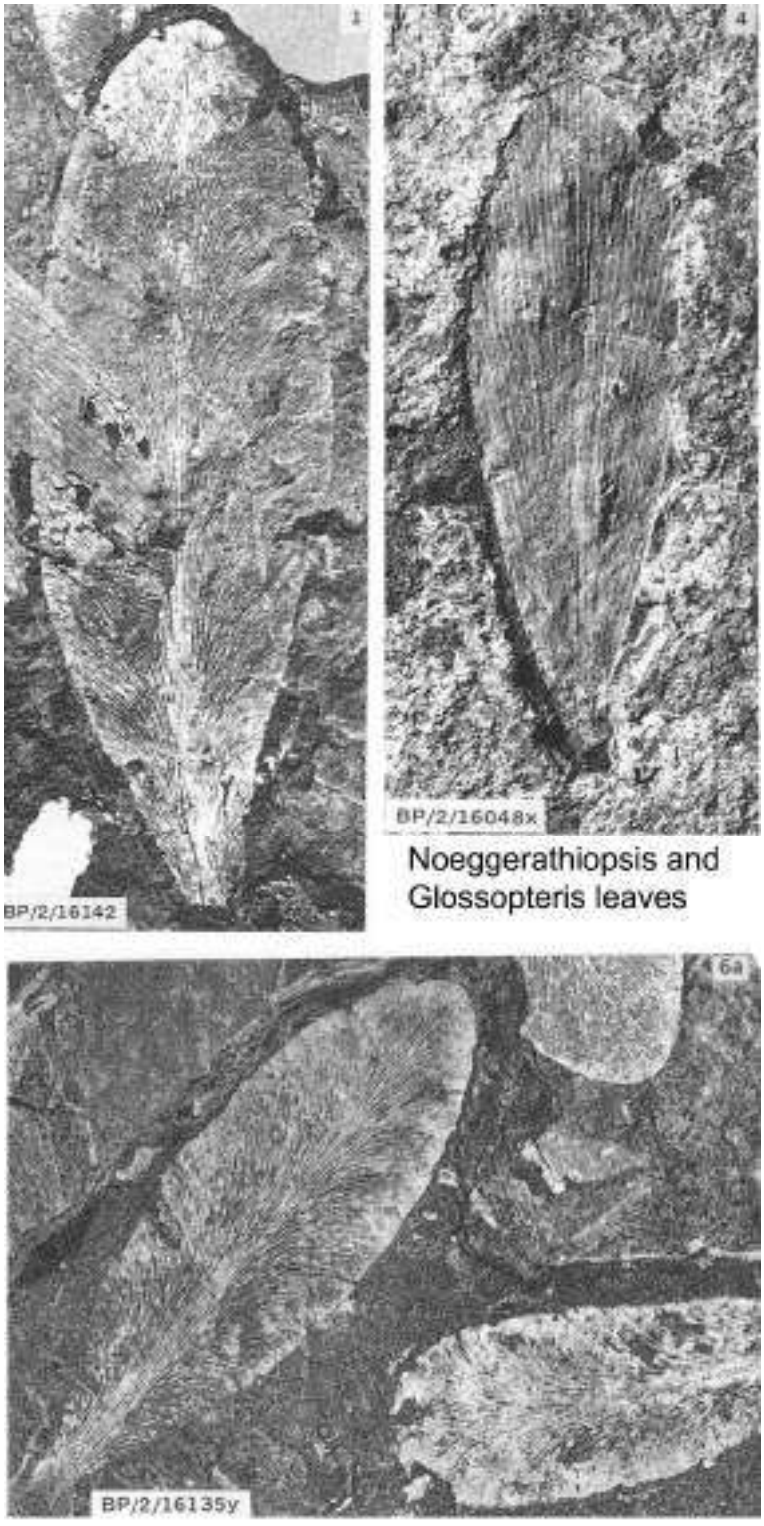

Figure 5: More examples of fossil plants from the Vryheid Formation.

Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
January 2020

I) Personal details

Surname	:	**Bamford**
First names	:	**Marion Kathleen**
Present employment	:	Professor; Director of the Evolutionary Studies Institute. Member Management Committee of the NRF/DST Centre of Excellence Palaeosciences, University of the Witwatersrand, Johannesburg, South Africa-
Telephone	:	+27 11 717 6690
Fax	:	+27 11 717 6694
Cell	:	082 555 6937
E-mail	:	marion.bamford@wits.ac.za ; marionbamford12@gmail.com

ii) Academic qualifications

Tertiary Education: All at the University of the Witwatersrand:
1980-1982: BSc, majors in Botany and Microbiology. Graduated April 1983.
1983: BSc Honours, Botany and Palaeobotany. Graduated April 1984.
1984-1986: MSc in Palaeobotany. Graduated with Distinction, November 1986.
1986-1989: PhD in Palaeobotany. Graduated in June 1990.

iii) Professional qualifications

Wood Anatomy Training (overseas as nothing was available in South Africa):
1994 - Service d'Anatomie des Bois, Musée Royal de l'Afrique Centrale, Tervuren, Belgium, by Roger Dechamps
1997 - Université Pierre et Marie Curie, Paris, France, by Dr Jean-Claude Koeniguer
1997 - Université Claude Bernard, Lyon, France by Prof Georges Barale, Dr Jean-Pierre Gros, and Dr Marc Philippe

iv) Membership of professional bodies/associations

Palaeontological Society of Southern Africa
Royal Society of Southern Africa - Fellow: 2006 onwards
Academy of Sciences of South Africa - Member: Oct 2014 onwards
International Association of Wood Anatomists - First enrolled: January 1991
International Organization of Palaeobotany – 1993+

Botanical Society of South Africa
South African Committee on Stratigraphy – Biostratigraphy - 1997 - 2016
SASQUA (South African Society for Quaternary Research) – 1997+
PAGES - 2008 –onwards: South African representative
ROCEEH / WAVE – 2008+
INQUA – PALCOMM – 2011+onwards

vii) Supervision of Higher Degrees

All at Wits University

Degree	Graduated/completed	Current
Honours	7	0
Masters	10	4
PhD	12	5
Postdoctoral fellows	10	3

viii) Undergraduate teaching
Geology II – Palaeobotany GEOL2008 – average 65 students per year
Biology III – Palaeobotany APES3029 – average 25 students per year
Honours – Evolution of Terrestrial Ecosystems; African Plio-Pleistocene Palaeoecology; Micropalaeontology – average 2-8 students per year.

ix) Editing and reviewing
Editor: Palaeontologia africana: 2003 to 2013; 2014 – Assistant editor
Guest Editor: Quaternary International: 2005 volume
Member of Board of Review: Review of Palaeobotany and Palynology: 2010 –
Cretaceous Research: 2014 –
Journal of African Earth Sciences: 2020 -

Review of manuscripts for ISI-listed journals: 25 local and international journals

x) Palaeontological Impact Assessments

Selected – list not complete:

- Thukela Biosphere Conservancy 1996; 2002 for DWAF
- Vioolsdrift 2007 for Xibula Exploration
- Rietfontein 2009 for Zitholele Consulting
- Bloeddrift-Baken 2010 for TransHex
- New Kleinfontein Gold Mine 2012 for Prime Resources (Pty) Ltd.
- Thabazimbi Iron Cave 2012 for Professional Grave Solutions (Pty) Ltd
- Delmas 2013 for Jones and Wagener
- Klipfontein 2013 for Jones and Wagener
- Platinum mine 2013 for Lonmin
- Syferfontein 2014 for Digby Wells
- Canyon Springs 2014 for Prime Resources

- Kimberley Eskom 2014 for Landscape Dynamics
- Yzermyne 2014 for Digby Wells
- Matimba 2015 for Royal HaskoningDV
- Commissiekraal 2015 for SLR
- Harmony PV 2015 for Savannah Environmental
- Glencore-Tweefontein 2015 for Digby Wells
- Umkomazi 2015 for JLB Consulting
- Ixia coal 2016 for Digby Wells
- Lambda Eskom for Digby Wells
- Alexander Scoping for SLR
- Perseus-Kronos-Aries Eskom 2016 for NGT
- Mala Mala 2017 for Henwood
- Modimolle 2017 for Green Vision
- Klipoortjie and Finaalspan 2017 for Delta BEC
- Ledjadja borrow pits 2018 for Digby Wells
- Lungile poultry farm 2018 for CTS
- Olienhout Dam 2018 for JP Celliers
- Isondlo and Kwasobabili 2018 for GCS
- Kanakies Gypsum 2018 for Cabanga
- Nababeep Copper mine 2018
- Glencore-Mbali pipeline 2018 for Digby Wells
- Remhoogte PR 2019 for A&HAS
- Bospoort Agriculture 2019 for Kudzala
- Overlooked Quarry 2019 for Cabanga
- Richards Bay Powerline 2019 for NGT
- Eilandia dam 2019 for ACO
- Eastlands Residential 2019 for HCAC
- Fairview MR 2019 for Cabanga
- Graspan project 2019 for HCAC
- Lieliefontein N&D 2019 for Enviropro
-

xi) Research Output

Publications by M K Bamford up to December 2019 peer-reviewed journals or scholarly books: over 140 articles published; 5 submitted/in press; 8 book chapters.
Scopus h-index = 27; Google scholar h-index = 32; -i10-index = 80
Conferences: numerous presentations at local and international conferences.

xii) NRF Rating

NRF Rating: B-2 (2016-2020)
NRF Rating: B-3 (2010-2015)
NRF Rating: B-3 (2005-2009)
NRF Rating: C-2 (1999-2004)

APPENDIX B7

Socio-Economic Impact Assessment

UNITAS PARK EXTENSION 16

SOCIO-ECONOMIC IMPACT ASSESSMENT STUDY

APRIL 2020

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URBAN-ECON
Development Economists

Celebrate Development Diversity

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Version:
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SPECIALISTS DETAILS

Elena Broughton

Cell: 082 463 2325

E-mail: elena@urban-econ.com

Position: Manager/Senior Economist

Qualifications: MSc Technology Management, BSC (Hon) Technology Management, BCom (Hon) Economics

Experience: 13 years

Brief profile: Elena Broughton is a senior professional and the manager of the Innovation & Sustainable Development Unit at Urban-Econ. She has extensive knowledge in various fields of economic development that includes 13 years of experience in undertaking socio-economic impact assessment studies for a variety of private clients spanning the mining, manufacturing, energy, infrastructure, and retail sectors. She also acted as a peer reviewer in a number of socio-economic impact assessment studies and completed a few strategic socio-economic impact assessments. Her involvement in the field allowed her to develop a sound understanding of the South African environmental legislation and developmental policies and equipped her with a widespread knowledge of socio-economic implications and benefits of various new developments.

Siyasanga Qomoyi

Cell: 067 019 3454

E-mail: siyasanga@urban-econ.com

Position: Development Economist

Qualifications: Bachelor of Commerce, Bachelor of Administration Political Studies (Hons), Postgraduate Diploma- Applied Economics

Experience: 4 years

Brief profile: **Siyasanga** studied her undergraduate degree at UWC where she won the Golden Key in her second year for recognition of her academic performance. After completing her Honours Degree, she then studied applied economics at NMMU, there she was awarded a Merit Award for being a top Economics student in her class. After her postgraduate diploma, she interned at the City of Cape Town in the Organisational Policy and Planning Department in the Economic Research Unit where she was a research assistant intern. In 2018, she joined Urban-Econ. She has gained experience in conducting feasibility studies, monitoring and evaluation (M&E) projects, socio-economic impact assessment studies and assisting in economic research. She is currently pursuing a Master of Commerce in Development Economics at the University of Witwatersrand.

TABLE OF CONTENTS

SPECIALISTS DETAILS 3

LIST OF FIGURES 6

LIST OF TABLES 6

ACRONYMS AND ABBREVIATIONS 7

1. INTRODUCTION 8

1.1 Brief Description of the Project 8

1.1 Scope and Purpose of the Study 8

1.2 Methodology 9

1.3 Data gathering and consultation process 9

1.4 Assumptions, limitations and gaps in knowledge 10

2. POLICY REVIEW 11

2.1 Project alignment with national policies and strategic documents 11

2.2 Project alignment with provincial policies and strategic documents 13

2.3 Project alignment with municipal policies and strategic documents 14

3. SITE RELATED INFORMATION 17

3.1 Sense of place, history and cultural aspects 17

3.2 Study area Delineation 17

3.3 Land-use profile 19

4. BASELINE INFORMATION 21

4.1 Demographic Profile 21

4.1.1 Population and Household Size 22

4.2 Economy 23

4.2.1 Gross Value Added 23

4.2.2 Sectoral Contribution 24

4.3 Labour Force and Employment Structure 25

4.3.1 Employment Status and level of skills 25

4.3.2 Sectoral contribution to employment 26

4.3.3 Unemployment Rate 26

4.4 Household Income 27

4.4.1 Household Expenditure 28

5. ACCESS TO SERVICES AND STATE OF LOCAL BUILT ENVIRONMENT 29

5.1 Access to basic services 29
6. PROPERTY TRENDS ANALYSIS 30
6.1 National Macroeconomic determinants 30
6.2 Study Area Housing Trends 31
7. IMPACT ANALYSIS 35
7.1 Introduction 35
7.2 Preliminary Impact Assessment 35
7.2.1 Identify potential impacts 35
7.3 Impact criteria and ratings 35
7.4 Impact Analysis 37
7.4.1 Construction phase 37
7.4.2 Operational phase 38
8. CONCLUSION 44
REFERENCES 46

LIST OF FIGURES

Figure 1.1: Proposed development plan 8
Figure 1.2: Methodology 9
Figure 3.1: Study area delineation 18
Figure 3.2: Regional connectivity 19
Figure 3.3: Surrounding land uses 20
Figure 4.1: Population of the Province, District and Local Municipality (2008, 2013 & 2018) 21
Figure 4.2: Demographic profile of Unitas Park 22
Figure 4.3: Study area race profile in 2011 23
Figure 4.4: Study area GVA contribution, 2009-2018 24
Figure 4.5: Top economic sectors in the Emfuleni, 2018 .....
Figure 4.6: Employment status in Unitas Park in 2018 .....
Figure 4.7: Level of skill in Emfuleni, 2018 .....
Figure 4.8: Unemployed rate for the period 2009 to 2018 27
Figure 4.9: Household expenditure in The Emfuleni Local Municipality in 2018 .....
Figure 5.1: Access to basic services in Emfuleni Local Municipality in 2018 29
Figure 6.1: National Prime Lending Rate for the period 2010 to 2020 .....
Figure 6.2: National House Price Index for the period 2009 to 2019 .....
Figure 6.3: Average Consumer Price Index for the period 2009 to 2019 .....
Figure 6.4: Dwelling type for Unitas Park in 2011 31
Figure 6.5: Tenure status in 2011 .....
Figure 6.6: Residential market stock in Unitas Park .....
Figure 6.7: Median house prices (R' 000) 2009 – 2019 in Unitas Park 33
Figure 6.8: Property owner distribution in Unitas Park 33
Figure 6.9: Period of ownership .....

LIST OF TABLES

Table 4.1: Unitas Park Population and household size 22
Table 4.2: Sectoral contribution for 2008, 2013 and 2018 25
Table 4.3 : Sectoral contribution to employment in the Emfuleni Local Municipality in 2018 26
Table 4.4: Household income for Unitas Park in 2011 adjusted based on 2020 Average Consumer Price Index 27
Table 6.1: National macroeconomic determinants for property demand 30
Table 7.1: Impact Assessment Criteria 35
Table 8.1: Summary of potential impact significance before and after mitigations 44

ACRONYMS AND ABBREVIATIONS

CBD	Central Business District
EIA	Environmental Impact Assessment
ELM	Emfuleni Local Municipality
IDP	Integrated Development Plan
GDP	Gross Domestic Product
GGT	Growing Gauteng Together
GVA	Gross Value Added
NDP	National Development Plan
NGPF	New Growth Path Framework
NSDP	National Spatial Development Perspective
SDM	Sedibeng District Municipality
TOD	Transport Oriented Developments

1. INTRODUCTION

This document is prepared by **Urban-Econ Development Economists** in response to a request by **GCS Water and Environmental Consultants** on behalf of Phumaf Holdings Group to undertake a socio-economic impact study for the **Unitas Park Extension 16** mixed high-density development. The socio-economic impact study is conducted as part of the environmental impact assessment (EIA) process managed by **GCS Water and Environmental Consultants.**

1.1 Brief Description of the Project

The proposed development is a mixed high-density residential development consisting of 7 250 units. The site for the proposed development is in the Emfuleni Local Municipality and is located 6km north west of Vereeniging Central Business District (CBD) located between roads R54 and R42. The site can be accessed via Skippie Botha and Langraad Roads. The extent of the site is 151 Hectares and is owned by the Gauteng Provincial Government. The site is zoned "Farmland" and is currently vacant and it appears to not be yielding significant social or economic value or benefit. Figure 1-1 below provides a visual illustration of the proposed development.

Figure 1-1: Proposed development plan
(PHUMAF, 2020)

1.1 Scope and Purpose of the Study

The socio-economic impact assessment contains information that, together with that from other specialists, allows for the assessment of the project from a sustainable development perspective and assists in identifying "the most practicable environmental option" that provides the "most benefit and causes the least damage to the environment as a whole, at a cost acceptable to society", in the long term and the short term. Considering the above, and in line with the Environmental Impact Assessment (EIA) Regulations of 2014, the purpose of the socio-economic impact assessment is to assess the need and desirability of the project. It specifically aims

to ensure that the project, if approved, provides for justifiable social and economic development outcomes. As such, it aims to:

- determine the social and economic impact on the surrounding community,
- bring about a more sustainable and equitable biophysical and human environment.

Specifically, the study will identify and analyse the intended and unintended social and economic consequences, both positive and negative, of the proposed development, together with the ecological impact and propose management/mitigation strategies.

1.2 Methodology

Figure 1-2 below illustrates the methodology employed in the study.

Figure 1-2: Methodology

1. **Orientation:** The study started with the specialists gaining an understanding of the proposed project relating to the various stages of its lifecycle and the potentially affected environment.
2. **Data collection and policy review:** The policy review provides a brief description of the relevant policies. National, provincial and local government policies and strategic plans are reviewed to determine the alignment of the proposed project to the national, provincial and local government strategic objectives and whether the proposed project will contribute to the broader policy and strategic goals.
3. **Baseline profiling:** The baseline assessment provides the status quo of the study area to determine how the demographic dynamics of the area and their change over time will be impacted by the proposed development.
4. **Identifying anticipated impacts:** The step involves the identification of potential positive and negative impacts. The potential impacts are rated for significance and the proposed mitigation measures are provided.

1.3 Data gathering and consultation process

Primary data could not be gathered due to the effects of the Corona pandemic. Efforts to engage the project stakeholders telephonically were not successful, particularly because of people were not in their offices yet the majority of the contacts were office landlines. Also, a site visit could not be done because of the traveling restrictions emanating from the lockdown. The study therefore relied on available secondary data.

Secondary data gathering

Secondary data was sourced from the following databases and documents:

- Quantec Research Standardised Regional Data, 1993-2018
- Statistics South Africa Census, 2011
- Lightstone Reports, 2020
- National strategic documents
- Integrated Development Plan
    - Sedibeng District Municipality Integrated Development Plan
    - Emfuleni Local Municipality Integrated Development Plan
- Spatial Development Frameworks
    - Sedibeng Spatial Development Framework
    - Emfuleni Spatial Development Framework
- Gauteng Growth Management Perspective 2014

1.4 Assumptions, limitations and gaps in knowledge

The following section outlines the key assumptions, limitations and information gaps that may potentially have implications on the assessment and discussions of the study.

- In terms of the primary data, information could be gathered due Corona Virus pandemic and the lockdown that was announced on March 26, 2020.
- While all due care was taken to ensure that the assessment of impacts is accurate (and follows the conservative approach), provision of additional data could potentially impact the assessment of the significance of some impacts.
- Project-related information supplied by the team involved in the project for the purpose of the analysis is assumed to be reasonably accurate. Thus, all impacts are analysed based on this information. Any changes hereon cannot be accounted for in the analysis.
- The secondary data sources used to compile the economic baseline (dynamics of the economy and labour force), although not exhaustive, can be viewed as being indicative of broad trends within the study area.
- Possible impacts, as well as stakeholder responses to these impacts, cannot be predicted with complete accuracy, even when circumstances are similar, and these predictions are based on research and years of experience, taking the specific set of circumstance into account.

2. POLICY REVIEW

A policy review plays an integral role in the early stages of a project. The review provides a high-level indication of whether a project is aligned with the goals and aspirations of the developmental policy within a country and at a local level. Furthermore, the analysis indicates any red-flag or developmental concerns that could jeopardise the development of the project. This assists in amending and preventing costly and unnecessary delays.

The following government strategic documents applicable to the delineated study areas were examined:

National (South Africa):

- New Growth Path Framework (NGPF) (2010)
- National Development Plan (NDP) 2030 (2011 – 2030)
- National Spatial Development Perspective, 2006Housing Act, 1997 (Act 107 of 1997)

Regional (Gauteng province):

- Growing Gauteng Together (GGT), 2030

Local (City of Johannesburg Metropolitan Municipality):

- Sedibeng District Municipality Integrated Development Plan, 2018/19
- Sedibeng District Municipality Spatial Development Framework
- Emfuleni Local Municipality Integrated Development Plan
- Emfuleni Local Municipality Spatial Development Framework

2.1 Project alignment with national policies and strategic documents

The vision of the **New Growth Path Framework (NGPF)** is to ensure that jobs and decent work are at the centre of economic policy (Department of Economic Development, 2011). The framework states that public investment can create 250 000 jobs per annum in energy, transport, water, communications infrastructure and housing (Department of Economic Development, 2011). Five employment creation opportunities, or job drivers, have been identified by the NGPF, and these include: **(i)** infrastructure, **(ii)** main economic sectors, **(iii)** seizing potential of new economies, **(iv)** investing in social capital, and **(v)** public services and spatial development.

The proposed social development aligns with the NGPF job creation objectives. Fundamentally, the NGPF seeks to address socio-economic issues in low-income households by eradicating the income inequalities that exist within society. The measures it adopts place decent work opportunities as a key aspect to fight against inequality. Additionally, it includes measures that are aimed at enhancing local societies through skills development and small enterprise development. The framework considers basic and secondary education, and investment in health as critical components to achieve equality in the long run. The proposed development is anticipated to provide access to income through employment opportunities. It is also envisaged to contribute towards human capital development through the transfer of skills and knowledge

during the construction phase of the development, as well as the overall improvement of the standard of living in the medium to long run through sustained employment opportunities.

The proposed mixed-high density development is anticipated to create temporary employment opportunities during the construction phase as well as sustained medium to long-term employment opportunities during the operational phase of the development. Thus, the household income opportunities to be generated from the project will improve the standard of living of the individuals and households within the study area as they will have better access to goods and services.

The **National Development Plan (NDP) 2030** aims to address the South African development challenges of poverty and inequality by 2030. The Plan states that although South Africa has made strides into developing inclusive societies, the societies remain highly unequal due to poverty, lack of adequate employment, poor quality of education and the legacy of the apartheid spatial divide which dominates the landscape (National Planning Commission, 2011). Building capabilities, expanding opportunities and employment have been identified as key aspects of change that can enhance social cohesion through reducing poverty and raising living standards. As such, the plan prioritises three areas, raising employment through faster economic growth, improving the quality of education, skills development and innovation and building the capability of the state to play a developmental, transformative role (National Planning Commission, 2011).

The employment opportunities that are anticipated to occur as a result of the proposed mixed high-density development align with the NDPs' objective to expand employment opportunities in the economy. Employment opportunities created by the proposed development will provide individuals and households with access to income, enabling those individuals and households to access goods and services. Essentially, this contributes to the improvement of households' standard of living.

The **National Spatial Development Perspective, 2006** is an important tool for establishing coordinated government actions and aligning them to meet social, economic and environmental objectives. The NSDP highlights principles and mechanisms for guiding infrastructure investment and development decisions. These principles include:

- Rapid economic growth that is sustained and inclusive for achieving other policy objectives.
- The constitutional obligation of the government to provide all citizens with basic services such as water, electricity, health and education facilities wherever they reside.
- Government spending on fixed investment should focus on localities of economic growth and/or economic opportunities. Government fixed investment should prioritise economic growth to motivate private sector investment to stimulate economic activities and create long-term employment opportunities.
- Regarding low economic potential, government should in addition to providing essential services, prioritise human capital development by providing social transfers such as grants, education and training and poverty relief programmes.

- Future settlements and economic development opportunities should be channelled into activity corridors and nodes that are adjacent to or link the main growth centres to address the spatial distortions caused by apartheid.

The proposed development aligns with the NSDP by creating job opportunities and contributing towards the growth of the local and regional economy through anticipated business activities and transactions that will take place during the construction and the operational phase.

2.2 Project alignment with provincial policies and strategic documents

The **Growing Gauteng Together (GGT), 2030,** is a plan of action that reflects the collective vision for the Gauteng City Region and highlights priority actions in response to the global and domestic challenges confronting the Province. There are seven priority area that the GGT, 2030, seeks to address and these include: **(i)** economy, jobs and infrastructure **(ii)** education, skills revolution and health **(iii)** integrated human settlements, basic services and land release **(iv)** safety, social cohesion and food security **(v)** building a capable, ethical and developmental state **(vi)** a better Africa and better world and **(vii)** sustainable Development for future generation

The GGT, 2030, hopes to achieve a better economic outlook for South Africa which would primarily be driven by a best-case scenario of the performance of the Gauteng province termed "Nayi Le Walk". In this scenario, the outlook for the province includes the following dynamic impacts:

- Economic growth- the Gauteng economy is anticipated to more than double over the next 11 years
- Employment and unemployment- the provincial economy is anticipated to contribute 3,1 million jobs to total employment by 2030 and the unemployment rate is expected to decrease by half, from 31% to 15%.
- Per capita GDP- The GDP is expected to increase by 70%, from R68 000 to R115 000 in 2030
- Poverty rate- The Nayi Le Walk growth path is estimated to reduce the provincial poverty rate by 40% over the next decade.
- Income inequality- the inequality rate measured by the Gini index, is anticipated to decline the 8 percentage points over an 11-year period. it is expected to decline from 70% currently to 62% by 2030.
- Industrial restructuring- An increase in the primary and secondary sector output and employment is anticipated. The primary and secondary sector share is expected to increase from 2,3% and 21.3% to 4,2% and 35,3% respectively.

The growth path of the Gauteng Province is said to drive the growth of the other eight provinces over the next decade. The proposed mixed high-density development aligns with one of the priority areas such as the economy, job creation and infrastructure. Short term and sustainable employment opportunities are anticipated to occur as a result of the proposed development.

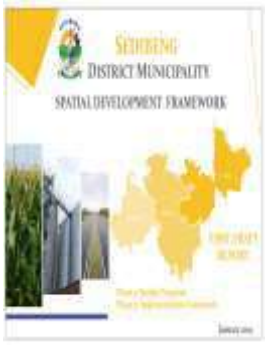
2.3 Project alignment with municipal policies and strategic documents

The **Sedibeng District Municipality Integrated Development Plan, 2019/20** is a strategic planning instrument that guides and informs all planning, budgeting management and decision-making processes in the district municipality over a five (5) year period. The IDP adheres to the constitutional mandate and the intended purpose of municipal integrated development planning which includes:

- To ensure sustainable provision of services
- To promote social and economic development
- To promote a safe and healthy environment
- To give priority to the basic needs of communities
- Encourage the involvement of communities

One of the key performance areas of the IDP is to contribute towards human capital by promoting low to high skills and building social capital by promoting united, non-racial, integrated and safer communities. The SDM intends to be a place where life-long learning is promoted and done in partnership with communities, educational institutions and the private sector.

The proposed mixed high-density development aligns with the IDP as it is anticipated to bring about social and economic benefits for the study area through employment creation and access to income. The promotion of human capital development is one of the anticipated features that the proposed development is anticipated to contribute towards. The recruitment of various skilled labour during the construction phase of the proposed development will open opportunities for skills and knowledge transfer.



The **Sedibeng District Municipality Spatial Development Framework** seeks to achieve:

- **Spatial sustainability** by creating a more consolidated settlement structure in the SDM to promote cost effective and sustainable provision of engineering and community services infrastructure and by ensuring sustainable use of land and other natural resources in the District
- **Spatial justice** through the inclusion of urban and rural communities previously excluded from services and facilities through processes of urban and rural restructuring and consolidation. As well as providing communities with access to economic and social resources to improve their living conditions.
- **Spatial efficiency** by ensuring that resources are channelled to areas in the SDM that display economic potential and development need.
- **Spatial resilience** by diversifying the district economy by focusing on agriculture, tourism, industry, mining and business development.

Land uses in the Sedibeng District Municipality comprise of towns and settlements, informal settlements, extensive agriculture, agricultural holdings, business, industrial, mining, and protected areas. These land uses are linked to movement networks in the SDM which include major national roads (N1, N12 and the N13) and provincial roads that transverse the municipal areas. The proposed mixed high-density development aligns with the current zoning of the site which is primarily characterised by towns and settlements.

The **Emfuleni Spatial Development Framework 2017- 2025** is a strategic land development document that provides the strategic direction of the municipality regarding spatial development. The vision for the spatial development of the Emfuleni Local Municipality (ELM) is to develop the Emfuleni Local Municipality into a public transport oriented structure that provides an efficient urban form that promotes equitable access opportunities, the cost effective provision and use of municipal services infrastructure and support the socio-economic development of local communities.

Essentially, the Emfuleni Local Municipality SDF vision deals with affordable housing development, nodal development, infrastructure development and public transport provision. The implementation of these aspects is aimed at achieving the broader developmental goals relating to sustainable development, poverty alleviation and the attraction of economic opportunities to the Emfuleni Local Municipality. The development objectives of the SDF entail:

- Creating an efficient urban form
- Increasing density and compactness
- Integrating land use and transportation
- Establishing sustainable socio-economic development
- Protection of open space and high potential agricultural soils
- Promoting urban renewal of established areas

The ELM SDF encourage land use densification in development corridors as well as Transport Oriented Developments. The proposed mixed high-density development aligns with the SDF in the promotion of densification in land uses and trannsport oriented developments as the site for the proposed development links to national and regional roads which enable mobility through the use of public transportation, thus promoting access to places of economic opportunity.

The **Emfuleni Local Municipality Integrated Development Plan, 2019/20** is a five-year plan that provides the local municipalities developmental visions and objectives. It is highlighted in the ELM IDP that the current urbanisation in the ELM is highly fragmented and therefore future urban developments and expansions within the local municipality should be done in a manner that achieves **urban consolidation, density and compactness.**

The ELM IDP prioritises the renewal of communities through the implementation of key deliverables including, the provision of basic services, regeneration of property development to improve the quality of living for all in the area of Emfuleni. One of the focus areas towards renewing communities involves changing the nature of housing delivery through the provision of basic services, **mixed housing developments**, developing comprehensive human settlement (formalisation of informal settlements) and hostel upgrading. The proposed mixed-high density development aligns with the IDP's focus on community renewal as mixed housing developments form part of the housing typologies in the provision of housing in the local municipality.

Synthesis

The national, provincial, and local policy framework focus on the broader objectives of economic development and job creation. More so, other key developmental aspects that all spheres of government promote include spatial redress, the provision of basic services and the overall improvement of lives. The proposed mixed high-density development speaks to these objectives. The ELM IDP prioritises mixed housing developments as one of the ways of changing the nature of housing delivery in the local municipality and also highlights that future urban developments and expansions in the ELM should seek to achieve urban consolidation, density and compactness. The proposed development therefore aligns with the ELM's objectives of achieving urban infill and consolidation.

3. SITE RELATED INFORMATION

This section provides the spatial context of the site and indicates the potential alignment of the proposed site to the current form of the study area. The site information includes the history, historical and cultural characteristics of the area, from a district and local perspective, the locational description of the site and an assessment of surrounding land uses.

3.1 Sense of place, history and cultural aspects

The study area falls in the Sedibeng District Municipality. The Sedibeng District Municipality is regarded as **category C**[1] and covers the southern part of the Gauteng Province and is comprised of three local municipalities: Emfuleni, Midvaal and Lesedi. The towns within the municipalities include Vereeniging, Vanderbijlpark, Meyerton and Heidelberg (Sedibeng District Municipality, 2020). Unitas Park falls under the Emfuleni Local Municipality and is one of the small settlements in Vereeniging and is within six kilometre-radius of six large peri-urban townships of Evaton, Sebokeng, Sharpville, Boipatong, Bophelong Tshepiso. The Emfuleni Local Municipality has a rich political history as it captures the South African War which led to the signing of the Peace Treaty in Vereeniging, the heritage assets such as the Sharpeville monument and the liberation struggle which is embodied by the signing of the Constitution of the Republic of South Africa (Act 106 of 1996) in Sharpeville (Emfuleni Local Municipality, 2020). Other significant historical events or developments that the area is associated with include:

- Having the highest number of political massacres during the apartheid era, including the Sharpeville massacre
- Vaal uprising
- Sebokeng zone 7 massacre
- Eikenhof shootings
- Boipatong massacre

3.2 Study area Delineation

Figure 3-1 below illustrates the primary and the secondary study areas. The primary study area which comprises the proposed project area, also includes areas such as Sebokeng, Falcon Ridge, Arconpark, Unitas Park, Duncoanville and Tshepiso. The secondary study area includes areas such as Evaton and Bophelong. The primary market area indicates the immediate catchment areas where immediate demand for the proposed development can be derived as these areas are relatively closer to the site. The secondary market area indicates the additional demand that can be captured by the development.

[1] A category C municipality is a municipality that has municipal executive and legislative authority in an area that includes more than one municipality, http://www.dac.gov.za/sites/default/files/chapter%207.pdf

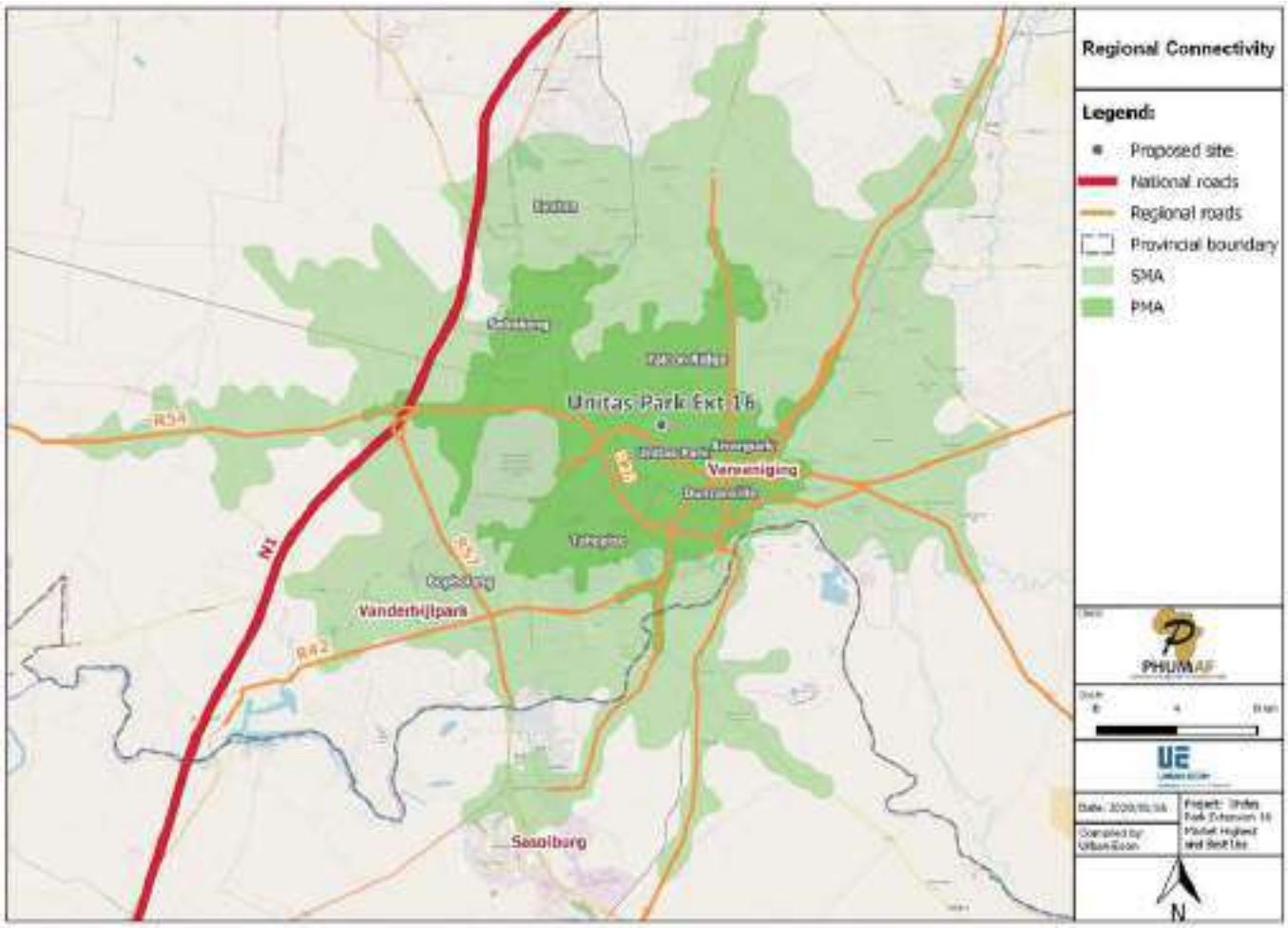


Figure 3-1: Study area delineation

Figure 3-2 illustrates the study areas connectivity to national, regional and other roads. Links to roads networks indicates the level of access or convenience to public transport system. The primary and secondary study areas are accessible through the N1 national road as well as regional roads including the R28, R57 and 54.

In terms of the connectivity of the overall Emfuleni Local Municipality, the Emfuleni local municipality is located south of Johannesburg and southwest of Ekurhuleni and is peripherally located withing Gauteng. Thus, the ELM is not well located in terms of access to core employment opportunities which are found within the region, mostly found within the triangle formed by the Johannesburg Central Business District, the Tshwane CBD and the OR Tambo International Airport. The ELM is, however, well connected to its neighbouring municipal areas by the N1 freeway and the R59 freeway and therefore provides access to these areas and the employment opportunities that exist therein (Emfuleni Local Municipality, 2017).

Figure 3-2: Regional connectivity

3.3 Land-use profile

Land uses surrounding the site as illustrated in Figure 3-3 indicate that the site is predominately surrounded by residential properties and open spaces as well as agricultural holdings. There are very limited commercial activities surrounding the site. There is also limited sports and recreation and education use surrounding the site. The ELM Spatial Development Framework proposes land use estimates for the ELM and provide the plans for urban expansion for areas in the local municipality for the periods 2017-2020 and 2020-2025. The land areas required for urban expansion in the ELM are calculated based on population growth and the existing backlog in the ELM. It is estimated that the ELM requires approximately 1900ha of land for **residential expansion** up to the year 2020 and an additional 1700ha of land for residential expansion up to 2025 (Emfuleni Local Municipality, 2017). In addition, further consolidation and **densification** of the development triangle situated between Vanderbijlpark, Sebokeng and Vereeniging CBD. Further densification of agricultural holding areas such as Mantevrede and **Unitas Park** for the period 2020 to 2025 is encouraged.

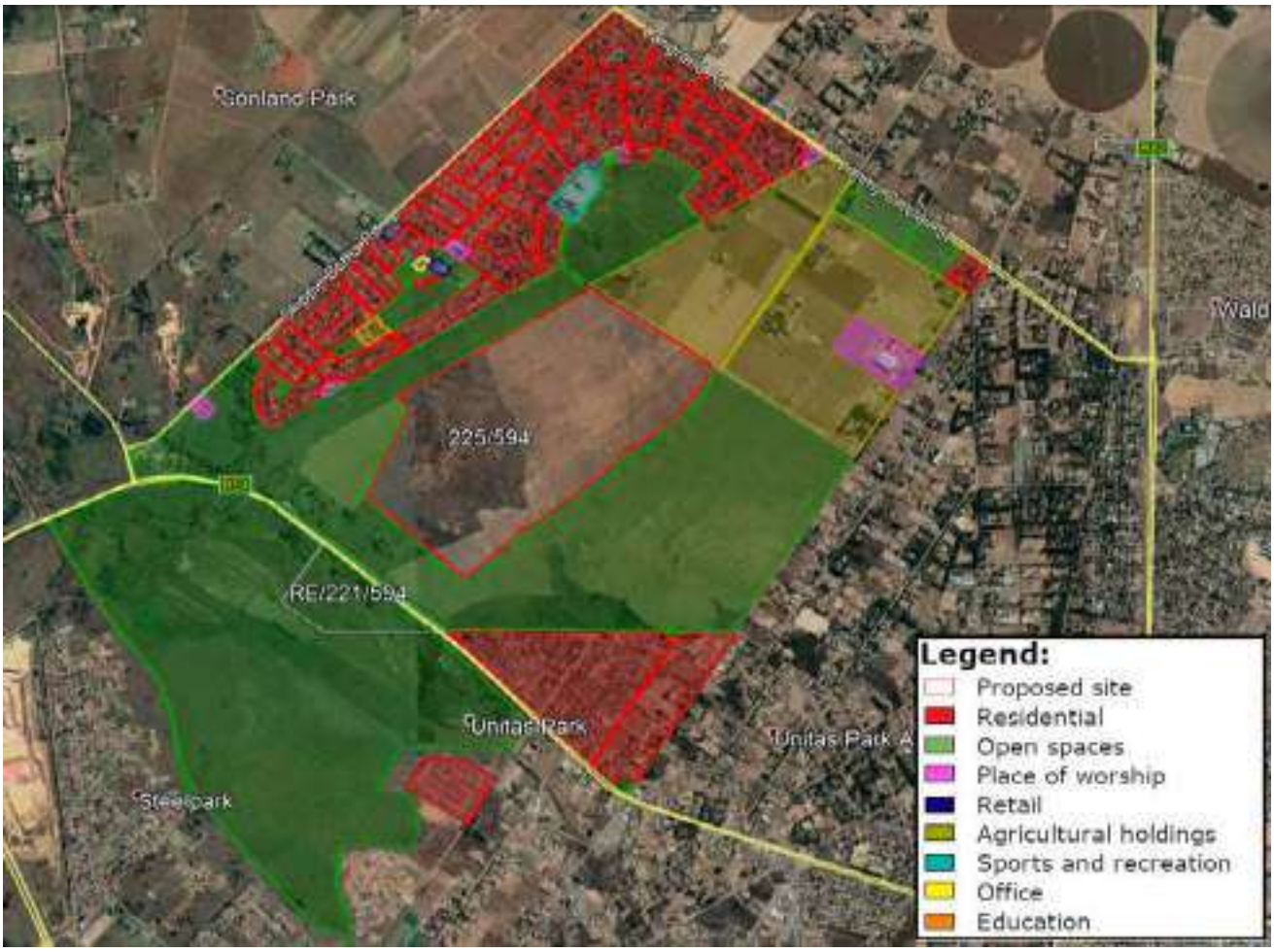


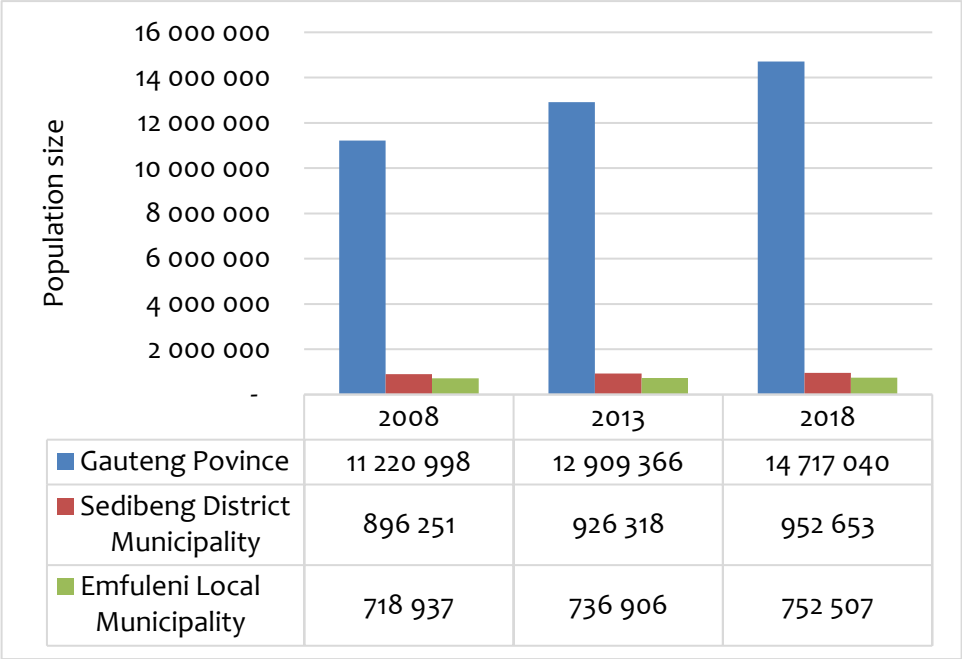
Figure 3-3: Surrounding land uses

4. BASELINE INFORMATION

This chapter examines key socio-economic characteristics of the study area, as per delineation provided in the previous chapter. The analysis of the status quo is essential as it provides both qualitative and quantitative data related to the communities and economies under observation, creating a baseline against, which the impacts can be assessed.

4.1 Demographic Profile

The demographic analysis provides the population characteristics of the study area and estimates the changes in the population and household size over time. The demographic analysis also indicates the characteristics and distribution of gender as well as age within the study area. Figure 4-1 below provides the population growth of the Gauteng Province, the Sedibeng District Municipality, and the Emfuleni Local Municipality in 2008, 2013 and 2018. The figure illustrates a consistent increase and provides an indication of how the population has increased potentially due to reproduction and immigration. Thus, the constant increase in the population size require the provision of housing, basic services as well as economic opportunities.



	2008	2013	2018
Gauteng Povince	11 220 998	12 909 366	14 717 040
Sedibeng District Municipality	896 251	926 318	952 653
Emfuleni Local Municipality	718 937	736 906	752 507

Figure 4-1: Population of the Province, District and Local Municipality (2008, 2013 & 2018) (Census data, 2011)

Figure 4-2 below illustrates the demographic profile of Unitas Park based on the 2011 Census data. Based on the 2011 Census data the total population in Unitas Park was 2 579 and consist of 717 households. The study area predominantly consists of females (50,9%) than males (49,1%) and the dominant gage group in the area are young people between 0 to 14 years as well as those aged 31 to 45 years.

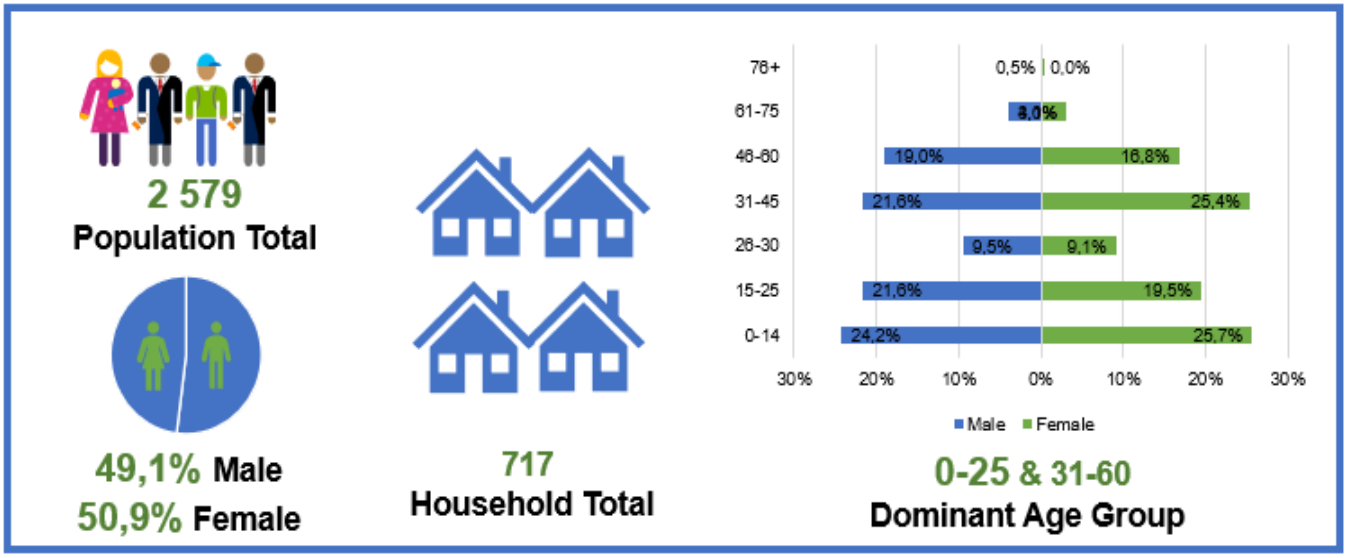


Figure 4-2: Demographic profile of Unitas Park
(Urban-Econ calculations based on Census, 2011 data)

The 2011 Census data is outdated and therefore does not provide a rather realistic view of the current population figures. The population and household figures have been augmented and estimated based on the average population and household growth rates of the Emfuleni Local Municipality and these figures are provided in the subsection below.

4.1.1 Population and Household Size

The population and household size provide an indication of how the area is growing and developing overtime. The increase in the population and household size also highlights a future need for housing, services, and amenities. Table 4.1 below provides the estimated population and household size of Unitas Park. The population size is anticipated to increase by 0,5% and the household size is anticipated to increase by 0,7% over ten-years. Shifts in the study area's population and household size will potentially lead to an increase need for housing. The development there provides a supply of housing stock in the study area which may potentially cater for the increasing population.

Table 4.1: Unitas Park Population and household size

	Average growth rate	2020	2025	2030
Population	0,5%	2 685	2 747	2 811
Household Size	0,7%	765	794	825
Average Household Size	3,5			

(Urban-Econ calculations based on Census 2011 and Quantec 2018 data)

Figure 4-3Figure 4-3 below illustrates the race profile for the study area in comparison to the provincial, district and local municipality. The race profile indicates that the study area predominantly consists of the Black African population (84%) as is the case provincially and within the district and local municipality.

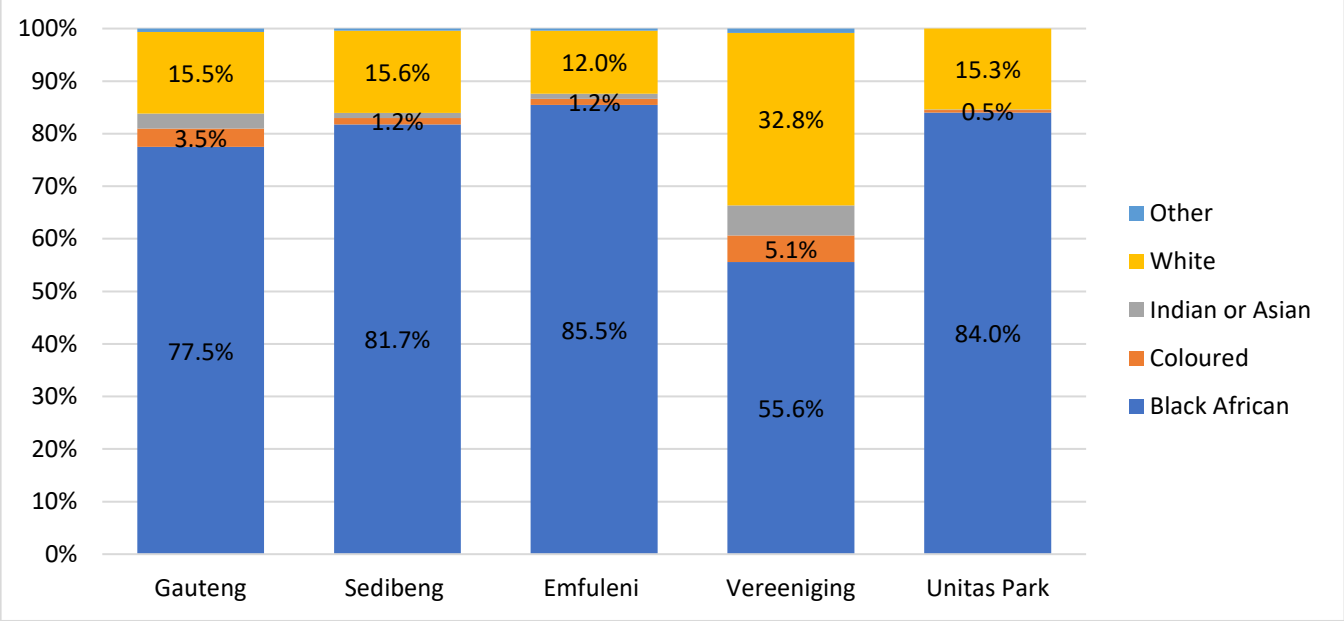


Figure 4-3: Study area race profile in 2011
(Urban-Econ calculations based on Census 2011 data)

4.2 Economy

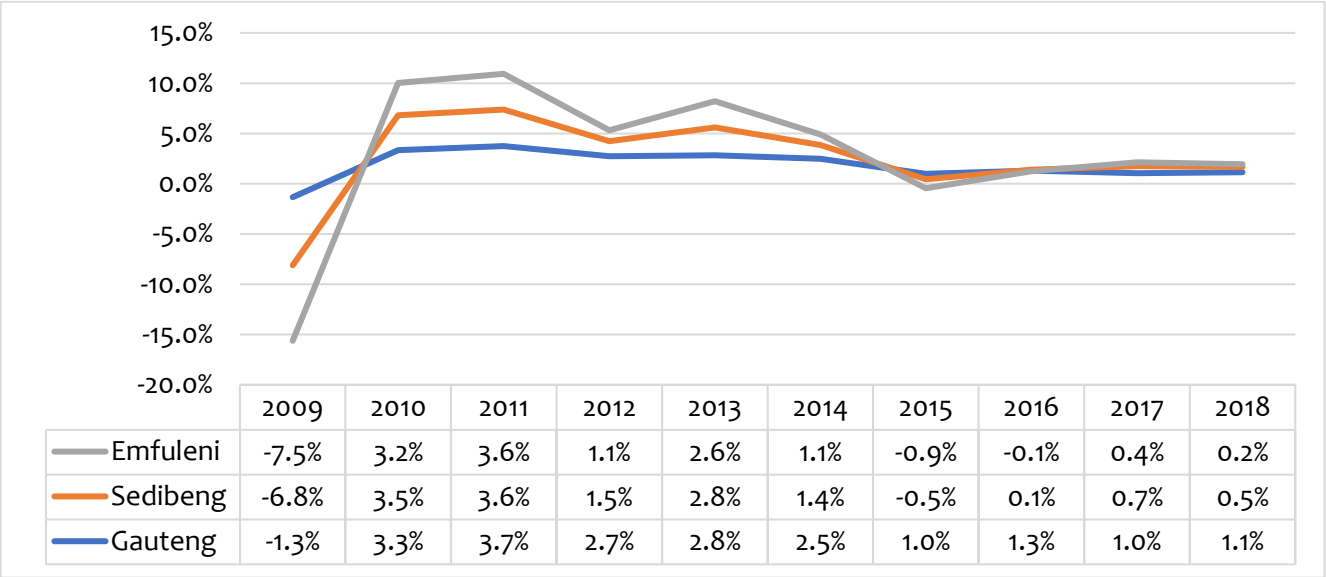
The structure of the economy and the composition of its employment provide valuable insight into the dependency of an area on specific sectors and its sensitivity to fluctuations of global and regional markets. Knowledge of the structure and the size of each sector are also important for the economic impact results' interpretation, as it allows the assessment of the extent to which the proposed activity would change the economy, its structure, and trends of specific sectors. The economic analysis includes an analysis of the following:

- Local economy contribution to the national GDP
- Gross Value Added
- Sectoral contribution

4.2.1 Gross Value Added

The GVA measures the total output and income in the local economy, thus providing an indication of the total sum value of goods and services produced over a period of time. Figure 4-4 illustrates the GVA contribution of the Gauteng province, the Sedibeng district municipality and the Emfuleni local municipality between 2009 and 2018. The local district municipality's GVA moved in tandem with that of the Gauteng Province over the period 2009 to 2019. However, the Sedibeng District Municipality performed better than Gauteng province in 2010. The GVA in the province district and local municipality has decreased significantly over the ten-year period. In 2018 the Gauteng GVA was 1,1% while that of the Sedibeng District Municipality and the Emfuleni Local Municipality was 0,5% and 0,2% respectively. The provincial, district and local municipality economic performance reflects the overall performance of the national economy. The national Real Gross Domestic Product in the fourth quarter of 2019 declined by 1,4% and the decline was attributed to the negative contribution by the transport, storage and communication industry and the trade, catering and

accommodation sectors (Statistics South Africa, 2019).



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Emfuleni	-7.5%	3.2%	3.6%	1.1%	2.6%	1.1%	-0.9%	-0.1%	0.4%	0.2%
Sedibeng	-6.8%	3.5%	3.6%	1.5%	2.8%	1.4%	-0.5%	0.1%	0.7%	0.5%
Gauteng	-1.3%	3.3%	3.7%	2.7%	2.8%	2.5%	1.0%	1.3%	1.0%	1.1%

Figure 4-4: Study area GVA contribution, 2009-2018
(Urban-Econ calculations based on Quantec data, 2018)

4.2.2 Sectoral Contribution

Error! Reference source not found. indicates that the economy of the Emfuleni Local Municipality is predominately driven by the secondary and tertiary sectors. The top three economic sectors in the local municipality include, manufacturing, general government and the finance and business services sector. In 2018, the manufacturing sector contributed R10 158 000 to the local economy, while the general government and finance and business services sector contributed R6 266 million and R5 442 million respectively in the same year. The manufacturing sector also has a large presence in the Sedibeng District Municipality economy. The sector is however vulnerable to challenges such as electricity supply constraints and labour constraints (Sedibeng District Municipality, 2020).

Figure 4-5: Top economic sectors in the Emfuleni, 2018

Table 4.2 below provides the contribution of economic sectors to the Emfuleni local municipality in 2008, 2013 and 2018. The manufacturing sector had the largest contribution between the three-year period. However, the contribution of the manufacturing sector has since decreased over the period. The sector contributed 33,8% to the local economy in 2008 and decreased to 28,1% in 2018. On the other hand, the contribution of the construction increased within the stated years. The sector's contribution increased from 3,6% in 2008 to 4,5% in 2018. The construction sector in the local municipality is anticipated to be further developed through construction activities that are anticipated to take place during the construction phase of the development. Overall, the below sectors are anticipated to be positively impacted by the proposed mixed high-density development:

- Construction

- Wholesale, and retail trade, catering and accommodation
- Transport, storage and communication

Construction workers who come from other areas are anticipated to spend their disposable income on accommodation, retail goods and services during the construction phase, thereby contributing positively to the wholesale and retail trade sector of the area. The transportation of building material and equipment is anticipated to increase the activities in the transport sector of the local economy, thereby resulting in a positive impact on the transport sector.

Table 4.2: Sectoral contribution for 2008, 2013 and 2018

Economic sectors	2008	2013	2018
Agriculture, forestry and fishing	0,5%	0,5%	0,6%
Mining and quarrying	2,2%	2,5%	3,1%
Manufacturing	33,8%	29,8%	28,1%
Electricity, gas and water	3,8%	3,4%	2,8%
Construction	3,6%	4,3%	4,5%
Wholesale and retail trade, catering and accommodation	13,0%	14,4%	15,0%
Transport, storage and communication	7,3%	7,3%	7,3%
Finance, insurance, real estate and business services	13,2%	14,1%	15,1%
General government	17,2%	18,1%	17,3%
Community, social and personal services	5,4%	5,6%	6,1%

4.3 Labour Force and Employment Structure

Employment is the primary means by which individuals who are of working age may earn an income that will enable them to provide for their basic needs and improve their standard of living. As such, employment and unemployment rates are important indicators of socio-economic well-being. The employment structure of the study area also includes an analysis of the formally employed labour in the study area.

4.3.1 Employment Status and level of skills

Error! Reference source not found. below illustrates the employment status of Unitas Park in 2018. In the study area, 54,2% of the working age population are employed, while 45,7% of the working age population includes those who are unemployed and economically inactive. The employment status in the study area is an important factor that indicates individuals or households' level of access to income and the ability to access goods and services. essentially, the employment status provides a significant indication of the standard of living in the study area.

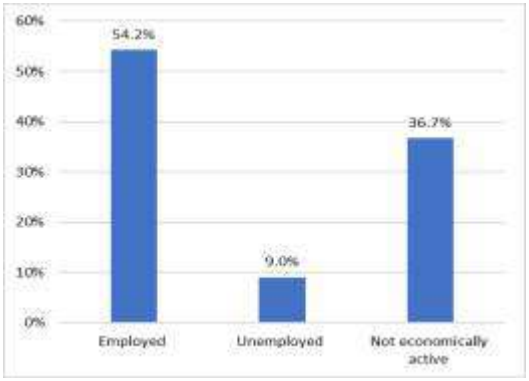


Figure 4-6: Employment status in Unitas Park, 2018

The proposed mixed high-density development is anticipated to create employment opportunities during the construction and operational phases. The employment of construction workers during the construction phase forms part of the direct employment creation that is anticipated to take place. Indirect employment will be realised through developers who will potentially require intermediate goods and services to utilise in the construction phase of the development. Suppliers are expected to employ labour to produce and provide these intermediate goods

and services. The operational phase of the development will also create employment opportunities, including permanent, temporal or contractual work. Employment during the construction phase includes the employment of, inter alia, building managers, cleaning and maintenance staff as well as security guards. Employment opportunities are anticipated to generate income for individuals and households. Individuals and households will spend this income on goods and services, and this is anticipated to have a positive effect on business profits and businesses may have an incentive to create more job opportunities. This is therefore anticipated to result in a multiplier effect and potentially improve the socio-economic status of Unitas Park.

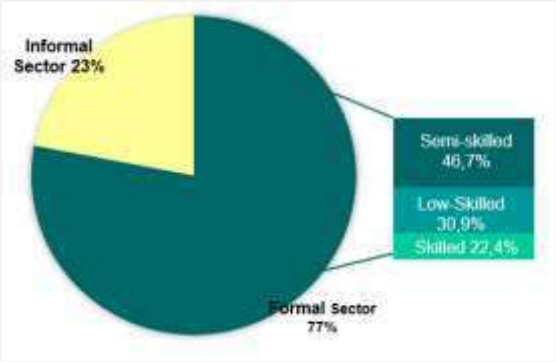


Figure 4-7: Level of skill in Emfuleni, 2018

Error! Reference source not found.Error! Reference source not found. illustrates the level of skill of the labourforce in the Emfuleni local municipality in 2018. The figure indicates that there are more people employed in the formal sector (77%) than in the informal sector (23%), with semi-skilled labour (46,7%) dominating the formal sector labour pool and 22,4% skilled labour.

4.3.2 Sectoral contribution to employment

Table 4.3 below provides the sectoral contribution to formal and informal employment in the Emfuleni Local Municipality in 2018. There is a significant percentage of semi-skilled labour in each of the economic sectors in the Emfuleni Local Municipality. The sectors that contributed to the employment of semi-skilled labour include, the mining and quarrying sector (64%), construction sector (63,7%) and the transport, storage and communication sector (62,3%). Community, social and personal services contributes significantly to the employment of low-skilled labour (66,7%). There is a relatively low contribution to the employment of skilled labour in each of the economic sectors in the study area. General government has the highest contribution to the employment of skilled labour in the study are (44,7%).

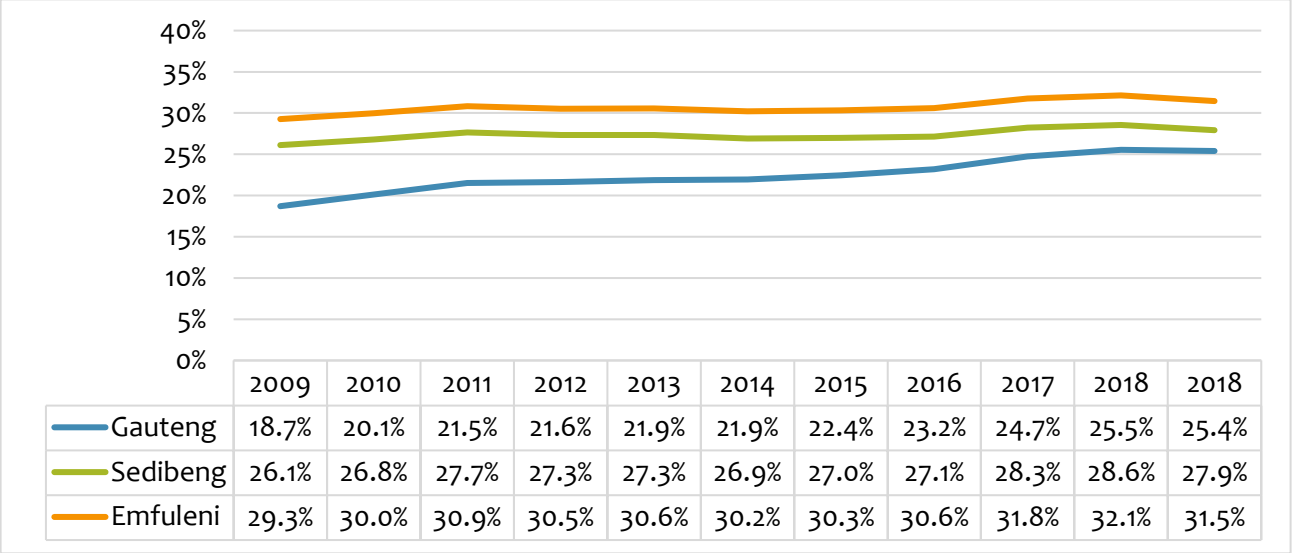
Table 4.3 : Sectoral contribution to employment in the Emfuleni Local Municipality in 2018

Economic Sectors	Formal sector: Skilled	Formal sector: Semi-skilled	Formal sector: Low skilled
Agriculture, forestry and fishing	8,4%	40,9%	50,7%
Mining and quarrying	10,7%	64,0%	25,3%
Manufacturing	16,0%	56,2%	27,8%
Electricity, gas and water	19,7%	57,1%	23,2%
Construction	14,8%	63,7%	21,4%
Wholesale and retail trade, catering and accommodation	19,5%	56,9%	23,6%
Transport, storage and communication	17,7%	62,3%	20,0%
Finance, insurance, real estate and business services	25,3%	52,1%	22,6%
General government	44,7%	38,3%	17,0%
Community, social and personal services	17,0%	16,3%	66,7%

(Urban-Econ calculations based on Quantec data, 2018)

4.3.3 Unemployment Rate

Employment is an important factor that determines individuals or households' access to income, which provides the means to access goods and services and therefore provides an indication of the standard of living in the particular area. Figure 4-8 below illustrates the provincial, district and local municipality's unemployment rate between 2009 and 2018. The Emfuleni Local Municipality has the highest unemployment rate throughout the ten-year period compared to the Gauteng Province and the Sedibeng District Municipality. The ELM unemployment rate was recorded at 31,5% in 2018. The high unemployment rate in the local municipality indicates low employment prospects in the local economy. Unemployment in the local area is above the national average. The national unemployment rate in the fourth quarter of 2019 was 29,1% and remined the same as the third quarter of 2019 (Statistics South Africa , 2019). The proposed development is anticipated to improve employment prospects within the local area through temporary employment opportunities during the construction phase of the development. Moreover, long-term and sustainable employment opportunities are anticipated to be realised during the operational phase.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2018
Gauteng	18.7%	20.1%	21.5%	21.6%	21.9%	21.9%	22.4%	23.2%	24.7%	25.5%	25.4%
Sedibeng	26.1%	26.8%	27.7%	27.3%	27.3%	26.9%	27.0%	27.1%	28.3%	28.6%	27.9%
Emfuleni	29.3%	30.0%	30.9%	30.5%	30.6%	30.2%	30.3%	30.6%	31.8%	32.1%	31.5%

Figure 4-8: Unemployed rate for the period 2009 to 2018 (Urban-Econ calculations based on Quantec, 2018 data)

4.4 Household Income

Household income can be used as an important factor in assessing and determining households' access to goods and services as well as indicating the standard of living of the study area. Table 4.4**Error! Reference source not found.** outlines the household income distribution in Unitas Park and indicates that more than half of the households are low income earning households (55,9%), while there is an almost equal proportion of middle (22,5%) and high income earning households (21,6%). The proposed development is anticipated to contribute positively to household income. Employment opportunities generated by the proposed development will provide households with income which is anticipated to contribute to better access to goods and services and relatively improve the standard of living of the study area population.

Table 4.4: Household income for Unitas Park in 2011 adjusted based on 2020 Average Consumer Price Index

Unitas Park

No income	50,2%	55,9%	Low
R1- R7 282	4,4%		
R7 284- R14 597	0,8%		
R14 566- R29 373	0,5%		
R29 130- R57 869	3,6%	22,5%	Middle
R58 258- R114 781	3,2%		
R116 514- R219 200	6,8%		
R23 027- R233 027	8,9%		
R466 052- 840 458	12,5%	21,6%	High
R932 103- R1 680 916	6,9%		
R1 864 204- R3 361 832	2,0%		
R3 728 407- 6 391 721	0,2%		

(Urban-Econ calculations based on Census data, 2011, StatsSA 2019)

4.4.1 Household Expenditure

Figure 4-9 provides the expenditure of the households in the Emfuleni Local Municipality and indicates that a large portion of the household's disposable income is spent on food, beverage and tobacco (25%) as well as a combination of other goods and services[2] (40%). A notable percentage of the household income is also spent on rent (11%). The proposed development is anticipated to have a positive impact on household income, this is anticipated to also affect the level of spending. Households may potentially have more disposable income to spend on goods and services and potentially spend. Expenditure on rent potentially indicates the demand that may be captured from households who are willing to pay rent. The demand for the for the proposed mixed high-density development will potentially be influenced by household's disposable income, expenditure and affordability.

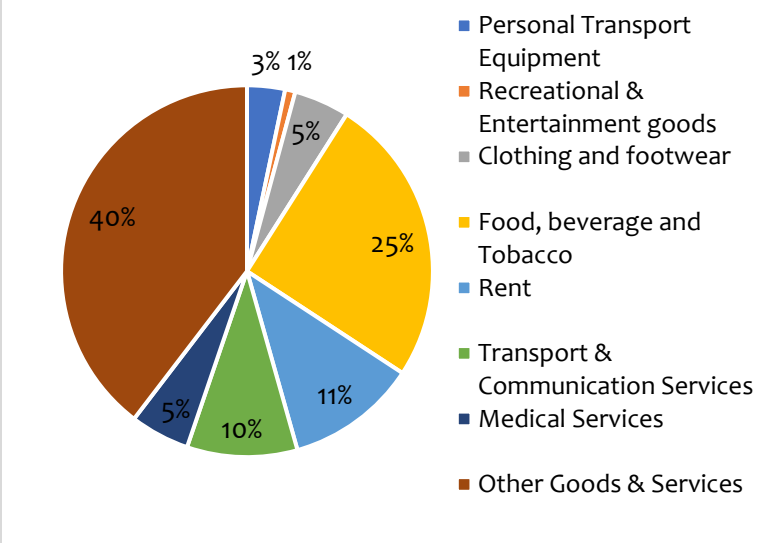


Figure 4-9: Household expenditure in The Emfuleni Local Municipality in 2018
(Urban-Econ calculations based on Quantec data, 2018)

[2] Other goods and services include, inter alia, household appliances, motor parts and accessories, medical products and services as well as recreational and educational services

5. ACCESS TO SERVICES AND STATE OF LOCAL BUILT ENVIRONMENT

Access to shelter, water, electricity, sanitation, and other services are indicators that assist to determine the standard of living of the people in the area under investigation. Infrastructure and the state of local infrastructure is another indicator to contemplate when considering living standards. The availability of social and economic infrastructure including roads, educational facilities, and health facilities further indicates the nature of the study area, which is valuable in developing a complete profile of the circumstances in which communities are living. These measurements create a baseline against, which the potential impacts of the proposed project can be assessed.

5.1 Access to basic services

Figure 5-1 below indicates the level of access to basic services in the Emfuleni Local Municipality in 2018 and indicates that:

- A significant portion of the households in the Emfuleni Local Municipality had access to electricity. Approximately 92,1% of the houses use electricity as a source of energy for lighting while the remaining 7,9% of the households use, paraffin, gas, solar, candles.
- Households in the Emfuleni Local Municipality have adequate access to water. An estimated 99,4% of the households have access to piped water. Piped water is either accessed inside a dwelling, inside a yard, or in a community stand less or more than 200 km from the dwelling. Approximately 0,6% of the household's access water from boreholes/rainwater tank or well, from a dam/river/stream or spring, from a water carrier/tanker or water vendor or from other unspecified sources.
- The majority of the households in the Emfuleni local municipality have access to sanitation services. Approximately 90,3% of the households have access to flush or chemical toilets while the remaining estimated 9,7% of the households use access to pit latrine, bucket latrine or none/unspecified sanitation sources.
- Approximately 90,7% of the households in the Emfuleni local municipality have their waste removed by the local municipality.

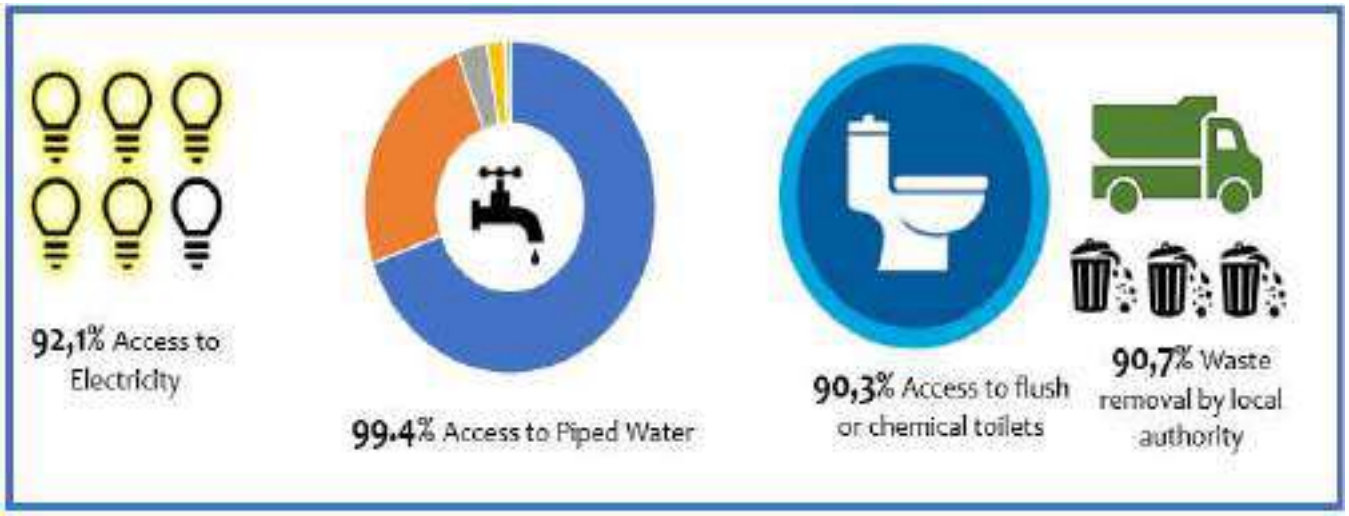


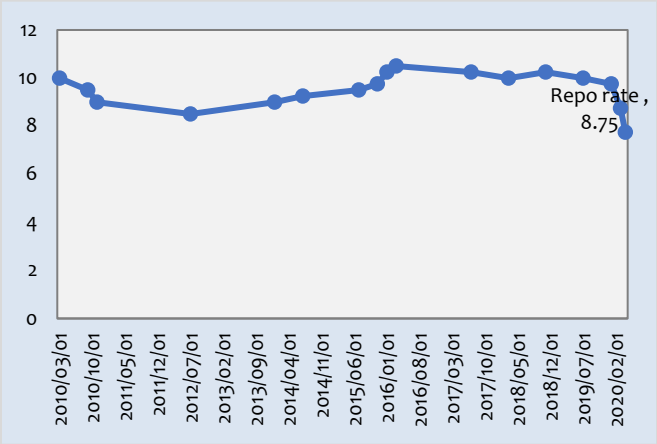
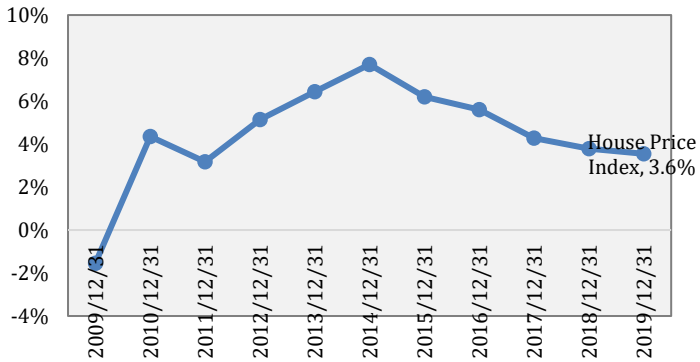
Figure 5-1: Access to basic services in Emfuleni Local Municipality in 2018 (Quantec data, 2018)

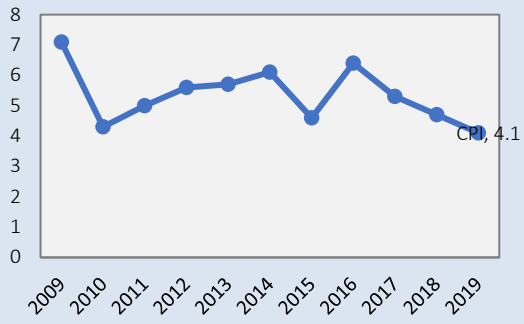
6. PROPERTY TRENDS ANALYSIS

6.1 National Macroeconomic determinants

Significant determinant factors that influence the demand for the property market should be considered as important in gauging the demand for the proposed mixed high-density development. Table 6.1 provides an overview the national key determinants for residential property.

Table 6.1: National macroeconomic determinants for property demand

Indicator	Trends	Implication
South African Interest Rates	 **Figure 6-1: National Prime Lending Rate for the period 2010 to 2020 (South African Reserve Bank, 2020)**	The prime lending rate is the rate at which commercial banks lend to people. The South African Reserve Bank decreased the prime lending rate from 8,75 percent in March 2020 to 7,75 percent in April 2020 The decrease in the prime interest rate brings relief to property owners and can encourage people to enter into the market since credit is more affordable
National House Prices Index (% growth year-on year)	 **Figure 6-2: National House Price Index for the period 2009 to 2019 (Statistics South Africa, 2020)**	The house price index is used to measure house prices and trends within a particular market. The house shows the trend in the South African house price index and indicates that the quarterly growth of the house price index in 2018 was 3,8 percent and declined to 3,6 percent in 2019, which potentially indicates slow growth in the national housing market.

Indicator	Trends	Implication
Inflation (Headline CPI – all urban areas)	 **Figure 6-3: Average Consumer Price Index for the period 2009 to 2019 (Statistics South Africa, 2020)**	The Headline CPI declined between 2018 and 2019, with the average CPI in 2018 measuring at 4.7 percent and 4,1 percent in 2019. The CPI is still within the SARB target of between 3.0 and 6.0 percent. Lower inflation rates can also contribute to more stabilised growth in house prices.

6.2 Study Area Housing Trends

This section provides an analysis of the residential market in Unitas Park. The analysis of the property trends in the study area include:

- Dwelling typology
- Tenure status
- Residential market stock
- Average house price
- Property ownership distribution

Dwelling types

Figure 6-4 illustrates the dwelling types in Unitas Park based on the Census 2011 data and indicates that the majority of the households in the study area primary reside in house or brick structure houses on a separate stand or yard (80%). The population also consists of a considerable percentage of households that reside in a house or flat in the backyard (17,6%)

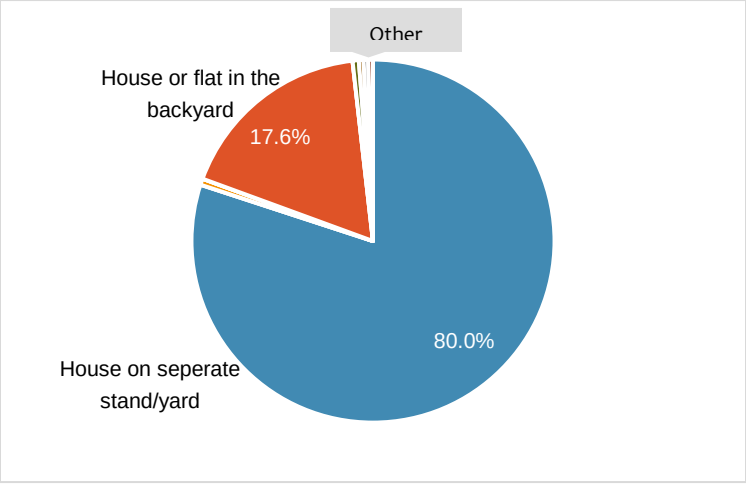


Figure 6-4: Dwelling type for Unitas Park in 2011 (Urban-Econ calculations based on Census data, 2011)

Tenure status

Figure 6-5 indicates that most of the households in Unitas prefer to own their homes as opposed to renting. Of the households that own their homes, 64,9% have not yet paid them off 64,9% while the remaining 22,6% have fully paid them off. There is a relatively minute number of households renting in the study area (8,9) as well as those who occupy homes without paying rent 2,8%.

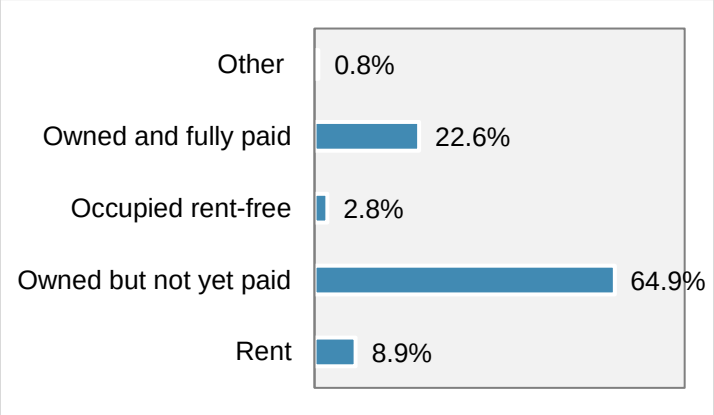


Figure 6-5: Tenure status in 2011
(Urban-Econ calculations based on Census data 2011)

Residential market stock

Figure 6-6 indicates that the housing stock in Unitas Park is predominantly freeholds (99,75%) with an insignificant supply of freeholds in estates (0,28%). The high prevalence of freehold units in the study area may be attributed to the benefits that accompany the ownership of a freehold property. Some of the benefits of owning a freehold property include independence; owners have the liberty to have full title ownership as well as freedom

to make improvements to their properties (such as renovations) without the need to get approval from a body corporate (Property24, 2017).

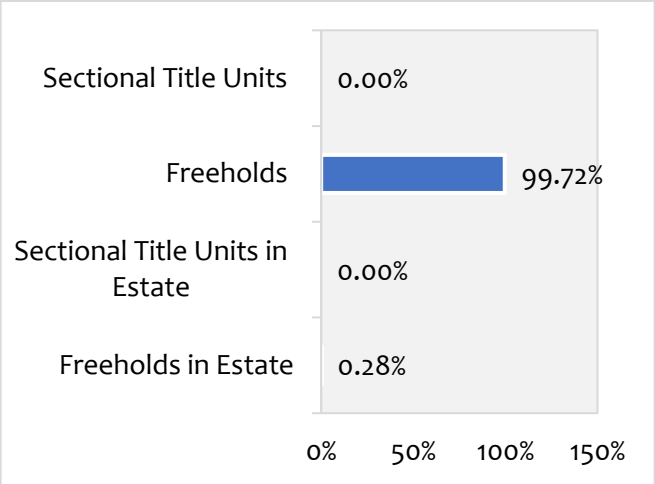
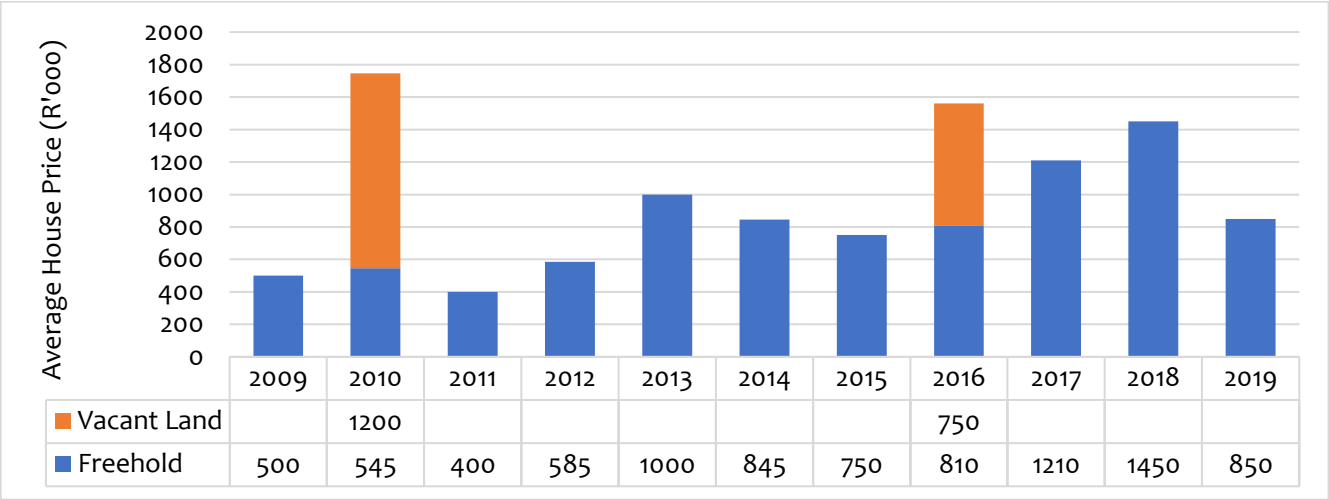


Figure 6-6: Residential market stock in Unitas Park
(Lightstone report, 2020)

Average house prices

Figure 6-7 below indicates the average house prices in Unitas Park for the available residential market stock. Average house prices indicate affordability, growth trends and the overall residential market in the study area. Evidently, freehold property dominates the housing market in the study area. Average house prices fluctuated within the ten-year period between 2009 to 2019. The only prices listed in the area are for freehold property

as well as vacant land, this shows the high prevalence of freehold property in Unitas Park. The average house price of freehold property in Unitas Park increased from R500 000 in 2009 to R850 000 in 2019.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Vacant Land		1200						750			
Freehold	500	545	400	585	1000	845	750	810	1210	1450	850

Figure 6-7: Median house prices (R' 000) 2009 – 2019 in Unitas Park (Lightstone report, 2020)

Property ownership distribution

Figure 6-8 below indicates the ownership, buying and selling trends in Unitas Park for the period January 2019 to December 2019. Stable property owners in the study area are predominantly pensioners 65 years and older while recent buyers are mature adults between the age of 50 and 64 years. The figure indicates that there has not been a record of pensioners who have bought property in the area between January 2019 to December 2019. On the other hand, mature adults, middle aged and young adults have been active in buying property. Conversely, recent property sellers have predominantly been pensioners (40%), mature adults (30%) and middle-aged individuals (30%), while young adults have not been active in selling property between January2019 to December 2019.

Figure 6-8: Property owner distribution in Unitas Park (Lightstone Report, 2020)

Figure 6-9 indicates the period of ownership for existing property owners and recent property sellers in the study area. Recent sellers and existing owners have had ownership of their properties for a significantly long period, i.e. 71% of recent sellers and 70% of existing property owners owned their property for 11 years and more.

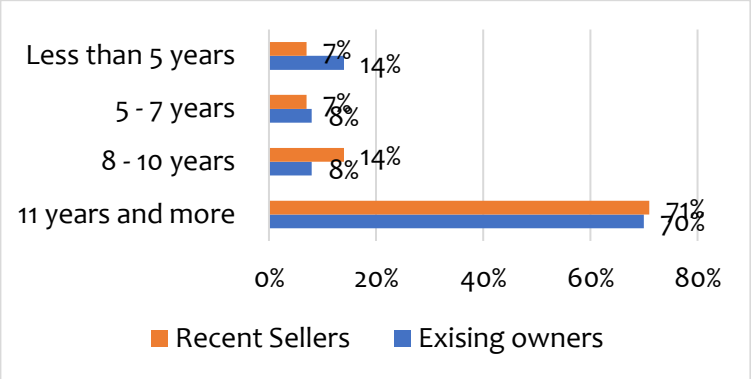


Figure 6-9: Period of ownership (Lightstone Report, 2020)

The property ownership distribution indicates that the residential market in the study area is primarily dominated by mature and older individuals. Although stable owners in the study area are older individuals, there is a relatively notable number of recent buyers who are young adults. Income levels as well as household compositions are some of the factors that may potentially influence the decision to purchase residential property. The proposed mixed high-density development may include single or bachelor units which may potentially attract demand from individuals who live on their own as well as those living in relatively large households.

7. IMPACT ANALYSIS

7.1 Introduction

This chapter presents the analysis of the socio-economic impacts that are expected to ensue as a result of the development of the proposed mixed high-density development and an evaluation of these impacts according to the predefined criteria. The assessment took a targeted approach towards the analysis of the potential impacts which are anticipated during the construction and the operational phase of the proposed mixed high-density development.

7.2 Preliminary Impact Assessment

7.2.1Identify potential impacts

The preliminary impacts of the proposed development are assessed and characterised as either positive or negative. The potential impacts that will potentially occur due to the proposed development are listed below:

- Stimulation of the local and regional economy
- Creation of temporal and sustainable employment opportunities
- Household income
- Demographic shift
- Impact on basic services
- Impact on the sense of place

7.3 Impact criteria and ratings

The various identified impacts are assessed based on the impact assessment criteria provided in Table 7.1 below:

Table 7.1: Impact Assessment Criteria

Severity
• Insignificant / non-harmful – **1** • Small / potentially harmful – **2** • Significant / slightly harmful – **3** • Great / harmful – **4** • Disastrous / extremely harmful / within a regulated sensitive area – **5**
Spatial scale
How big is the area that the aspect is impacting on? • Area specific (at impact site) – **1** • Whole site (entire surface right) – **2** • Local (within 5km) – **3** • Regional / neighbouring areas (5km to 50km) – **4** • National – **5**
Duration
• One day to one month (immediate): **1** • One month to one year (Short term): **2** • One year to 10 years (medium term): **3** • Life of the activity (long term): **4**

- Beyond life of the activity (permanent): **5**

Frequency of activity

How often is the specific activity done?

- Annually or less: **1**
- 6 months: **2**
- Monthly: **3**
- Weekly: **4**
- Daily: **5**

Frequency of impact

How often does the activity impact on the environment?

- Almost never / almost impossible / >20%: **1**
- Very seldom / highly unlikely / >40%: **2**
- Infrequent / unlikely / seldom / >60%: **3**
- Often / regularly / likely / possible / >80%: **4**
- Daily / highly likely / definitely / >100%: **5**

Legal issues

- No legislation: **1**
- Fully covered by legislation: **5**

Detection

How quickly/easily can the impacts/risks of the activity be detected on the environment, people, and property?

- Immediately: **1**
- Without much effort: **2**
- Need some effort: **3**
- Remote and difficult to observe: **4**
- Covered: **5**

Impact ratings

Each impact identified will be assessed in terms of scale (spatial scale), magnitude (severity) and duration (temporal scale). Consequence is then determined as follows:
Consequence = Severity + Spatial Scale + Duration

The Risk of the activity is then calculated based on frequency of the activity and impact, how easily it can be detected and whether the activity is governed by legislation. Thus: **Likelihood = Frequency of activity + frequency of impact + legal issues + detection**

The risk is then based on the consequence and likelihood.
Risk = Consequence x likelihood

Risk impact rating criteria:

- 1-55: Low (L) Risk
- 56-169: Medium (M) Risk
- 170-600: High (H) Risk

7.4 Impact Analysis

7.4.1 Construction phase

Demographic shift – influx of migrant workers

A demographic shift is anticipated to occur during the construction phase of the proposed development due to the influx of migrant workers who come from other areas looking for employment opportunities. The construction phase of the proposed development will attract those who are looking for job opportunities and may be willing to relocate to the area during the construction phase. The migrant workers may potentially remain during the operational phase of the development as they may anticipate permanent work opportunities including building management positions, security, cleaning and maintenance services. The influx of migrant workers into the area may potentially result to an increase of informal settlements or backyard houses and the overall increase in the population in the short and medium term.

Change in the sense of place

The activities that will take place during the construction phase of the proposed development such as the movement of construction vehicles, construction workers as well as the noise from the construction vehicles is anticipated to impact nearby residents. The proposed development is expected to affect the activities on the road and result in the obstruction of roads, driveways and walkways with the movement of construction vehicles and construction workers and will potentially impact the flow of traffic in the study area.

Stimulation of the local and regional economy

The proposed mixed high-density development is anticipated to have a positive impact on the local and regional economy. Business transactions that are anticipated to take place during the construction phase such as the purchase of building materials and equipment from local producers as well as outsourcing are anticipated to boost local businesses. It is anticipated that the proposed development will require the movement of goods, may attract labours from other areas who may potentially require accommodation and therefore, local and regional economic sectors such as the construction, transport and wholesale and retail trade sectors are anticipated to be positively impacted by the proposed development. The following are the broad activities that are anticipated to result in the simulation of the local and regional economy

- Growth in business activity
- Increased private investment
- Increase in household income- increased spending on goods and services which will result to the flow of money back into the economy through the multiplier effect.

Creation of temporary employment opportunities

The proposed development is anticipated to result in the creation of **direct**, **indirect** and employment opportunities. Direct employment opportunities are anticipated to occur through the employment of construction workers, and this is anticipated to be short term or last until the construction phase is complete. The development is anticipated to attract a pool of skilled, semi-skilled labour in the local area and is expected to result in the transfer of skills during the construction phase.

Additional activities during the construction phase such as transactions with building material suppliers will potentially create indirect job opportunities, as suppliers are expected to potentially hire additional factory workers as well as equipment and material producers due to the demand for building equipment.

Household income

The temporal employment opportunities created during the construction phase will provide households with income. The disposable income will enable households to have access to retail goods and services such as educational and medical services. The wage and salary levels are to be competitive and take consideration of the skills levels of the employed construction workers.

7.4.2 Operational phase

Demographic shift - immigration of middle-income households during operations

The proposed development is anticipated to attract middle-income households into the area during the operational phase of the proposed development. The demographic shift may result in an increased demand for the proposed mixed high-density units as the middle-income households who have the means to pay rent may choose to reside in the proposed mixed high-density units. The demographic shift is also anticipated to result in the growth of the local economy as the middle-income households are expected to spend their disposable income on goods and services.

Service delivery and infrastructure upgrades

Activities that are anticipated to take place include the upgrading of roads, water, electricity, sewer, and storm water systems. The service delivery upgrades will be to ensure that there is adequate access to services for the demographic shift that will occur as a result of the proposed development.

Change in the sense of place

The proposed development is a mixed high-density development, and this may potentially obstruct the view of the residence. The sense of place may also be impacted by potential noise, vagrants outside the premises as well as illegal parking.

Stimulation of the local and regional economies through direct and multiplier effects

Employment that will created from the proposed development will result in an increase in the demand for goods and services as households will have access to disposable income. The increase in consumption expenditure will contribute to the growth of the local and regional economies. The investment created from increased business activities is also anticipated to contribute to the stimulation of the local economy. The table below indicates the impact rating of the anticipated direct net regional economic gain in production and GDP during the operational phase of the proposed development.

Creation of sustainable employment opportunities-direct, indirect and induces employment opportunities

Direct employment creation during the operational phase of the development is anticipated to be sustainable and the duration is anticipated to be longer than the employment created during the construction phase. The following activities are anticipated to create direct employment opportunities during the operational phase

- Cleaning and maintenance of the buildings
- Safety and security
- Building management

Indirect employment creation will occur though the transactions between suppliers for services. Such services may be outsourced from external companies and may provide those companies to hire more employees to produce the supplies or offer the needed services. These services may include:

- Cleaning material suppliers
- Security services

Induced employment creation will be created through retail jobs that will be created as those who are employed during the operational phase of the development will spend their disposable income on goods and services. The increase in business sales may potentially create and an incentive for retail stores to employ more workers.

Access to household income

Workers who are employed in the development during the operational phase will have access to disposable income and this is anticipated to have a positive social and economic impact. Households will have the means to purchase goods and services such as food, clothing, medical services and educational services. Households are therefore anticipated to have an improved standard of living.

Potential impact description	Phase	Environmental Significance before and after mitigations							Impact rating	Significance rating	Proposed mitigation measures Management and mitigation measures
		Consequence			Likelihood						
		Severity	*Spatial*	*Duration*	*Frequency activity*	*Frequency impact*	*Legal issues*	*Detection*			
Demographic shift- influx of migrant workers	Construction phase	2	3	4	1	4	1	4	90	Before mitigations (M)	• Prioritise employment of construction workers coming from the nearby residential settlements • Ensure the transfer of skills. Highly skilled construction workers must collaborate with low to medium skilled workers in order to facilitate the skills sharing and transfer process. • Establish skills desks in Unitas Park to identify the labour force with the correct skills that could be employed immediately or could be trained for specific positions during construction
		1	3	4	1	4	1	4	80	After mitigations (M)	
Change in the sense of place	Construction phase	3	2	4	1	4	1	1	63	Before mitigations (M)	• Create strict controls on the roads leading to the facility and prevent people from parking on the side of the roads, driveways, and other public areas that may inconvenience other road users and cause traffic congestion. • Vehicles should be towed away if parked in the non-designated areas and such practices should be made abundantly clear among the construction workers and construction managers to avoid unnecessary conflicts. • There are however limited mitigative measures that can be taken to mitigate the potential noise impacts that may arise from the construction, such as the sound of the building machinery and equipment. • The construction of the development should take place during the day when most of the residents in the area are anticipated to be at school or work or occupied by other activities.
		2	**2**	**4**	**1**	**4**	**1**	**1**	56	After mitigations (M)	
Stimulation of the local and	Construction phase	3	4	4	5	5	5	4	209	Before mitigations (H)	• Utilise domestically produced building material and equipment

Potential impact description	Phase	Environmental Significance before and after mitigations							Impact rating	Significance rating	Proposed mitigation measures Management and mitigation measures
		Consequence			Likelihood						
		Severity	*Spatial*	*Duration*	*Frequency activity*	*Frequency impact*	*Legal issues*	*Detection*			
regional economy		4	4	4	5	5	5	4	228	After mitigation (H)	• Prioritise the procurement of goods and services from the local SMMEs and particularly SMMEs located in the study area.
Creation of temporary employment opportunities	Construction phase	3	4	4	4	4	5	3	172	Before mitigations (H)	• Prioritise employment of construction workers coming from the nearby residential settlements particularly those in the primary market area. • Establish skills desks in Unitas Park Extension 16 to identify the labour force with the correct skills that could be employed immediately or could be trained for specific positions during construction.
		4	4	4	4	4	5	3	192	After mitigations (H)	
Impact on household income	Construction phase	4	4	4	4	4	5	4	208	Before mitigations (H)	• The labourers employed during the construction and the operational phase must be given a contract that stipulates the required hours of work as well as the pay rate/wage or salary amount. • The contract of employment should stipulate the duration of employment (temporal or permanent) depending on the phase of the development. • The salary must be competitive or adhere to the minimum wage standards.
		4	4	4	4	4	5	4	208	After mitigations (H)	
Demographic shift - immigration of middle-income households during operational phase	Operational phase	3	3	4	1	3	1	4	80	Before mitigations (M)	None
		3	3	4	1	3	1	4	80	After mitigations (M)	

Potential impact description	Phase	Environmental Significance before and after mitigations							Impact rating	Significance rating	Proposed mitigation measures Management and mitigation measures
		Consequence			Likelihood						
		Severity	*Spatial*	*Duration*	*Frequency activity*	*Frequency impact*	*Legal issues*	*Detection*			
Service delivery and infrastructure upgrades	Operational phase	3	4	5	1	4	5	2	156	Before mitigations (M)	• Ensure that the bulk of services that will occur as a result of the project will be extended to the primary communities (Sebokeng, Falcon Ridge, Arcon Park and Unitas Park) as well as the secondary areas (Evaton and Bophelong) • Ensure that the road conditions are improved and necessary expansion of the road networks (additional lanes) are made to avoid worsening the road congestion in the area particularly during peak hours • Upgrade the stormwater infrastructure in the area to benefit existing residents as wells as those who will occupy the proposed development
		3	4	5	1	4	5	2	156	After mitigations (M)	
Change in the sense of place	Operational phase	3	3	5	5	4	1	2	132	Before mitigation (M)	• Ensure that the parking capacity on site is adequate to accommodate the number of people in the development • Ensure that the facility is designed in such a way as to limit any noise pollution outside its site, as well as noise pollution that can reach the commercial and other sections surrounding the site • Ensure that the facility and its surrounding developments have adequate security and that it is visible to any onlooker as a preventative measure • Ensure that no people are allowed to sleep on the roads leading to the facility as well as on site itself • The proposed development is anticipated to be high-density. The height of the development may obstruct some of the residents' exposure to the sun and certain views. There are however no mitigation measures that can be taken to avoid such an impact
		3	3	5	5	4	1	2	132	After mitigations (M)	

Potential impact description	Phase	Environmental Significance before and after mitigations							Impact rating	Significance rating	Proposed mitigation measures Management and mitigation measures
		Consequence			Likelihood						
		Severity	*Spatial*	*Duration*	*Frequency activity*	*Frequency impact*	*Legal issues*	*Detection*			
Stimulation of the local and regional economy through the multiplier effect	Operational phase	3	4	4	5	5	5	4	209	Before mitigations (H)	• Prioritise the procurement of goods and services from the local SMMEs and particularly SMMEs located in the study area
		4	4	4	5	5	5	4	228	After mitigations (H)	
Creation of sustainable employment opportunities	Operational phase	4	4	4	5	5	5	2	204	Before mitigation (H)	• Establish relationships with local businesses/SMMEs and purchase building material from local businesses to increase business activity and profits which will provide an incentive for businesses to hire more workers • Establish skills desks in Unitas Park Extension 16 to identify the labour force with the correct skills that could be employed immediately or could be trained for specific positions during operation. • Create employment opportunities for labours with different skills set and incorporate labour intensive components during the construction phase which will provide employment opportunities and the inclusion of low-skilled labour.
		4	4	4	5	5	5	2	204	After mitigations (M)	
Impact on household income	Operational phase	3	4	4	3	4	5	2	154	Before mitigation (M)	• The labourers employed during the operational phase must be given a contract that stipulates the required hours of work as well as the pay rate/wage or salary amount. • The contract of employment should stipulate the duration of employment (temporal or permanent) during the operational phase of the proposed development. • The salary must be competitive or adhere to the minimum wage standards.
		4	4	4	3	4	5	2	168	After mitigations (M)	

8. CONCLUSION

The proposed mixed high-density development is anticipated to yield more positive socio-economic impacts than negative. The proposed development aligns with national, provincial and local policies and strategies in the promotion of broader objectives and goals for spatial integration, inclusivity and the creation of employment opportunities and the stimulation of economic growth. Employment creation, the simulation of the local and regional economy as well as access to household income are key benefits that the proposed development is anticipated to yield. The utilisation of the site for a mixed high-density development is anticipated to yield positive economic and social benefits than its current use, as it is currently vacant. Overall, the anticipated positive impacts outweigh the anticipated negative impacts more so with mitigative measures put in place to enhance the positive impacts as well as to minimise the negative impacts. The following are some of the key mitigative measures recommended:

- Prioritise employment of construction workers from nearby areas and ensuring the transfer skills
- Create strict controls on the roads leading to the facility and prevent people from parking on the side of the roads, driveways, and other public areas that may inconvenience other road users and cause traffic congestion
- Vehicles should be towed away if parked in the non-designated areas and such practices should be made abundantly clear among the construction workers and construction managers to avoid unnecessary conflicts
- The construction of the development should take place during the day where most of the residents in the area are anticipated to be at school or work or occupied by other activities. No construction activities are anticipated to take place during the day
- Utilise domestically produced building material and equipment and prioritise the procurement of goods and services from the local SMMEs
- Prioritise local people for employment opportunities
- Provide contracts that stipulates the required hours of work as well as the pay rate/wage or salary amount for labour during construction and operational phase
- Employment contrasts should stipulate the duration of employment (temporal or permanent) depending on the phase of the development and the salary must be competitive or adhere to the minimum wage standards
- Ensure adequate parking on site to accommodate the number of people in the development.

Table 8.1: Summary of potential impact significance before and after mitigations

Impact	Status before mitigations	Significance after mitigations
Change in the sense of place	Construction phase: Moderate (63) Operational phase: Moderate (132)	Construction phase: Moderate (56) Operational phase: Moderate (132)
Residential shifts due to residential development	Construction phase: Moderate (90) Operational phase: Moderate (80)	Construction phase: Medium (80) Operational phase: Medium (80)
Stimulation of the local and regional economy	Construction phase: High (209) Operational phase: High (209)	Construction phase: High (228) Operational phase: High (228)
Creation of temporal and permanent employment opportunities	Construction phase: High (192) Operational phase: Moderate (204)	Construction phase: (228) Operational phase: (204)
Impact on household income	Construction phase: High (208) Operational phase: Moderate (154)	Construction phase: (208) Operational phase: Moderate (168)

Impact	Status before mitigations	Significance after mitigations
Service delivery and infrastructure upgrades	Operational phase: Moderate (156)	Operational phase: Moderate (156)

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APPENDIX B8

Traffic Impact and Access Study

TRAFFIC IMPACT & ACCESS STUDY REPORT
UNITAS PARK EXTENSION 16- FINAL REPORT

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CONFIGURATION CONTROL

Project: Proposed Mixed Use Unitas Park Extension 16

Title: Traffic Impact & Access Study for Proposed Mixed Use Residential development Unitas Park Extension 16 Situated on Portion 222 of the farm Houtkop 594-IQ (SG Diagram 7423/2008). Portion 222 of the farm Houtkop 594-IQ is in the process of subdivision and will be known as Portion 225 (a portion of 222) of the farm Houtkop 594-IQ (Subdivision Diagram 4362/2009) in the Emfuleni Local Municipality.

Created by: Sikelela Mnguni *(Pr.Tech.Eng)*

REVISION RECORD

Revision	Date	Compiled	Saved as	Project Minutes
A0	07 July 2020	Sikelela Mnguni *(Pr.Tech.Eng)*	Proposed Unitas Park Extension 16 *TIA RT. A1*	None
A1	02 November 2020	Sikelela Mnguni *(Pr.Tech.Eng)*	Proposed Unitas Park Extension 16 *TIA RT. A1*	None

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DECLARATION

It is herewith certified that this Traffic Impact & Access Study for Proposed Mixed Use Residential development Unitas Park Extension 16 Situated on Portion 222 of the farm Houtkop 594-IQ (SG Diagram 7423/2008). Portion 222 of the farm Houtkop 594-IQ is in the process of subdivision and will be known as Portion 225 (a portion of 222) of the farm Houtkop 594-IQ (Subdivision Diagram 4362/2009) in the Emfuleni Local Municipality has been prepared according to requirements of the South African Traffic Impact and Site Traffic Assessment Manual.

Prepared : Sikelela. Mnguni (*Pr.Tech. Eng-201170212*)

Signed:

Date: 02 November 2020

Clients Approval :

Signed:

Date:

TRAFFIC IMPACT & ACCESS STUDY FOR PROPOSED MIXED USE RESIDENTIAL DEVELOPMENT UNITAS PARK EXTENSION 16 SITUATED ON PORTION 222 OF THE FARM HOUTKOP 594-IQ (SG DIAGRAM 7423/2008). PORTION 222 OF THE FARM HOUTKOP 594-IQ IS IN THE PROCESS OF SUBDIVISION AND WILL BE KNOWN AS PORTION 225 (A PORTION OF 222) OF THE FARM HOUTKOP 594-IQ (SUBDIVISION DIAGRAM 4362/2009) IN THE EMFULENI LOCAL MUNICIPALITY

TABLE OF CONTENTS

Chapter	Description		Page
1	INTRODUCTION		**4**
	1.1	Background	4
	1.2	Approval of Submission	4
2	DEVELOPMENT DETAILS		**5**
	2.1	Locality	5
	2.2	Development and Property Particulars	5
3	STUDY AREA		**6**
	3.1	The extent of the Study Area	6
	3.2	The planned or proposed major development	6
4	PLANNED FUTURE ROADS, RAIL NETWORK & PUBLIC TRANSPORT		**7**
	4.1	Planned future roads	7
	4.2	Rail Network	9
	4.3	Public Transportation	10
5	EXISTING AND PROPOSED ACCESS TO THE DEVELOPMENT		**14**
	5.1	Existing Major Access	14
	5.2	Proposed Access	15
6	TRAFFIC FLOWS & DEVELOPMENT TRIPS		**15**
	6.1	Existing Traffic Flows	15
	6.2	Traffic Evaluation	16
	6.3	Development Trip Generation and Traffic Volume Scenario-Adjusted Factors	17
	6.4	Mixed-use Developments (MUD)	17

	6.5	LOW VEHICLE OWNERSHIP (LVO) & VERY LOW VEHICLE OWNERSHIP (VLVO)	17
	6.6	TRANSIT NODE OR CORRIDORS	18
	6.7	TRIP SUMMARY	18
	6.8	GROWTH RATE	19
	6.9	Total Future Traffic Flows with Development	20
	6.10	Trip Distribution and Assignment	20
7		**TRAFFIC IMPACT AND CAPACITY ANALYSIS**	**20**
	7.1	General	20
	7.2	2020 Background Scenario Without Development	21
	7.3	2025 With Development Scenario	26
8		**ACCESS**	**32**
	8.1	General	32
9		**PARKING PROVISION**	**33**
10		**NON-MOTORISED & PUBLIC TRANSPORT FACILITIES**	**34**
	10.1	Pedestrian Facilities	34
	10.2	General	35
11		**ROAD UPGRADES HIGH-LEVEL COST ESTIMATES**	**36**
12		**CONCLUSION AND RECOMMENDATION**	**37**
13		**REFERENCES**	**39**

LIST OF ANNEXURES

ANNEXURE A

- TRIP GENERATIONS

ANNEXURE B: BOOK OF DRAWINGS

- LOCALITY MAP-FIGURE PH_001
- PROPOSED DRAFT LAYOUT OF THE DEVELOPMENT-FIGURE PH_002
- FUTURE K-ROUTE AND PWV ROUTE MASTER PLAN-FIGURE PH_003
- PUBLIC TRANSPORTATION AND PROPOSED IRPTN ROUTES-FIGURE PH_004 & FIGURE PH_004a
- ACCESS POINTS TO THE DEVELOPMENT & COUNTING STATIONS -FIGURE PH_005
- 2020 AM & PM PEAK BACKGROUND VOLUMES -FIGURE PH_006
- 2025 AM & PM PEAK BACKGROUND + DEVELOPMENT VOLUMES -FIGURE PH_007

1 INTRODUCTION

1.1 Background

Phumaf Holdings (Pty) Ltd has been appointed by Gauteng Province Human Settlement to complete the Traffic Impact & Access Study for Proposed Mixed Use Residential development Unitas Park Extension 16 Situated on Portion 222 of the farm Houtkop 594-IQ (SG Diagram 7423/2008). Portion 222 of the farm Houtkop 594-IQ is in the process of subdivision and will be known as Portion 225 (a portion of 222) of the farm Houtkop 594-IQ (Subdivision Diagram 4362/2009) in the Emfuleni Local Municipality.

The site is well-connected on a regional scale. To the south is Houtkop Road (R54), to the south-west is the R28 and to the east is the R59 (Old Johannesburg Road). The proposed PWV 20 runs to the west of the site and the proposed K55 abuts the site on its eastern boundary.

On a more local level, the extension of Houtkop Road, Skippie Botha Road, and Langrand Road provides connectivity to the north, east, and west. As shown in the locality plan indicated in Figure PH_001 as shown in the book of drawings.

The development consists of the following land use:

- Proposed Mixed Use Residential Development

The purpose of this report is to assess the traffic impact at surrounding intersections, due to the additional traffic that the development will generate together with measures to mitigate the impact.

1.2 Approval of Submission

This report will be subject to approval from the relevant roads authorities. This report will be submitted to the following roads authorities for approval:

- Emfuleni Local Municipality (ELM)
- Gauteng Department of Roads and Transport (GDRT)

2 DEVELOPMENT DETAILS

2.1 Locality

The site is well-connected on a regional scale. To the south is Houtkop Road (R54), to the south-west is the R28 and to the east is the R59 (Old Johannesburg Road). The proposed PWV 20 runs to the west of the site and the proposed K55 abuts the site on its eastern boundary.

On a more local level, the extension of Houtkop Road, Skippie Botha Road, and Langrand Road provides connectivity to the north, east, and west. As shown in the locality plan indicated in Figure PH_001 as shown in the book of drawings.

2.2 Development and Property Particulars

The development particulars of the Proposed Mixed Use Residential Development Unitas Park Ext. 16 are summarized in Table 1.

TABLE 1: PROPOSED MIXED USE RESIDENTIAL DEVELOPMENT UNITAS PARK EXTENSION 16 SITUATED ON PORTION 222 OF THE FARM HOUTKOP 594-IQ (SG DIAGRAM 7423/2008). PORTION 222 OF THE FARM HOUTKOP 594-IQ IS IN THE PROCESS OF SUBDIVISION AND WILL BE KNOWN AS PORTION 225 (A PORTION OF 222) OF THE FARM HOUTKOP 594-IQ (SUBDIVISION DIAGRAM 4362/2009) IN THE EMFULENI LOCAL MUNICIPALITY	
Name of the Applicant	GAUTENG PROVINCE HUMAN SETTLEMENT 37 Sauer Street Marshalltown JOHANNESBURG 2001 Tel: +27 (0)11 355 6000 Fax: +27 (0)11 355 6211
Name of the Development	Proposed Mixed Use Residential development Unitas Park Extension 16 Situated on Portion 222 of the farm Houtkop 594-IQ (SG Diagram 7423/2008). Portion 222 of the farm Houtkop 594-IQ is in the process of subdivision and will be known as Portion 225 (a portion of 222) of the farm Houtkop 594-IQ (Subdivision Diagram 4362/2009) in the Emfuleni Local Municipality

The proposed layout of the development for Proposed Mixed Uses Residential Development Unitas Park Ext. 16 is shown in (Figure PH_002 as shown in the book of drawings).

3 STUDY AREA

3.1 The extent of the Study Area

The extent of the study area is determined by the extent of the expected additional traffic that may be generated by the proposed development.

The guideline document **"Manual for Traffic Impact Studies"** of the **Department of Transport** was used to determine the different scenarios and the extent of the study area.

The site is well-connected on a regional scale. To the south is **Houtkop Road (R54),** to the south-west is the **R28** and to the east is the **R59 (Old Johannesburg Road).** The proposed **PWV 20** runs to the west of the site and the proposed **K55** abuts the site on its eastern boundary.

On a more local level, the extension of **Houtkop Road**, **Skippie Botha Road,** and **Langrand Road** provides connectivity to the north, east, and west. As shown in the locality plan indicated in **Figure PH_001 as shown in the book of drawings**.

3.2 The planned or proposed major development

Planned or proposed major developments and land-uses in the area have been taken into consideration and these include the following:

a) Approved but not yet implemented developments;
b) Land with potential or latent lands that have been taken into account.

At the time of doing this study, no latent development rights were received from the Emfuleni Local Municipality Planning Department.

4 PLANNED FUTURE ROADS, RAIL NETWORK & PUBLIC TRANSPORT

4.1 Planned future roads

Movement patterns provide an understanding of how an area functions because it illustrates the spatial relationships between settlements and core areas (employment and shopping areas) and the linkages that exist between such spatial entities.

The Schematic PH_001 shows the movement of people within Emfuleni and between Emfuleni and the neighbouring municipal areas. Six primary core areas are located within and close to Emfuleni. Movement within Emfuleni largely occurs within a triangle, anchored by the core areas of Vanderbijlpark, Vereeniging, and Sebokeng. Movements between Emfuleni and neighbouring municipal areas occur along three axes. The first axis is located between Vereeniging and Sebokeng towards Lenasia and Johannesburg. The second axis is located between Vanderbijlpark, Vereeniging, and Meyerton towards Ekurhuleni. The third axis is located between Sebokeng, Vanderbijlpark, and Sasolburg.

Schematic PH_001 MOVEMENT AXIS

A strong movement of people occurs between Vanderbijlpark, Vereeniging, and Meyerton towards Johannesburg along the P156 freeway. A strong movement also occurs between Sebokeng and Johannesburg, especially during morning and afternoon peak hours, as commuter access employment opportunities in Johannesburg and surrounding areas. A strengthening of movement in the future can be expected between Vereeniging and Sebokeng, as urban development and densification occur along this corridor. Movement along the corridor between Vereeniging, Sebokeng, and Johannesburg is supported by the existing commuter railway line

The South African Road Classification and Access Management Manual is an official road planning document supported by SANRAL and the National Department of Transport (NDOT). According to the South African Road Classification and Access Management Manual, the road hierarchy within South Africa functions on 5 levels. The first level contains freeways, consisting of national freeways and provincial PWV roads and these are classified as Class 1 roads. These roads provide regional access, connecting an area to neighbouring cities and towns. The second and third levels comprise major and minor arterials (or K-routes), which aim to provide better intra-urban access between suburbs and activity areas. These are classified as Class 2 and 3 roads. The fourth level comprises collector roads, which are classified as Class 4 roads. These roads connect residential areas to the mentioned arterial network. On the fifth level, local streets provide direct access to land uses and link these land uses to the mentioned collector roads. These are classified as Class 5 roads.

In essence, freeways and arterials are highly mobile and therefore aim to connect people over large distances to activity areas and neighbouring settlements. Collector roads and local streets provide good accessibility and therefore aim to connect people and land use to more mobile roads. Road-based public transport systems (minibus taxis and busses) mostly use arterials and collector roads, because these provide an efficient balance between mobility and land use accessibility.

Figure PH_004 & 004a in the book of drawings depicts the road network serving Emfuleni area. The N1 freeway passes through the centre of Emfuleni, linking Emfuleni to Johannesburg and Soweto. The primary role of this freeway is to link Gauteng Province to the Free State Province and the Western Province and therefore fulfills a through-traffic function, rather than serving Emfuleni specifically. The P156 freeway, on the other hand, primarily serves Emfuleni, linking Vanderbijlpark and Vereeniging to Ekurhuleni and the OR Tambo International Airport. Due to its function, corridor development is increasingly occurring along the P156 freeway, especially in the Vereeniging and Meyerton areas. The P156 freeway is located on the eastern boundary of Emfuleni.

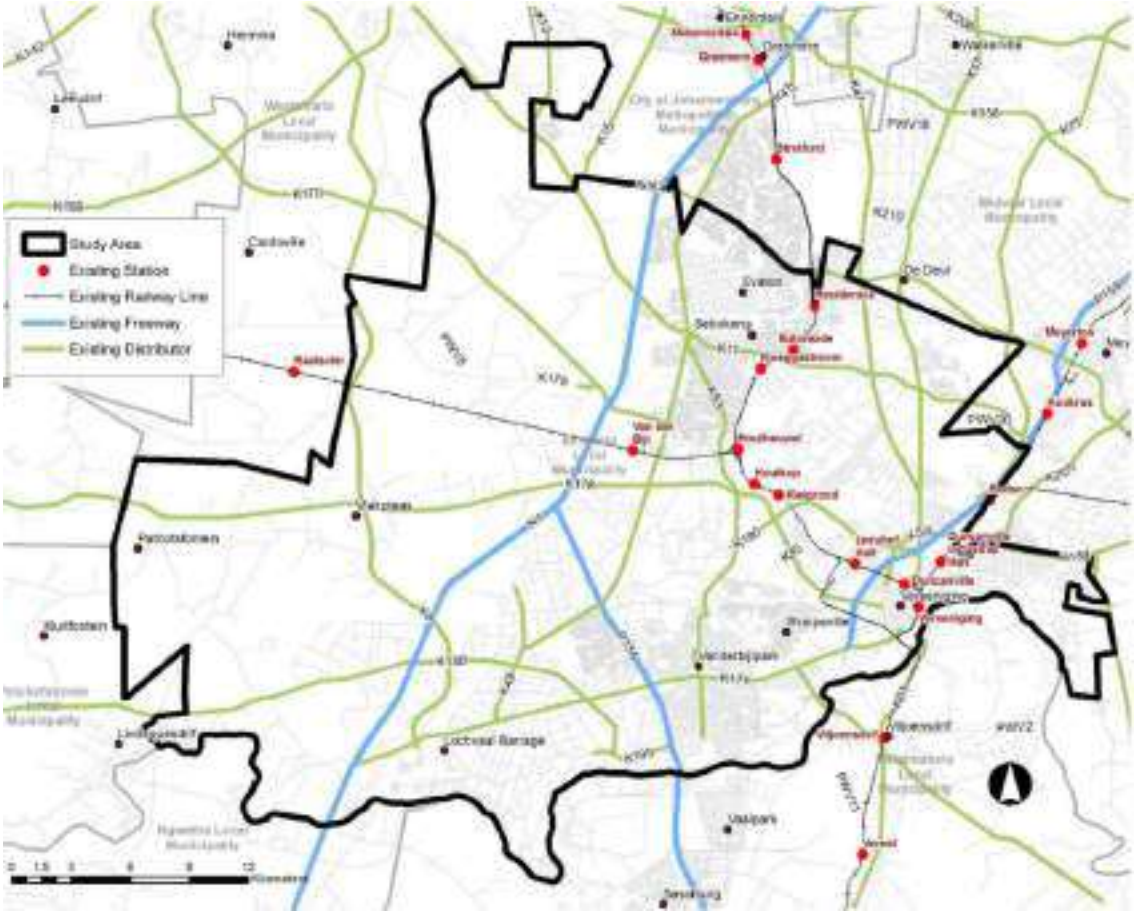
Most of Emfuleni's planned K-route network has been developed, although not all the K-routes have been developed to a dual carriageway level. Many of the K-routes are also in need of rehabilitation, especially K-routes such as the K174 (Barrage Road). Despite this, the complete K-route network allows urban infill and expansion to take place in almost any part of Emfuleni, providing the access infrastructure needed for urban development. Four K-routes can be highlighted as prominent K-routes serving Emfuleni. The first is the K53 (Moshoeshoe Road that becomes the Golden Highway), which runs between Vanderbijlpark and Sebokeng. This is an important commuter spine serving Emfuleni. The second K-route worth mentioning is the K174 (Barrage Road), linking Vanderbijlpark to Vereeniging. This road is a gateway route into Emfuleni and the Municipality is thus concerned over the type of development that take place along this route. The K178 links Sebokeng to Vereeniging and the shopping and employment opportunities found within Vereeniging. This K-route is expected to become a major commuter spine, as urban development intensifies along this route. The fourth K-route is the K164, which links Evaton to Meyerton. Savanna City (a 14000-residential unit development) will be situated on and have access from the K164, which will increase the prominence of this K-route.

Figure PH_003 in the book of drawings depicts The proposed PWV 20 runs to the west of the site and the proposed K55 abuts the site on its eastern boundary.

4.2 Rail Network

Emfuleni is served by a rail network that connects Emfuleni to neighbouring areas in Gauteng and the Free State. As depicted in Schematic PH_002, this rail network consists of 3 lines. The first rail line stretches along with the P156 (R59) freeway and links Sasolburg to Vereeniging, Meyerton, and Germiston. This rail line is primarily a freight line but does contain commuter railway stations along the line. The second railway line stretches from Sasolburg, via Vereeniging towards Sebokeng, Orange Farm, and Johannesburg.

This railway line also functions as a freight railway line, although it also
fulfills a significant commuter railway line function. The third railway line stretches from Sebokeng towards Westonaria. This railway line is exclusively used for rail freight purposes.



Schematic PH_002: RAIL NETWORK

Emfuleni is served by a commuter rail network that connects Emfuleni to neighbouring areas in Gauteng. This commuter rail network consists of 2 lines. The first rail line stretches from Vereeniging to Meyerton towards Germiston. This commuter railway line contains commuter railway stations, with prominent stations being the Vereeniging Station, the Duncanville Industrial Halt Station, and the Meyerton Station. The use of this railway line as a commuter railway line is limited due to fragmented urban development and low residential densities along this railway line. The second commuter railway line stretches from Vereeniging towards Sebokeng, Orange Farm, and Johannesburg. Prominent stations along this line are Houtheuwel Station, Residentia Station, and Stretford Station. This railway line traverses densely built-up urban areas, as is found in Sebokeng and Orange Farm, and it, therefore, fulfills a significant commuter railway line function.

4.3 Public Transportation

Emfuleni comprises an extensive bus network that serves the municipal area. A prominent bus route is the bus route linking Vereeniging to Sebokeng along with the K53 (Moshoeshoe Road) and the K45 (Golden Highway). This bus route links Evaton and Sebokeng to the Vereeniging CBD and the industrial areas located within Vereeniging. Other bus routes worth mentioning are the bus route linking Vereeniging to Meyerton, the bus route linking Vereeniging to Residentia Station, and the Bus route linking Evaton to Meyerton. Linking the bus network to the commuter rail network will enable the bus network to act as a feeder system to the commuter rail network. This will give Emfuleni access to an integrated hierarchy of public transport modes servicing different parts of the municipal are and it will greatly improve the current public transport network serving Emfuleni.

Emfuleni comprises an extensive minibus taxi network. This network largely uses the same routes and serves the same areas within the municipal area that the bus network does. The only significant exception is that a minibus taxi route links the Vanderbijlpark CBD to Sebokeng via Mittal Steel; a route that the bus network does not serve. A disadvantage of the minibus taxi network is that the routes of this network are not fixed and can, therefore, change in the future. Therefore, the minibus taxi route does not indicate fixed locations where Emfuleni can develop. Bus routes and in particular commuter railway lines provide a much better indication of where to densify Emfuleni.

Developing Emfuleni's transportation infrastructure is dealt with in terms of the road network and public transport network. Whereas the road network primarily refers to provincial and metropolitan roads, the public transport network refers to the public transport routes and stations that make up the transportation network. Figure PH_005 in the book of drawings illustrates the transportation infrastructure development proposals made for Emfuleni.

Emfuleni is a municipality with a population nearing 1 million people. In other words, Emfuleni is becoming a metropolitan area. It is, therefore, necessary that Emfuleni starts positioning itself for this responsibility. A key function of a metropolitan area is to provide public transport of a high standard to support its metropolitan population. Emfuleni thus needs to start identifying its public transport routes, so that it can start shaping its land-use structure (which takes time) to serve this public transport network. To this end, Emfuleni can proactively promote public transport by (a) engaging with PRASA to further develop the Vereeniging-Johannesburg commuter railway line (especially concerning station development) and (b) identify and develop a Strategic Public Transport Network (SPTN) to serve urban areas within Emfuleni that are not served by the Vereeniging-Johannesburg commuter railway line.

Emfuleni is served by a commuter rail network that connects Emfuleni to neighbouring areas in Gauteng. Prominent station along this line is Houtheuwel Station, Residentia Station, and Stretford Station. Currently, the use of this railway line as a commuter railway line is limited due to fragmented urban development and low residential densities along this railway line. Urban development along the Vereeniging-Sebokeng-Orange Farm commuter railway line will provide the necessary commuter thresholds needed to ensure the viable operation and expansion of this commuter railway line.

Concerning further developing the Vereeniging-Johannesburg commuter railway line, it is proposed the 2 new stations are developed along this line to better serve envisaged urban expansion areas within Emfuleni. The first proposed station is located at the proposed Sonlandpark Regional Node and will serve the Sonlandpark and Boipatong areas. The second proposed station is located north of Houtheuwel Station and will better serve the envisaged Lethabong extensions. The additional stations along this commuter rail line will provide opportunities for Transit-Oriented Development (TOD). This will involve focusing on new higher density, mixed-use development around these commuter rail stations. The layout of the land uses concerning the stations are of critical importance, because it will determine the level of access that commuters will have to these stations. It should be noted that the station proposals above area Emfuleni SDF proposals and not PRASA proposals at this stage.

In addition to the above, a Strategic Public Transport Network (SPTN) is proposed by the Emfuleni SDF that will serve urban areas within Emfuleni that are not served by the Vereeniging-Johannesburg commuter railway line. Two SPTN routes have been identified. The first route links Vereeniging to Sebokeng along the K53 (Moshoeshoe Road) and the K45 (Golden Highway), and then turns eastward at Evaton towards Residentia Station. This SPTN route links Evaton and the Sebokeng CBD to the Vereeniging CBD. This route can be extended southwards across the Vaal River up to Sasolburg. The second SPTN route utilizes Barrage Road (K147) and links the Vanderbijlpark CBD, the Bedworthpark Regional Node, the proposed River City Node, the Vereeniging CBD, and the Three Rivers Node. This route can be extended northeastwards up to Meyerton.

It is important to note that where an SPTN route utilizes a K-route (arterial), flexible, public transport oriented design parameters will be required, especially where this route traverses or abut an activity node. For example, pedestrian crossing and accesses will have to be addressed differently within such sections of the SPTN route. Also, the development of the SPTN route can already at this stage be planned to accommodate higher-order road-based public transport systems in the future, such as the Bus Rapid Transit (BRT) system. The implementation of a BRT system can then be phased over time. The following phasing will most probably be logical:

- Phase 1: Design SPTN routes to allow the long-term implementation of the BRT system
- Phase 2: Start operating municipal system on SPTN route
- Phase 3: Construct major BRT stations at regional nodes
- Phase 4: Start operating BRT system
- Phase 5: Construct minor BRT stations at other locations along SPTN route
- Phase 6: Construct dedicated BRT lanes

Having a longer-term view of public transport network development will enable municipal planners to develop a land-use structure that can support the envisaged public transport network in the future. Municipal planners can promote the development of activity nodes at commuter railway stations and envisaged SPTN/BRT stations that would (a) apply higher land use densities, (b) a greater land use mix and (c) a pedestrian-oriented structure. These are all critical elements needed to support the viable operation of a public transport system and station.

TABLE 2: PROPOSED PUBLIC TRANSPORT ROUTES, STATIONS, AND LAND USE INTEGRATION

SPTN Route/ railway line	Nodal Area	Station or Rank or Stop	Integration Principles
Proposed Barrage Road SPTN route	Vanderbijlpark CBD	▪ Proposed bus station and minibus taxi rank within CBD	▪ Design and locate mixed land uses at commuter railway station ▪ Design and construct pedestrian walkways to facilitate access to proposed bus station and minibus taxi rank
Vereeniging-Johannesburg commuter railway line	Vereeniging CBD	▪ Existing Vereeniging commuter railway station ▪ Proposed bus station and minibus taxi rank at commuter railway station	▪ Design and locate mixed land uses at commuter railway station ▪ Design and construct pedestrian walkways to facilitate access to a commuter railway station
Proposed Barrage Road SPTN route	River City Node (part of Vanderbijlpark CBD)	▪ Proposed bus station and minibus taxi rank within Node	▪ Develop higher-density residential uses to support proposed bus station and minibus taxi rank ▪ Design and construct pedestrian walkways to facilitate access to proposed bus station and minibus taxi rank
Vereeniging-Johannesburg commuter railway line	Sebokeng CBD	▪ Existing Houtheuwel commuter railway station ▪ Existing bus station and minibus taxi rank within CBD	▪ Develop higher-density residential uses to support a commuter railway station with required commuter numbers ▪ Design and construct pedestrian walkways to facilitate access to commuter railway station
Proposed Barrage Road SPTN route	Bedworthpark Regional Node	▪ Proposed bus station and minibus taxi rank within node	▪ Design and locate mixed land uses at proposed bus station and minibus taxi rank ▪ Design and construct pedestrian walkways to facilitate access to proposed bus station and minibus taxi rank

SPTN Route/ railway line	Nodal Area	Station or Rank or Stop	Integration Principles
Proposed Golden Highway SPTN route	Evaton Regional Node	▪ Proposed bus station and minibus taxi rank within node	▪ Develop higher-density residential uses to support proposed bus station and minibus taxi rank ▪ Design and construct pedestrian walkways to facilitate access to proposed bus station and minibus taxi rank
Proposed Barrage Road SPTN route	Three River Regional Node	▪ Proposed bus station and minibus taxi rank within node	▪ Design and locate mixed land uses at proposed bus station and minibus taxi rank ▪ Design and construct pedestrian walkways to facilitate access to proposed bus station and minibus taxi rank
Vereeniging-Johannesburg commuter railway line	Sonlandpark Regional Node	▪ Proposed Sonlandpark commuter railway station ▪ Proposed bus station and minibus taxi rank at commuter railway station	▪ Design and locate mixed land uses at proposed commuter railway station ▪ Design and construct pedestrian walkways to facilitate access to the proposed commuter railway station
Proposed Golden Highway SPTN route	Boitumelo Community Node	▪ Proposed bus station and minibus taxi rank within node	▪ Design and locate mixed land uses at proposed bus station and minibus taxi rank ▪ Design and construct pedestrian walkways to facilitate access to proposed bus station and minibus taxi rank
Vereeniging-Johannesburg commuter railway line	Kwaggashoom Community Node	▪ Existing Kwaggashoom commuter railway station	▪ Develop higher-density residential uses to support a commuter railway station with required commuter numbers
Vereeniging-Johannesburg commuter railway line	Residensia Community Node	▪ Existing Residensia commuter railway station	▪ Develop higher-density residential uses to support a commuter railway station with required commuter numbers

As alluded to above, the efficient functioning of the public transport system within Emfuleni will not only require a well-developed public transport network but will also require well-developed public transit stations and stops that are strategically located along the public transport routes. The major public transit stations and stops should preferably be located within the nodal areas. Many of the existing, planned, and proposed nodes will be served by the existing and proposed commuter railway stations of the Vereeniging-Johannesburg commuter railway line. These include, amongst others, the Residensia Station, Houtheuwel Station, Vereeniging Station, and the proposed Sonlandpark Station. Where nodal areas are served by a road-based public transport network (SPTN), such as the Vanderbijlpark CBD, the Bedworthpark Regional Node, and the Evaton Regional Node, a bus station, and minibus taxi rank should make up the public transit station serving such a node. It is proposed that major transit stations and stops within Emfuleni be located at localities set out in Table 2 above, which correspond with the Transit-Oriented Developments (TODs) proposed for Emfuleni. Pick-up and drop-off stops can be places at 400-600m intervals along the SPTN routes.

To ensure the optimal use of each public transit station and stop, it will have to be integrated through a competent design with surrounding land uses. This design will need to focus on pedestrian movement and how pedestrians exchange between the transit facility and the surrounding land uses. The competent building design is also necessary to ensure land use and transportation integration and will have to be applied to buildings (e.g. retail centers and walk-ups) bordering these transit stations.

5 EXISTING AND PROPOSED ACCESS TO THE DEVELOPMENT

5.1 Existing Major Access

Access to the site is problematic as there are currently no constructed roads linking to the site. The following are potential connections:

- The proposed K55 has two access points that have been provided for in the erf subdivision. This road, or a portion of it, must first be constructed before access to the site can be obtained. There is no indication as to when this will be done.
- There are three access points across the adjacent unproclaimed townships (Sonlandpark Ext 4, Unitas Park Ext 4, and Unitas Park Ext 2) based on their approved layouts. These townships must first be proclaimed and developed before such access can be obtained. To get access in the interim a right-of-way servitude will have to be registered on private property and the roads constructed.

Schematic PH_003: MOVEMENT AXIS

- There is a registered right of way servitude that links to Bennie Osler Street in the Unitas Park Agricultural Holdings. This road must still be constructed.
- Frederik Road in the Unitas Park Agricultural Holdings is constructed up to the north-eastern edge of the site. Thereafter it becomes a dirt road that borders a portion of the site. It continues north from the edge of the site as a dirt road that links up with Langrand Road. These roads will have to be upgraded to accommodate the increase in vehicular traffic anticipated by the development of the site.
- The currently approved layout allows for an access road to the south to connect to Houtkop Road. This connection will necessitate a right of way servitude over privately owned land and will not be allowed once the K55 is constructed due to the distance from the intersection of the K55 and Houtkop Road.

The only current feasible options to obtain access to the site is the construction of the southern portion of the K55 up to the boundary of the site. Another option will be the upgrade of Frederik Road. This in itself will not be sufficient as Frederik Road will not be able to cope with the increase in traffic.

Access to the development is also (indicated in Figure PH_005 as shown in the book of drawings).

5.2 Proposed Access

The concession to grant access to Proposed Mixed Use Residential Development Unitas Park Ext.16 from Municipality Road is the Emfuleni Local Municipality and Gauteng Department of Roads and Transport.

The only current feasible options to obtain access to the site is the construction of the southern portion of the K55 up to the boundary of the site.

6 TRAFFIC FLOWS & DEVELOPMENT TRIPS

6.1 Existing Traffic Flows

Detailed traffic surveys (traffic counts) were carried out at the following intersections :

- Houtkop Road and Gary Player Street intersection;
- Houtkop Road and Laurie Stevens Street intersection;
- Houtkop Road and Percy Sherwell Street intersection;
- Houtkop Road and Japie Krige Street intersection;
- Houtkop Road and Senator/Sprinkbok Street intersection;
- Houtkop Road and Leeuwkrol Drive/Van Riebeek Street intersection;
- Leeuwkrol Drive and Poole Street intersection;
- Leeuwkrol Drive and Johannesburg Road intersection; indicated in Figure PH_007 as shown in the book of drawings). The surveys were conducted for 13 hours (06:00-18:30) during the weekday on Thursday, 05 March 2020.

From the traffic counts a common peak hour was determined (the busiest hour) for each counted period and was found to be as follows:

- Morning peak 06:30-07:30
- Afternoon peak 16:00-17:00

6.2 Traffic Evaluation

The traffic impact of the proposed development has been assessed by examining the intersections in the area of influence. These intersections include:

- Houtkop Road and Gary Player Street intersection;
- Houtkop Road and Laurie Stevens Street intersection;
- Houtkop Road and Percy Sherwell Street intersection;
- Houtkop Road and Japie Krige Street intersection;
- Houtkop Road and Senator/Sprinkbok Street intersection;
- Houtkop Road and Leeuwkrol Drive/Van Riebeek Street intersection;
- Leeuwkrol Drive and Poole Street intersection;
- Leeuwkrol Drive and Johannesburg Road intersection.

The performance of each of the above intersections has been assessed by comparing the traffic flows (demand) with the estimated capacity (supply) for the critical movements at each intersection to obtain a Level of Service (LOS) for each movement and delays experienced.

Sidra Intersection 8.0, simulation software was used to evaluate the intersections.

The following parameters were used to evaluate capacity analysis:

The following definitions from the 2000 Highway Capacity Manual are used in this report:

- Capacity - The maximum hourly rate at which vehicles can reasonably be expected to traverse a lane or roadway during a given period under prevailing traffic and control conditions.
- Volume - The hourly rate of vehicle arrivals at an intersection.
- Volume to capacity ratio (v/c) - Is the ratio of volume to capacity.

Level of service (LOS) - Level of service is defined in terms of delay. Delay is a measure of driver discomfort, frustration, fuel consumption, and lost travel time. The levels of service for signalized and un-signalized intersections as defined in the 2000 Highway Capacity Manual are shown in Table 3 below.

TABLE 3: LEVEL OF SERVICE DEFINITIONS

Level of Service	Signalized intersections Stopped delay (seconds)	Unsignalized intersections Total delay (seconds)
A	< 10	< 10
B	> 10 and < 20	> 10 and < 15
C	> 20 and < 35	> 15 and < 25
D	> 35 and < 55	> 25 and < 35
E	> 55 and < 80	> 35 and < 50
F	> 80	> 50

An intersection is deemed to be operating acceptably at levels of service A to D. If an intersection operates at a level of service E or F or has a volume to a capacity ratio higher than 0.95 the intersection is considered to be operating at capacity.

6.3 Development Trip Generation and Traffic Volume Scenario-Adjusted Factors

Various trip adjustment factors have been introduced into the COTO document to allow for trip reductions. These adjustment factors are discussed briefly below.

6.4 Mixed-use Developments (MUD)

According to the COTO manual "mixed-use developments are defined as developments in an area that consist of two or more single-use developments between which trips can be made utilizing non-motorized modes of transport (such as walking). This has the net effect of reducing the vehicle trip generation in the area."

Since this development will consist of mixed land use, the reduction factors which have been applied are listed in Table 4 below. Note, Pm = Reduction factor for mixed-use development.

6.5 LOW VEHICLE OWNERSHIP (LVO) & VERY LOW VEHICLE OWNERSHIP (VLVO)

According to COTO "the vehicle ownership in areas with high levels of vehicle ownership varies between one or two per household. In areas with a low level of vehicle ownership, the majority of households (more than 50%) do not own a vehicle and rely on public transport for transportation.

In areas with a very low level of vehicle ownership, nearly all households (more than 90%) do not own a vehicle and rely on public transportation."

This study considered low to very low vehicle ownership and the reduction factors which have been applied are listed in Table 4 below. Note, Pv = Reduction factor for vehicle ownership.

6.6 TRANSIT NODE OR CORRIDORS

According to COTO "the transit reduction factors apply to developments that are located within a reasonable walking distance from a major transit node or stops on a major transit corridor."

This study considered transit nodes and a 15% reduction factor has been applied for all land uses as recommended in the COTO manual. See Table 4 below. Note, Pt = Reduction factor for transit nodes or corridors.

Table 4: Adjustment Factors Applied for Trip Reductions			
Trip Code	Pm	Pv	Pt
Single Dwelling Units	30%	80%	15%
Townhouses (Simplexes and Duplexes)	30%	80%	15%
Apartments and Flats	30%	80%	15%

6.7 TRIP SUMMARY

The detailed trip generation calculations are included in Annexure A. Using the COTO document the expected peak hour trip generation for the proposed development was calculated and indicated in Table 5 below.

Table 5: EXPECTED PEAK HOUR TRIP GENERATION (veh/h)					
WEEKDAY AM			WEEKDAY PM		
IN	OUT	TOTAL	IN	OUT	TOTAL
141	424	**566**	396	170	**566**

Table 5 shows that the proposed development will generate **566** trips during the weekday AM and weekday PM peak periods, respectively.

From Table 5 it can be seen that the development will generate a maximum of 566 trips during the weekday PM peak period. The Manual for Traffic Impact Studies requires that a traffic impact statement be done for developments that generate more than 50 but less than 150 peak hour trips as indicated in Table 6 below.

Table 6: Assessment Years for Traffic Studies (from Manual for Traffic Impact Studies)	
Type of Study	Assessment years to consider
Traffic Impact Statement (50-150 peak hour trips)	• Base year; • Any other year at the discretion of responsible road authority.
Traffic Impact Study (150-2000 peak hour trips)	• Base year; • Five years after the base year; • Any other year at the discretion of responsible road authority.
Traffic Impact Study (> 2000 peak hour trips)	• Base year; • Ten years after the base year; • Any other year at the discretion of responsible road authority.
Multiphase developments	• Base year; • Five years after the base year for developments < 2000 peak hour trips; • Ten years after the base year for developments > 2000 peak hour trips; • Any other year at the discretion of responsible road authority.

6.8 GROWTH RATE

TMH 16 South African Traffic Impact and Site Traffic Assessment Manual Volume 1 requires that a five-year horizon be considered for developments that generate more than 50 trips. TMH 17 South African Trip Data Manual recommends growth rates for developments as shown in Table 7.

Table 7: Typical Traffic Growth Rates	
Development Area	Growth Rates
Low Growth Area	• 0-3%
Average Growth Area	• 3-4%
Above-average growth areas	• 4-6%
Fast-growing areas	• 6-8%
Exceptionally high growth areas	• >8%

A growth rate of 3% was considered appropriate for this study

6.9 Total Future Traffic Flows with Development

The existing 2020 peak hour traffic volumes (see Figure PH_006 as shown in the book of drawings) were thus subjected to a 3% growth rate over five years; this is in line with an above-average growth rate as given in Table 7 above. The 2025 background plus development peak hour traffic volumes are presented in Figure PH_007 as shown in the book of drawings.

6.10 Trip Distribution and Assignment

Assumptions concerning the expected trip distribution were based on the location of the site access about the surrounding road network; the existing traffic volumes, travel patterns as well as the land use nature of the proposed development.

The expected trip distribution and development generated traffic of the proposed development can be seen in Figure PH_007 as shown in the book of drawings.

7 TRAFFIC IMPACT AND CAPACITY ANALYSIS

7.1 General

The AM and PM peak hour trip generation of the development was analysed. The critical peak hour analysis was considered for the following scenarios:

- 2020 without development scenario;
- 2025 with a development scenario.

2020 without development scenario demonstrates the existing intersection's operation. 2025 with a development scenario is the worst-case scenario and would indicate all the intersection upgrading the developer would be responsible for.

This analysis aims to ensure that the intersection of:

- Houtkop Road and Gary Player Street intersection;
- Houtkop Road and Laurie Stevens Street intersection;
- Houtkop Road and Percy Sherwell Street intersection;
- Houtkop Road and Japie Krige Street intersection;
- Houtkop Road and Senator/Sprinkbok Street intersection;
- Houtkop Road and Leeuwkrol Drive/Van Riebeek Street intersection;
- Leeuwkrol Drive and Poole Street intersection;
- Leeuwkrol Drive and Johannesburg Road intersection.

This analysis aims to ensure that the intersections and proposed accesses operate at an acceptable level of service. If the intersection should operate poorly the aim will be to at least improve the overall performance of the intersection.

7.2 2020 Background Scenario Without Development

The results of Sidra Intersection Capacity Analyses at the existing intersection of **Houtkop Road** and **Gary Player Street** are shown in **Table 8 & Table 9** for 2020 without development scenario.

Table 8 SUMMARY OF 2020 AM-PEAK CAPACITY ANALYSIS RESULTS *WITHOUT DEVELOPMENT*

Table 9 SUMMARY OF 2020 PM-PEAK CAPACITY ANALYSIS RESULTS *WITHOUT DEVELOPMENT*

The capacity analysis indicates that the intersection of **Houtkop Road** and **Gary Player Street** currently operates at **LOS F on the North** approach during **the PM peak**, an intersection upgrade required.

The results of Sidra Intersection Capacity Analyses at the existing intersection of **Houtkop Road** and **Laurie Stevens Street** are shown in **Table 10 & Table 11** for 2020 without development scenario.

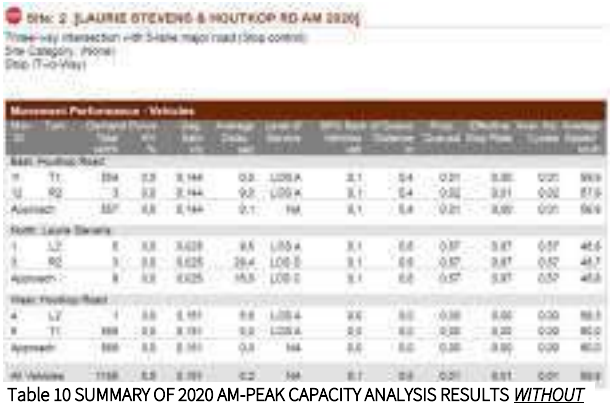


Table 10 SUMMARY OF 2020 AM-PEAK CAPACITY ANALYSIS RESULTS *WITHOUT DEVELOPMENT*

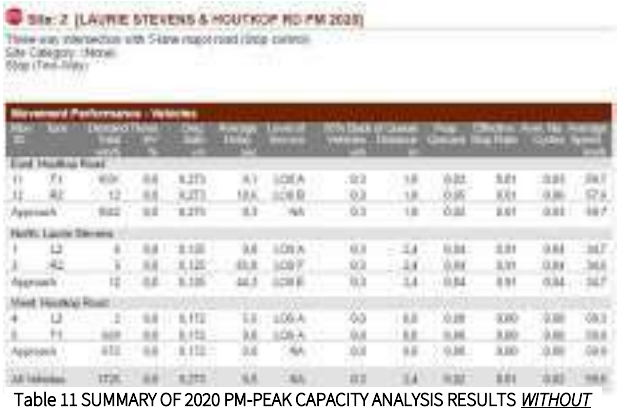


Table 11 SUMMARY OF 2020 PM-PEAK CAPACITY ANALYSIS RESULTS *WITHOUT DEVELOPMENT*

The capacity analysis indicates that the intersection of **Houtkop Road** and **Laurie Stevens Street** currently operates at **LOS E on the North** approach during **the PM peak**, an intersection upgrade required.

The results of Sidra Intersection Capacity Analyses at the existing intersection of **Houtkop Road** and **Percy Sherwell Street** are shown in **Table 12 & Table 13** for 2020 without development scenario.

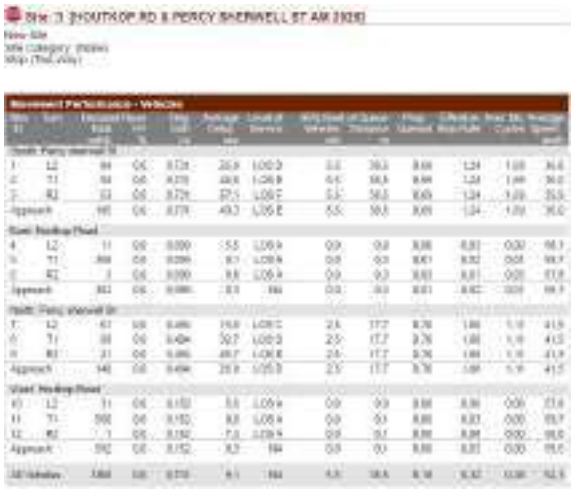


Table 12 SUMMARY OF 2020 AM-PEAK CAPACITY ANALYSIS RESULTS
WITHOUT DEVELOPMENT

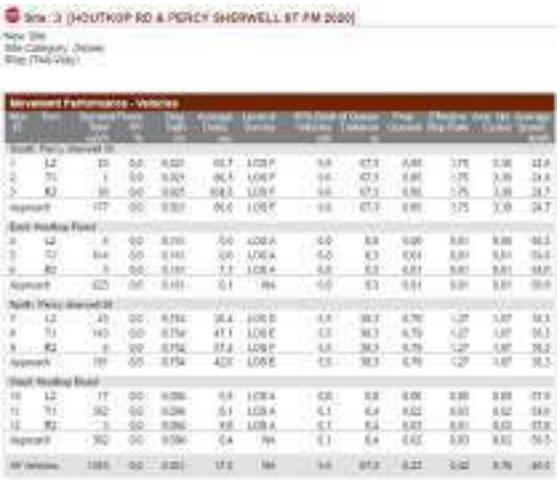


Table 13 SUMMARY OF 2020 PM-PEAK CAPACITY ANALYSIS RESULTS
WITHOUT DEVELOPMENT

The capacity analysis indicates that the intersection of **Houtkop Road** and **Percy Sherwell Street** currently operates at **LOS F on the South** approach during **the PM peak**, an intersection upgrade required.

The results of Sidra Intersection Capacity Analyses at the existing intersection of **Houtkop Road** and **Japie Krige Street** are shown in **Table 14 & Table 15** for 2020 without development scenario.

Table 14 SUMMARY OF 2020 AM-PEAK CAPACITY ANALYSIS RESULTS
WITHOUT DEVELOPMENT

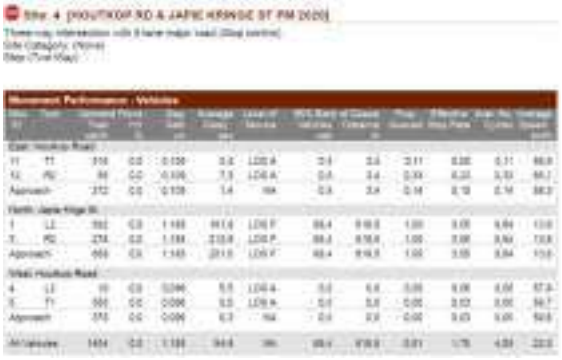


Table 15 SUMMARY OF 2020 PM-PEAK CAPACITY ANALYSIS RESULTS
WITHOUT DEVELOPMENT

The capacity analysis indicates that the intersection of **Houtkop Road** and **Japie Krige Street** currently operates at **LOS F on the North** approach during **the AM & PM peak**, an intersection upgrade required.

The results of Sidra Intersection Capacity Analyses at the existing intersection of **Houtkop Road** and **Senator/Sprinkbok Street** are shown in **Table 16 & Table 17** for 2020 without development scenario.

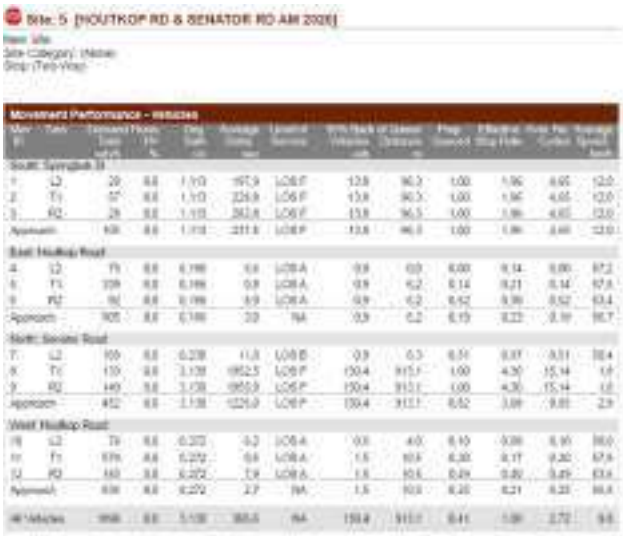


Table 16 SUMMARY OF 2020 AM-PEAK CAPACITY ANALYSIS RESULTS
WITHOUT DEVELOPMENT

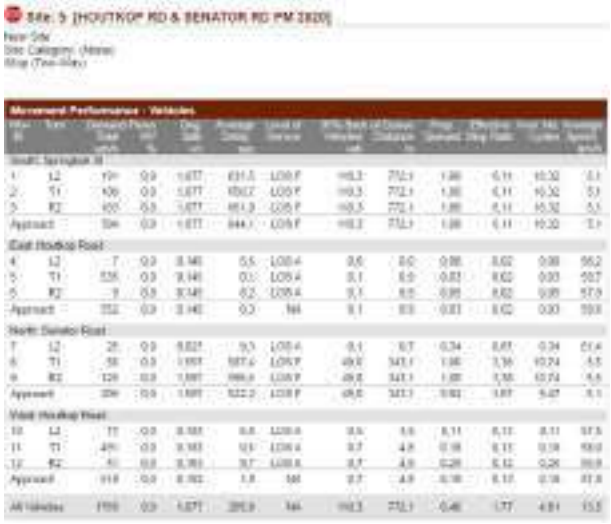


Table 17 SUMMARY OF 2020 PM-PEAK CAPACITY ANALYSIS RESULTS
WITHOUT DEVELOPMENT

The capacity analysis indicates that the intersection of **Houtkop Road** and **Senator/Sprinkbok Street** currently operates at **LOS F on the South & North** approach during **the AM & PM peak**, an intersection upgrade required.

The results of Sidra Intersection Capacity Analyses at the existing intersection of **Houtkop Road** and **Leeuwkrol Drive/Van Riebeek Street** are shown in **Table 18 & Table 19** for 2020 without development scenario.

Table 18 SUMMARY OF 2020 AM-PEAK CAPACITY ANALYSIS RESULTS
WITHOUT DEVELOPMENT

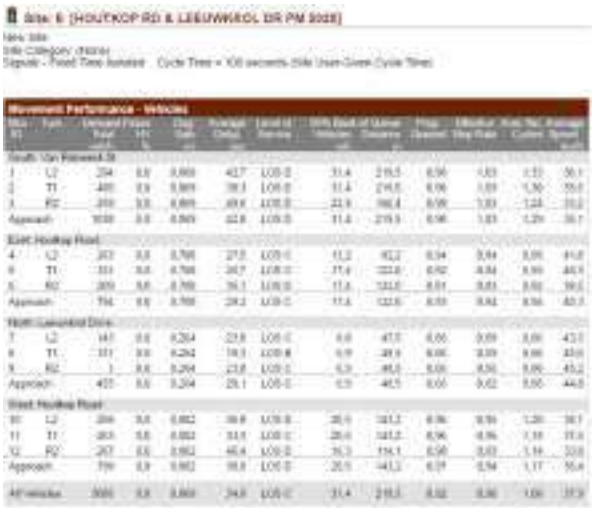


Table 19 SUMMARY OF 2020 PM-PEAK CAPACITY ANALYSIS RESULTS
WITHOUT DEVELOPMENT

The capacity analysis indicates that the intersection of **Houtkop Road** and **Leeuwkrol Drive/Van Riebeek Street** currently operates at **LOS F on the South & West** approach during **the AM peak**, an intersection upgrade required.

The results of Sidra Intersection Capacity Analyses at the existing intersection of **Leeuwkrol Drive** and **Poole Street** are shown in **Table 20 & Table 21** for 2020 without development scenario

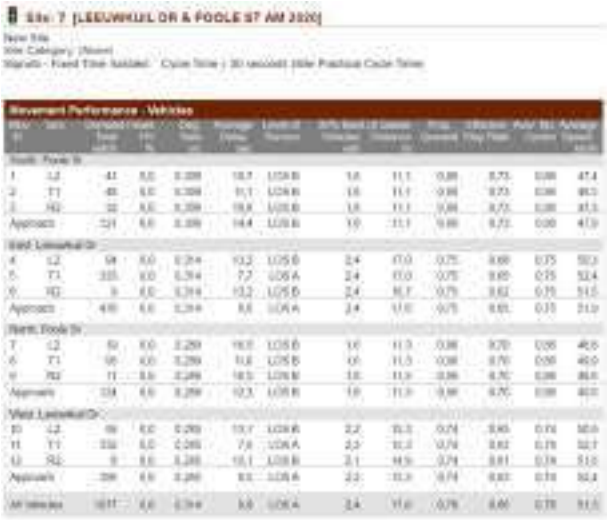


Table 20 SUMMARY OF 2020 AM-PEAK CAPACITY ANALYSIS RESULTS
WITHOUT DEVELOPMENT

Table 21 SUMMARY OF 2020 AM-PEAK CAPACITY ANALYSIS RESULTS
WITHOUT DEVELOPMENT

The capacity analysis indicates that the intersection of **Leeuwkrol Drive** and **Poole Street** currently operates at **LOS A** during both **the AM & PM peak**, an NO intersection upgrade required.

The results of Sidra Intersection Capacity Analyses at the existing intersection of **Leeuwkrol Drive** and **Johannesburg Road** are shown in **Table 22 & Table 23** for 2020 without development scenario

Table 22 SUMMARY OF 2020 AM-PEAK CAPACITY ANALYSIS RESULTS
WITHOUT DEVELOPMENT

Table 23 SUMMARY OF 2020 AM-PEAK CAPACITY ANALYSIS RESULTS
WITHOUT DEVELOPMENT

The capacity analysis indicates that the intersection of **Leeuwkrol Drive** and **Johannesburg Road** currently operates at **LOS F** during **the AM & PM peak**, an intersection upgrade required.

7.3 2025 With Development Scenario

The results of Sidra Intersection Capacity Analyses at the existing intersection of **Houtkop Road** and **Gary Player Street** are shown in **Table 24 & Table 25** for 2025 with a development scenario.

Table 24 SUMMARY OF 2025 AM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

Table 25 SUMMARY OF 2025 PM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

The capacity analysis indicates that the intersection of **Houtkop Road** and **Gary Player Street** currently operates at **LOS B** for both **the AM & PM peak**, with the intersection signalisation.

The results of Sidra Intersection Capacity Analyses at the existing intersection of **Houtkop Road** and **Laurie Stevens Street** are shown in **Table 26 & Table 27** for 2025 with a development scenario.

Table 26 SUMMARY OF 2025 AM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

Table 27 SUMMARY OF 2025 PM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

The capacity analysis indicates that the intersection of **Houtkop Road** and **Laurie Stevens Street** currently operates at **LOS A** for both **the AM & PM peak**, with the intersection signalisation.

The results of Sidra Intersection Capacity Analyses at the existing intersection of Houtkop Road and Percy Sherwell Street are shown in Table 28 & Table 29 for 2025 with a development scenario.

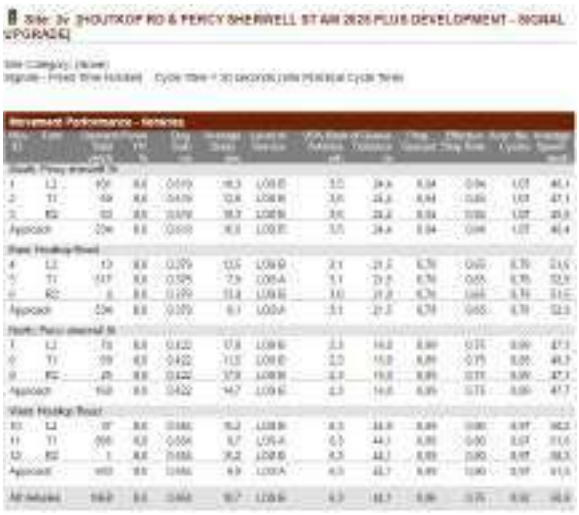


Table 28 SUMMARY OF 2025 AM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

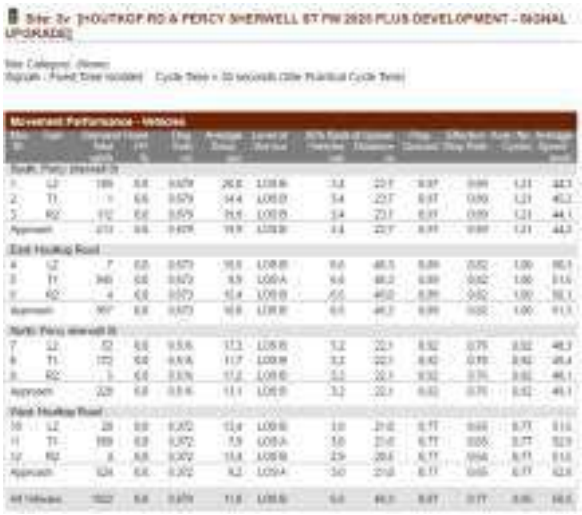


Table 29 SUMMARY OF 2025 PM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

The capacity analysis indicates that the intersection of Houtkop Road and Percy Sherwell Street currently operates at LOS A for both the AM & PM peak, with the intersection signalisation.

The results of Sidra Intersection Capacity Analyses at the existing intersection of Houtkop Road and Japie Krige Street are shown in Table 30 & Table 31 for 2025 with a development scenario.

Table 30 SUMMARY OF 2025 AM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

Table 31 SUMMARY OF 2025 PM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

The capacity analysis indicates that the intersection of Houtkop Road and Japie Krige Street currently operates at LOS C for both the AM & PM peak, with the intersection signalisation.

The results of Sidra Intersection Capacity Analyses at the existing intersection of Houtkop Road and Senator/Sprinkbok Street are shown in Table 32 & Table 33 for 2025 with a development scenario.

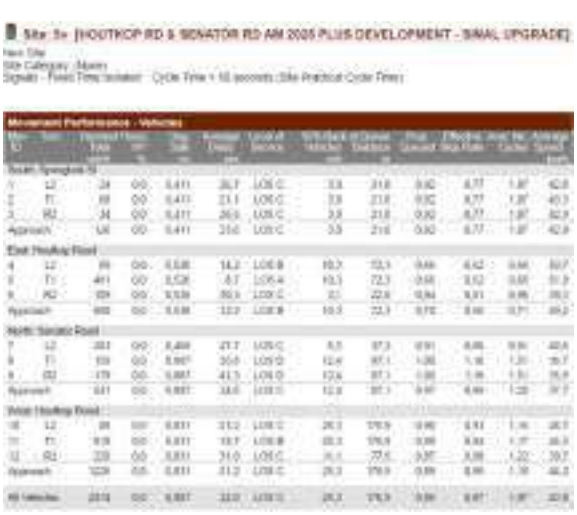


Table 32 SUMMARY OF 2025 AM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

Table 33 SUMMARY OF 2025 PM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

The capacity analysis indicates that the intersection of Houtkop Road and Senator/Sprinkbok Street currently operates at LOS C & B for the AM & PM peak, with the intersection signalisation.

The results of Sidra Intersection Capacity Analyses at the existing intersection of Houtkop Road and Leeuwkrol Drive/Van Riebeek Street are shown in Table 34 & Table 35 for 2025 with a development scenario.

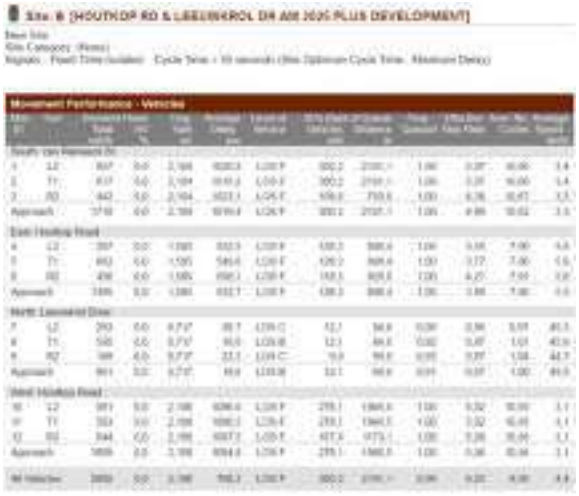


Table 34 SUMMARY OF 2025 AM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

Table 35 SUMMARY OF 2025 PM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

The capacity analysis indicates that the intersection of Houtkop Road and Leeuwkrol Drive/Van Riebeek Street currently operates at LOS F for the AM & PM peak, with the intersection signalisation has to be synchronized with the new signals.

The results of Sidra Intersection Capacity Analyses at the existing intersection of Leeuwkrol Drive and Poole Street are shown in Table 36 & Table 37 for 2025 with a development scenario

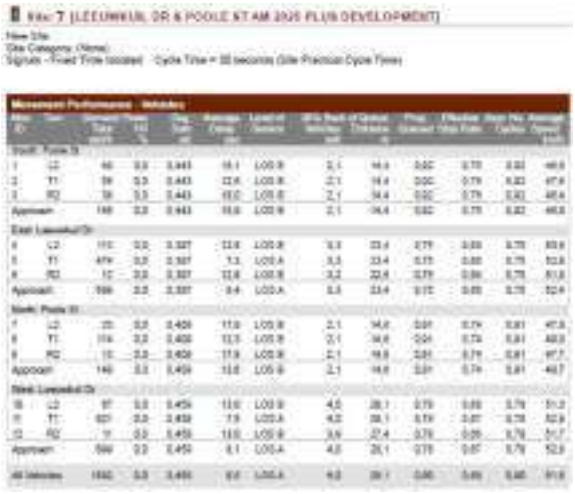


Table 36 SUMMARY OF 2025 AM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

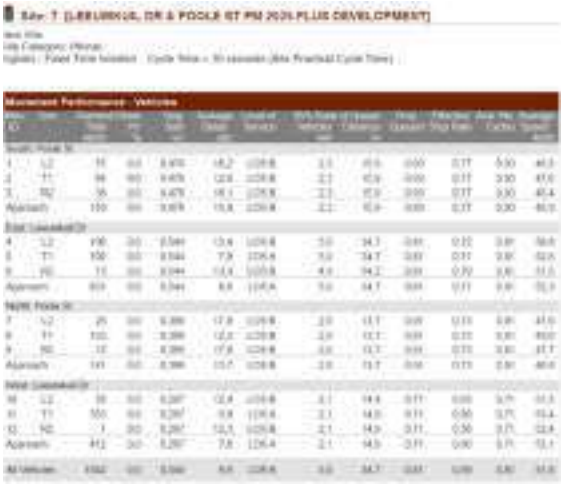
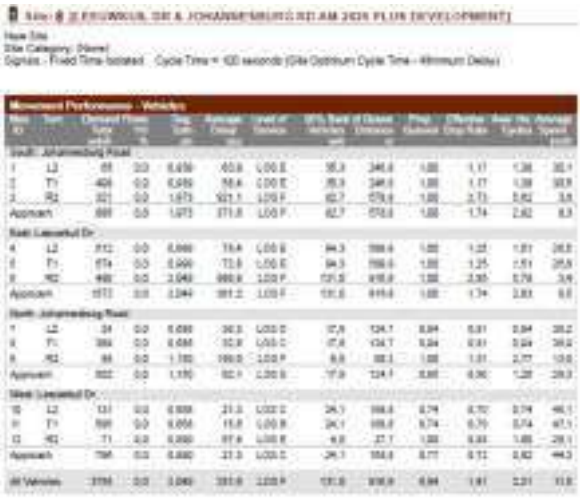
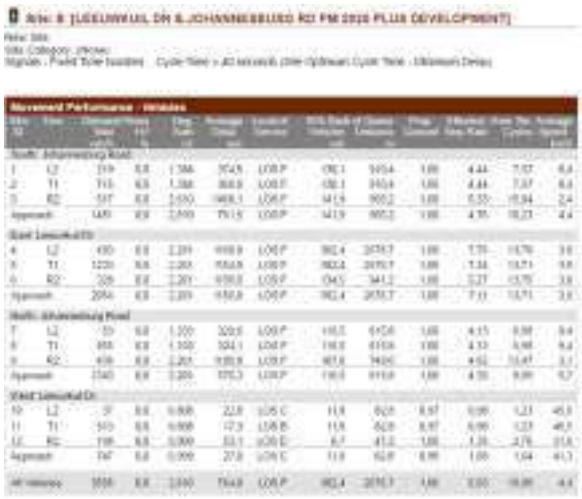


Table 37 SUMMARY OF 2025 PM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

The capacity analysis indicates that the intersection of Leeuwkrol Drive and Poole Street currently operates at LOS A for the AM & PM peak, with the existing signalisation.

The results of Sidra Intersection Capacity Analyses at the existing intersection of Leeuwkrol Drive and Johannesburg Road are shown in Table 38 & Table 39 for 2025 with a development scenario



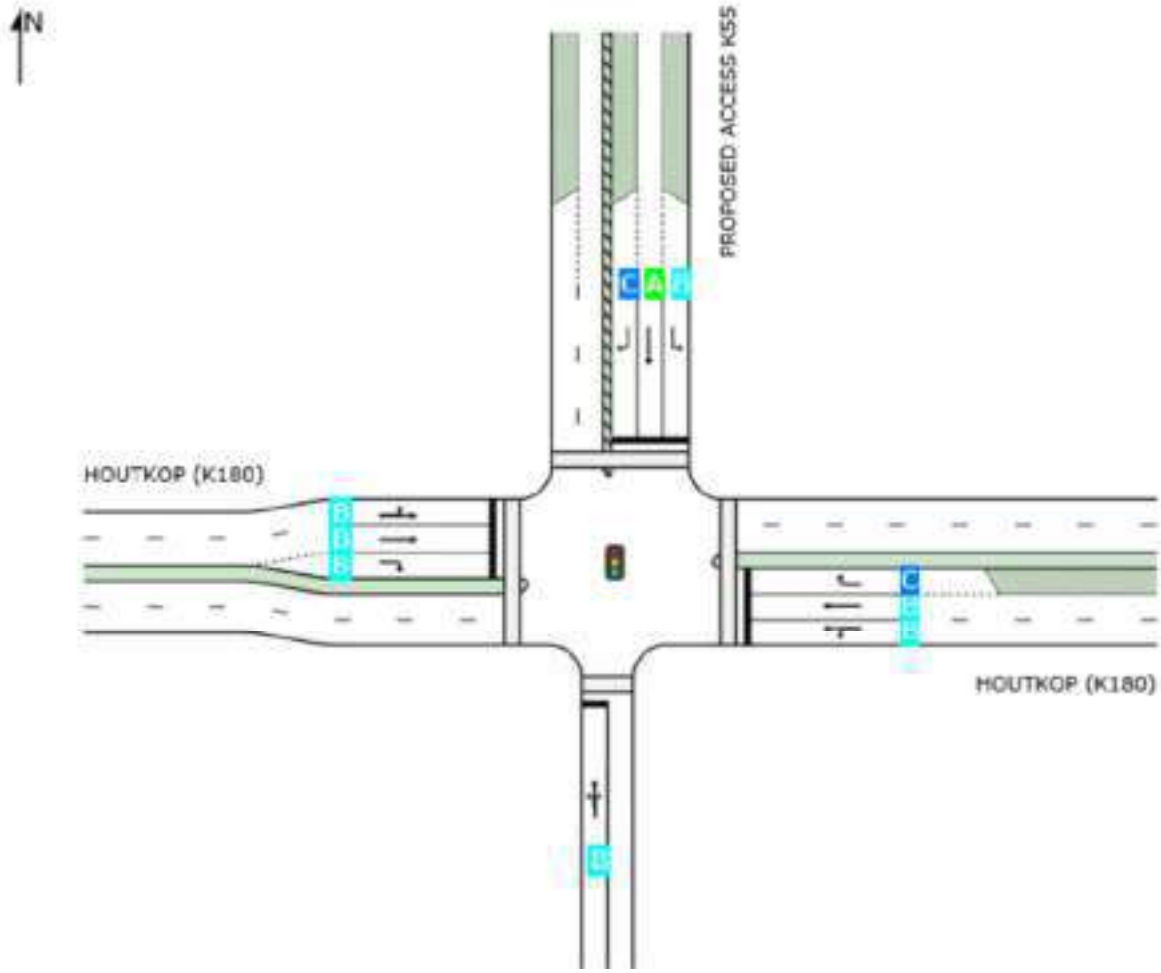


The capacity analysis indicates that the intersection of Leeuwkrol Drive and Johannesburg Road currently operates at LOS F for the AM & PM peak, with the intersection signalisation has to be synchronized with the new signals.

8 ACCESS

8.1 General

Access will be provided off Proposed K55 and K180 this intersection will to Gautrans Standards, and as per PRS 78/197/4Bp (refer below for the access layout configuration).



Schematic PH_004: PROPOSED SIGNALISED ACCESS

9 PARKING PROVISION

Parking will be provided within the site as required by the Emfuleni Local Municipality Town Planning Scheme.

10 NON-MOTORISED & PUBLIC TRANSPORT FACILITIES

10.1 Pedestrian Facilities

Pedestrian walkways have been provided along the site frontage of the proposed development as per the Emfuleni Local Municipality requirements or standards.

It is a requirement that pedestrian access must be provided to and from the development, particularly from public transport facilities. Currently, they are formal transport facilities in the vicinity of the development exist.

The planning of the development will however take into consideration possible future road-based public transport infrastructure along various provincial routes (existing or planned).

The conflict between vehicular and pedestrian/bicycle traffic must be minimised. As part of the development, pedestrian crossings would be provided at all major intersections and access points. Bicycle access and crossings, shared with pedestrians or otherwise, would be provided where appropriate.

The minimum footpath or cycleway and clear widths indicated in Table 40 must be provided along the perimeter of the development. The clear width is measured between the side of the road (outer edge of the kerb or shoulder) and the road reserve boundary.

Table 40 : Minimum Sidewalk, Walkway and Cycle Track Width*	
Descriptions	**Minimum Width**
Sidewalks/ Walkways with Buffer Strip • Minimum Width • Desirable Width • Buffer Strip Width	 1.5m 1.8m 0.6m
Sidewalks/Walkways without Buffer Strip	1.8m
Sidewalks in Business Areas	2.5-3.5m
Cycle Track	2.0m
Shared Cycle Track/Walkway	2.4m

*Reference COTO TMH16 Volume 2

Table 41: Desirable Pedestrian Buffer Strips*	
Road Class	**Desirable Buffer Width (m)**
Class 2	6.0
Class 3	4.5
Class 4a	3.0
Class 4b	2.5
Class 5a	0.6-2.5
Class 5b	0.6-1.5

*Reference COTO TMH16 Volume 2

10.2 General

In terms of the National Land Transport Transition Act (NLTTA) 22 of 2000, section 29, it is a requirement that an assessment of public transport is included in a traffic impact assessment.

The following comments are made regarding public transport:

It is recommended that road K180 be provided with a pair of public transport lay-bys in the form of bus and taxi stops at each access point where access to the township is gained. It is further recommended that the proposed lay-bys be constructed to the appropriate design standards of the relevant roads authority (See Schematic PH_005 below).

Schematic PH_005: Typical Public Transport lay-bys

11 ROAD UPGRADES HIGH-LEVEL COST ESTIMATES

TABLE 42: SUMMARY OF PRICING SCHEDULE		
SECTION	DESCRIPTION	AMOUNT
1	Houtkop Road and Gary Player Street intersection-Proposed Traffic Signal	R795 000,00
2	Houtkop Road and Laurie Stevens Street -Proposed Traffic Signal	R795 000,00
3	Houtkop Road and Percy Sherwell Street -Proposed Traffic Signal	R795 000,00
4	Houtkop Road and Japie Krige Street -Proposed Traffic Signal	R795 000,00
5	Houtkop Road and Senator/Sprinkbok Street -Proposed Traffic Signal	R795 000,00
6	Access on K55 & K180-Proposed Traffic Signal	R795 000,00
7	Proposed Bus-Laybys	R3 500 000,00
8	The proposed K55 has two access points that have been provided for in the erf subdivision.	R24 000 000,00
9	External and Site Works	R750 000,00
	Total Schedule of Prices	R33 020 000,00
	10% Contingencies	R3 302 000,00
	Subtotal	R36 322 000,00
	15% VAT	R5 448 300,00
	Estimated Order Magnitude	R41 770 300,00

12 CONCLUSION AND RECOMMENDATION

Based on the assessment of the existing and planned future road network, traffic counts, a traffic analysis and capacity analysis of road links in the study area, the following concluding remarks are relevant.

This Traffic Impact (TIA) & Access Study pertains for the establishment of a Proposed Mixed Use Residential development Unitas Park Extension 16 Situated on Portion 222 of the farm Houtkop 594-IQ (SG Diagram 7423/2008). Portion 222 of the farm Houtkop 594-IQ is in the process of subdivision and will be known as Portion 225 (a portion of 222) of the farm Houtkop 594-IQ (Subdivision Diagram 4362/2009) in the Emfuleni Local Municipality.

The site is currently undeveloped. The township locality and the surrounding road network are indicated on FIGURE PH_001 , 002 & 003.

The development consists of the following land use:

- Proposed Mixed Use Residential Development

Detailed traffic surveys (traffic counts) were carried out at the following intersections :

- Houtkop Road and Gary Player Street intersection;
- Houtkop Road and Laurie Stevens Street intersection;
- Houtkop Road and Percy Sherwell Street intersection;
- Houtkop Road and Japie Krige Street intersection;
- Houtkop Road and Senator/Sprinkbok Street intersection;
- Houtkop Road and Leeuwkrol Drive/Van Riebeek Street intersection;
- Leeuwkrol Drive and Poole Street intersection;
- Leeuwkrol Drive and Johannesburg Road intersection.

The proposed development will generate 566 trips during the weekday AM and weekday PM peak periods, respectively.

The site is well-connected on a regional scale. To the south is Houtkop Road (R54), to the south-west is the R28 and to the east is the R59 (Old Johannesburg Road). The proposed PWV 20 runs to the west of the site and the proposed K55 abuts the site on its eastern boundary.

The proposed K55 has two access points that have been provided for in the erf subdivision. This road, or a portion of it, must first be constructed before access to the site can be obtained. There is no indication as to when this will be done.

From the analysis performed, it was found that the impact of the proposed developments can be mitigated by means of several road and intersection improvements as shown in Section 7.3

The 2020 background traffic & future 2025 traffic show that there is an existing capacity constraint. Therefore the developers of the latent rights developments are required to contribute towards roads and intersection upgrades. The upgrading will be as per the requirements of ELM and GDRT.

Pedestrian walkways have been provided along the site frontage of the proposed development as per the Emfuleni Local Municipality requirements or standards.

It is a requirement that pedestrian access must be provided to and from the development, particularly from public transport facilities. Currently, they are no formal transport facilities in the vicinity of the development exist.

The planning of the development will however take into consideration possible future road-based public transport infrastructure along various provincial routes (existing or planned).

The conflict between vehicular and pedestrian/bicycle traffic must be minimised. As part of the development, pedestrian crossings would be provided at all major intersections and access points. Bicycle access and crossings, shared with pedestrians or otherwise, would be provided where appropriate.

The minimum footpath or cycleway and clear widths indicated in Table 40 must be provided along the perimeter of the development. The clear width is measured between the side of the road (outer edge of the kerb or shoulder) and the road reserve boundary.

In terms of the National Land Transport Transition Act (NLTTA) 22 of 2000, section 29, it is a requirement that an assessment of public transport is included in a traffic impact assessment.

The following comments are made regarding public transport:

It is recommended that road K180 be provided with a pair of public transport lay-bys in the form of bus and taxi stops at each access point where access to the township is gained. It is further recommended that the proposed lay-bys be constructed to the appropriate design standards of the relevant roads authority (See Schematic PH_005)

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- TMH 17 Volume 1, South African Trip Data Manual, Version 1.0, Committee of Transport Officials (COTO) September 2012
- Highway Capacity Manual, Transportation Research Board, National Research Council Washington D.C., 2010
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- The Development of an Operations Plan for an IRPTN North/South Corridor,City of Ekurhuleni, 2012.

APPENDIX B9

Highest and Best Use Market Study

GCS

Water & Environmental Consultants

UNITAS PARK EXTENSION 16 HIGHEST AND BEST USE MARKET STUDY

FEBRUARY 2020

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Table of Contents

List of Figures iv
List of Tables iv
List of Maps vi
Executive Summary vii
1. Introduction 1
1.1. Project Brief 1
1.2. Methodology 1
1.3. Report Outline 2
2. Spatial Analysis 3
2.1. Macro-Level Analysis 3
2.2. Regional Connectivity 4
2.3. Micro Context 4
2.4. Surrounding Land Uses 5
2.5. Market Area Delineation 7
3. Macro-Economic Analysis 8
3.1. GDP / GVA 8
3.2. Economic Sector Contribution 10
3.3. Interest and Inflation Rates 12
3.3.1. Interest Rate 12
3.3.2. Inflation Rate 13
4. Socio-Economic Analysis 14
4.1. Population and Households 14
4.2. Employment 15
4.2.1. Employment per Industry 15
4.2.2. Employment Profile 16
4.2.3. Unemployment Rate 16
4.3. Age Profile 17
4.4. Household Income 18
4.4.1. Weighted Average Income 20
4.5. Education 20
4.6. Living Standard Measure (LSM) 22
5. Market Perspective 23

DRAFT

5.1. Residential 23
5.1.1. House Price Index 23
5.1.2. House Market Stock 24
5.1.3. Period of Ownership 24
5.1.4. Average House Price 25
5.1.5. Housing Typologies 26
5.1.6. Tenure Status 28
5.1.7. Similar Projects in the Region 28
5.2. Retail 30
5.3. Office 34
5.3.1. Vacancy Rates 34
5.3.2. Rental Rates 34
5.3.3. Capitalisation Rates 34
5.4. Education 35
5.4.1. Schools 35
5.4.2. Tertiary Education and demand for student housing 37
5.5. Health Care 41
5.6. Innovation and Inubation Hub 43
5.6.1. Innovation Hub 43
5.6.2. Case Studies 44
6. Market Opportunity Analysis 49
6.1. Opportunity Analysis 49
6.2. The Way Forward 52
7. Market Potential Analysis 53
7.1. Residential 53
7.1.1. Household Features 53
7.1.2. Household Income 54
7.1.3. Affordability Ranges 54
7.1.4. Net Effective Demand 55
7.2. Retail 57
7.2.1. Methodology 57
7.2.2. Population Profile 58
7.2.3. Trading Densities 58

DRAFT

7.2.4. Leakages and Injections 59
7.2.5. Supply Analysis 59
7.2.6. Demand Analysis 60
7.3. Office 61
7.4. Education 61
7.4.1. Schools 61
7.4.2. Student Housing 63
7.5. Clinic 66
7.6. Unitas Park Innovation Hub Concept 68
7.6.1. Institutions 68
7.6.2. Industry Networks 69
7.6.3. Entrepreneurs 69
7.6.4. Place-Making 69
8. Supplementary Land Uses 70
8.1. Thresholds 70
8.2. The Way Forward 71
9. Conclusion and Recommendations 72
9.1. Conclusion 72
9.2. Recommendations 76
9.2.1. Scenario One 76
9.2.2. Scenario Two 78

DRAFT

List of Figures

Figure 1: Gross Value Added (Constant Prices in R million) 2000 - 2018 8
Figure 2: GVA Growth Trend 2000 - 2018 9
Figure 3: GVA contribution per sector 10
Figure 4: Sectoral growth in Emfuleni Local Municipality (2006 – 2018) 11
Figure 5: Interest rate 12
Figure 6: Inflation rate 13
Figure 7: Employment per industry 15
Figure 8: Employment profile 16
Figure 9: Age profile 18
Figure 10: Household income profile 19
Figure 11: Highest level of education 20
Figure 12: Attendance at an educational institution 21
Figure 13: FNB House Price Index 23
Figure 14: Residential market stock 24
Figure 15: Period of ownership (January 2019 to December 2019) 25
Figure 16: Average sale prices 26
Figure 17: Housing typologies in primary and secondary market areas 27
Figure 18: Tenure status 28
Figure 19: Savanna City RDP houses 29
Figure 20: Retail trading densities growth rates 31
Figure 21: Innovation Hub 43
Figure 22: Key facilities surrounding Pretoria's innovation hub 45
Figure 23: Residential Net Effective Demand 53
Figure 24: Annual household income 54
Figure 25: Retail Net Effective Demand 58
Figure 26: Student housing demand model 63

List of Tables

Table 1: Population and household profile 14
Table 2: Unemployment rate of Emfuleni Local Municipality (provided in percentages) 16
Table 3: Age group classification 17
Table 4: Weighted average income 20
Table 5: Living standard measure 22
Table 6: Savanna City average sales prices 29
Table 7: Retail stores in the primary market area 33
Table 8: Average rental rates (Rand per square meter per month) 34
Table 9: Capitalisation rate of office buildings 34
Table 10: Schools located in the primary market area 36

DRAFT

Table 11: Learner-educator ratio (LER) 36
Table 12: Tertiary institutions and distances from the proposed development site 37
Table 13: Enrolment at NWU Vaal Campus 38
Table 14: Number of students enrolled at Sedibeng TVET College 39
Table 15: Additional student housing supply 39
Table 16: NSFAS Grant Allocation 41
Table 17: Preliminary Opportunity Analysis Matrix 49
Table 18:Population and household growth 53
Table 19: Income categories for bonded developments 54
Table 20: Income categories for rental units 55
Table 21: NED for bonded housing 56
Table 22: NED for rental housing 56
Table 23: Population profile and growth 58
Table 24: Retail supply in the primary market area 59
Table 25: NED for retail space in the primary market area (cumulative demand in m^2) 60
Table 26: NED for office space (m^2) 61
Table 27: Population and household growth in the primary and secondary market areas 61
Table 28: Learner-educator ratio 62
Table 29: Threshold population 63
Table 30: Institutional capacity 63
Table 31: Student housing supply 64
Table 32: Student accommodation demand 65
Table 33: NED for student accommodation based on 15% interceptor factor 65
Table 34: Minimum norms and standards for ablution facilities 66
Table 35: Institutional capacity 67
Table 36: Threshold and access distances 70
Table 37: Bonded income categories, housing typologies, densities and forecasts 75
Table 38: Rental income categories, housing typologies, densities and forecasts 75
Table 39: Bonded requirements and demand for scenario one 76
Table 40: Rental requirements and demand for scenario one 76
Table 41: NED for student accommodation based on 15% interceptor factor 77
Table 42: Demand and requirements for social housing for scenario one 77
Table 43: Future retail and office space demand (m^2) for scenario one 78
Table 44: Bonded requirements and demand for scenario two 78
Table 45: Rental requirements and demand for scenario two 79
Table 46: NED for student accommodation based on 15% interceptor factor 79
Table 47: Demand and requirements for social housing for scenario two 79
Table 48: Future retail and office space demand (m^2) for scenario two 80

DRAFT

List of Maps

Map 1: Macro-Level Analysis 3
Map 2: Regional connectivity 4
Map 3: Site-level analysis 5
Map 4: Surrounding land uses 6
Map 5: Market area delineation 7
Map 6: Savanna City 30
Map 7: Distribution of retail centres 32
Map 8: Distribution of schools in the primary market area 35
Map 9: Distribution of tertiary institutions in the market area 37
Map 10: Vaal University of Technology number of student enrolments 38
Map 11: Distribution of key health care facilities 42
Map 12: Existing supply of schools in the primary market area 62
Map 13: Distribution of clinics in the primary market area 67

DRAFT

Executive Summary

Park Extension 16 is located in Vereeniging, Gauteng Province. The proposed site is approximately 151 hectares in extent and is planned to include 7 250 high-density residential units.

Spatial Analysis

Vereeniging is located approximately 60 km south of Central Johannesburg and approximately 12 km from the Free State provincial boundary. The major land uses surrounding the proposed development site include open spaces, residential development, and agricultural holdings. The proposed development will be a mixed-use development with the potential to add great value to the area and will complement the existing urban fabric by providing supplementary services, activities and other complementary land uses.

Macro-Economic Analysis

GVA output of South Africa in 2018 was approximately R2.85 billion. A notable decline in the South African GVA in from 2008 to 2009 can be identified, due to the Global Recession. The economy of South Africa also experienced stubborn growth since 2015. The manufacturing sector makes the largest contribution (28%) to the total GVA of Emfuleni LM, followed by general governance contributing 17%. However, manufacturing has shown a notable decline indicating that the industry is struggling and will affect the local economy and employment opportunities.

ArcelorMittal, a major supplier and manufacturer of steel products, is based in Vereeniging and created many job opportunities for people in the area. However, lacklustre performance, increasing electricity prices and increasing costs of raw materials resulted in a 30.5% decrease in share price in the past year, large-scale job losses and a drop in headline earnings. This will continue to affect employment and unemployment rate in the area and household income of people employed in the area.

The current interest rate stands at 9.25%, which is down by 0.75% since the beginning of 2019. This is a good indication of home affordability since a decline in the interest rate enables better bond affordability and household expenditure.

Since 2011, the inflation rate has remained relatively stable, and the current inflation rate stands at 3.7%. A lower inflation rate decreases financial pressure on households, which bodes well for home affordability as households have increased disposable income.

Socio-Economic Analysis

Population and Household

The population growth projections are based on a five-year historic growth rate of 0.42% per annum and a household growth rate of 0.99%. The population growth projections indicate the projected population for the primary market area (PMA) for 2021 is estimated at 319 531 people, comprising 99 855 households and is expected to increase to 331 812 people and 109 123 households by 2030. The projected increase in the population figures and the number of households shows that the demand for housing in the demarcated market area is growing.

Employment

Community, social and personal services (18%), and wholesale and retail trade (18%) make the largest contribution towards employment in the market. Additional land uses related to these industries can be considered for the proposed mixed-use development. The unemployment rate in Emfuleni LM increased from 29.3% in 2008 to 31.5% in 2018 meaning that people have less disposable income. The impact on the housing market is that people have less money available and may not be able to purchase a house or may encounter bond repayment issues.

Age Profile

The total PEA population accounts for approximately 70% of the total population and therefore a large portion of the population is able to generate personal income. A moderate portion of the population is below the age of 15 years and therefore it can be assumed that the demand for various goods and services will continue to exist as the younger portion of the population become economically active. A fairly large number of the population are economically active meaning this population can potentially spend money on housing and goods and services. However, the unemployment rate is increasing and will decrease disposable income of households.

Household Income

The annual weighted average household income of the PMA is R132 466.37 per annum. Overall, the delineated market area consists of low-income households which may limit disposable income of households. This means that less people will be able to purchase a house.

Education

A total of 33% of the primary market's population have completed high school and 36% completed some level of secondary school. A moderate to low education level results in a decrease in household income and reduces the ability of households to gain access to capital to purchase a house or that households are more likely to live in more affordable accommodation types.

Market Perspective

Residential

The housing market in Vereeniging experienced a continuous increase from 329 points in 2010 to 515 points in 2018. The performance of the housing market is increasing and, therefore, may be an indication that the demand for housing is also increasing.

The market area consists of 99.3% freehold residential units and indicate that freehold stock is most in demand. This could also be an indication of a market that requires higher densities.

The population in the surrounding area own their homes for longer, but recent sellers of 11 years and more may be an indication of a market that is moving out. One reason for this is the declining local economy leading to fewer job opportunities available. Therefore, people may seek job opportunities in other areas, neighbouring towns, or cities.

The average house price for freehold units increased from R446 000 in 2009 to R1 025 000 in 2018. The average sales price decreased with almost 20% to from the R1025 000 in 2018 to R824 700 in 2019. Since 2016, the average sales price for sectional title schemes continued to increase to R 765 000 in 2018, after which it experienced a decrease in the average sales price, reaching R588 000 in 2019. The average sales

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price for vacant land increased from R166 500 in 2013 to R424 000 in 2019. The general decline in house prices (evidently seen in 2018/19) can be an indication of a residential market that is in an oversupply of houses to buy.

The tenure profile indicates that fully paid homes currently make up the largest portion of the PMA (39%). However, rental tenure is also popular presenting an opportunity to provide a mix of tenure types.

Retail

The trading density growth (as recorded in September 2019) increased with 4.3% over a period of one year in current price terms. The growth of 4.3% consisted of 5.5% growth in sales and a 1.2% increase in the trading area. The per capita spent increased with 1.7% while foot count increased with 2.5%, also contributing to the increase in trading density. The largest merchandise categories include electronics, food (grocery and supermarket tenants) and department stores.

There is no retail centre within 5 km from the proposed development site in Unitas Park, indicating the need for a retail centre to serve the population of Sonland Park and Unitas Park. The PMA consists of approximately 208 000 m2 gross leasable area (GLA) of retail space. The major anchor shops are Shoprite Checkers, Pick n Pay, and PEP. This indicates the presence of stores that capture and appeal to the local market and could be considered for a newly developed retail centre.

Office

The average rental rate in Three Rivers is R68.58 per square meter per month, whereas the average rental rate for Central Vereeniging is R62.52. The area surrounding the proposed site is not popular in terms of office space. Due to the low number of offices in the PMA, there are limited data regarding vacancy rates. It is however recommended that office space only be considered as an auxiliary land use and should target small businesses or consider office space for government departments.

Education

The nearest primary school is approximately 3.5 km from the proposed site. Additionally, a total of 77 schools are situated within the primary market area. Most schools in the PMA are primary schools. It is also evident that the demand for primary education is high due to the learner-educator ratio being higher than the average as per the OECD Indicators.

There are four main tertiary institutions in the market area. Sedibeng TVET College (Vereeniging Campus) is the closest campus to the proposed site and located approximately 10 km from the site. Other tertiary institutions are also located within reasonable proximity to the proposed development, indicating that the proposed development site could include student housing as part of the mixed-use development.

The following summarises the growth in the number of students enrolled at tertiary institutions (as identified above).

	2016	2020
NWU Vaal Campus	6748	7931
Vaal University of Technology	19079	19402
Sedibeng TVET College	11 000	10 598

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The supply of student beds currently stands at 4 873 [1] Based on the data provided in the table above, it is evident that the number of student enrolments are increasing.

Clinics

The majority of clinics are located near the borders of the PMA. A total of 11 clinics are identified in this area, with most of these clustered in Sebokeng. The clinic closest to the proposed site is the Vaal Men and Women's clinic in Duncanville and is located approximately 8.6 km from the proposed site. The lack of clinics within 8 km of the proposed site indicates the need for a clinic to serve the population, especially in Unitas Park and Sonland Park.

Market Opportunity Analysis

The preliminary opportunity analysis considers the findings of the macro-economic and socio-economic property market trends and spatial analysis. This enables the identification of land uses with the highest development potential under current market conditions. The land uses identified with the highest development potential include residential, student housing, retail, clinic, school and office.

Market Potential Analysis

Residential

The demand for new residential development was determined by applying a set of residential indicators to the demand calculation model. The household income ranges and the projected household numbers were used to project the demand for both bonded and rental housing in the market area. The Net Effective Demand (NED) calculates the market gap for new housing development in the demarcated market area.

An injection factor refers to the potential tenants who would relocate to the direct market area if an opportunity to do so was presented. A leakage factor refers to the net outflow of households from within the direct market area. A 20% injection factor was applied to the effective demand whereas a 35% leakage factor was applied to compensate for the migration of households from the direct market area.

The NED presents the development potential (market gap) for residential development within the demarcated market area in Vereeniging (see table below).

YEAR	BONDED					
	Subsidised	FLISP	Affordable Housing	Middle Income	High Income	Total
2021	839	374	160	169	23	1 565
2025	1 996	890	382	403	54	3 725
2028	2 895	1 290	554	585	78	5 401
2029	3 200	1 426	612	646	86	5 971
2030	3 509	1 564	671	709	95	6 547

[1] Due to time constraints, not all the number of beds have been included in this study. However some of the larger and popular student accommodation have been included as part of the supply.

The housing market is growing and there is a demand for new residential development. The greatest demand in the primary market area for bonded housing is subsidised and FLISP housing.

The following table shows the rental demand in the demarcated market area in Vereeniging.

RENTAL							
YEAR	CRU	Social Housing		Affordable Housing	Middle Income	High Income	Total
		Primary Market	Secondary Market				
2021	135	168	108	86	92	13	603
2025	322	401	258	205	218	30	1 434
2028	467	581	374	298	316	44	2 080
2030	566	705	454	361	383	53	2 521

There is a greater demand for CRU (705 units by 2030) and social housing (56 units by 2030).

Retail

The demand calculation model calculated the total effective demand for retail floor space and is expressed as GLA (m^2). The demand model is based on the interaction between the population and number of households, household income and expenditure, leakages and injections, and trading densities

The following table presents the NED retail floor space in the primary market area.

	2020	2022	2025	2028	2030
NED	14 900	17 700	22 006	26 441	29 472

The NED is expected to increase to reach 22 006 m^2 by 2025 and 29 472m^2 by 2030.

Office

Growth projections are applied to office standard industrial parameters, which allows for the calculation of the total increase in effective demand for office floor space required per annum to sustain the office sector's growth in the market area.

The following table provides the NED for office space in the primary market area.

	2020	2022	2025	2026	2028	2030
NED	1 354	2 773	7 292	8 880	12 182	15 662

The NED for the office space in the primary market is expected to increase to 15 662m^2 by 2030.

Schools

The main factors used for determining the demand for schools are the supply of schools in the market area, population numbers, and learner-educator ratios. The closest school is located 3.5 km from the proposed site. The table below indicates the average learner-educator ratio and average OECD indicators.

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Schools	Learner-educator ratio (LER)	Average OECD Indicators[2]
Primary schools	32:1	19:1
Secondary schools	25:1	28:1

The learner-educator ratio for primary schools is higher compared to that of the OECD indicators, which also indicates the demand for additional schools. The minimum norms and standards was used to identify the threshold population for determining the demand for educational facilities.

Educational facility	Threshold Population
Crèche/nursery	2 400 – 3 500
Primary Schools	2 200 – 6 600
High School	4 000 – 10 000

To calculate the demand and institutional capacity for various educational facilities, the projected population was divided by the respective threshold population. The following table presents the calculated demand and the number of educational facilities.

Year of full potential	2021	2023	2025	2028
Crèche/nursery	3	5	7	10
Primary schools	3	5	8	11
Secondary / High school	2	3	4	6

Student Housing

The calculations used to quantify the need for student accommodation made use of the projected demand and existing and future supply in student accommodation. The following table provides the estimated projected student enrolments at the various tertiary institutions.

	2021	2022	2025	2028	2030
North-West University Vaal Campus	8 225	8 533	9 529	10 642	11 455
Vaal University of Technology	19 346	19 378	19 475	19 572	19 638
Sedibeng TVET College	10 756	10 918	11 417	11 938	12 299

The interception factor refers to the portion of demand within the market areas that the proposed student accommodation development will be able to capture. A conservative approach is applied to ensure a realistic outcome therefore, a 15% interceptor factor was used to calculate the effective demand. The NED for student housing is expected to increase from 3 703 beds in 2021 to 4 751 beds in 2030.

	2021	2022	2025	2028	2030
Number of students	38 327	38 829	40 421	42 152	43 392

[2] OECD, Education at a Glance 2014 OECD Indicators: OECD Indicators, p. 446-452

Number of beds	4 873	4 873	4 873	4 873	4 873
Interceptor factor	15%	15%	15%	15%	15%
NED	3 703	3 810	4 140	4 497	4 751

Clinics

Most clinics in the market area are clustered in Sebokeng. The clinic closest to the proposed development is the Vaal Men and Women's clinic in Duncanville and is located approximately 8.6 km from the proposed site. This illustrates the need for a clinic to serve the population in the PMA.

Year of full potential	**2021**	**2023**	**2025**	**2028**	**2031**
Clinic	1	2	3	5	4

The table above indicates that five clinics will be required by 2028 to serve the growing population in this area.

Innovation and Incubation Hub

The innovation and incubation hub can play an important role in establishing networks, partnership and an integrated mixed-use development space. It can also facilitate economic growth and create job opportunities through skills development and mentoring programmes. These skills can be implemented and used in various small businesses and various industries. Partnerships with various institutional and educational facilities can be established in thereby driving research programmes, can provide innovative inputs within various programmes run by the hub.

Supplementary Land-Uses

The minimum norms and standards is used to identify supplementary land uses. The population threshold indicates the number of people required to sustain a particular facility. Schools, clinics and government department offices are identified as additional land uses.

Conclusion and Recommendations

The recommendations provide two scenarios that incorporate development potential and requirements for residential units, retail and office space, and additional social amenities. Scenario one considers all residential units within a given year whereas scenario two excludes CRU and subsidised housing.

Scenario One

Scenario one looks at the requirements and the demand for various facilities for the proposed mixed-use development. The residential demand and requirements include all residential categories for both bonded and rental housing. The following table provides a breakdown of the residential demand and requirements for bonded housing.

	2021	**2023**	**2025**	**2028**	**2031**
Subsidised	839	1 412	1 996	2 895	4 209
FLISP	374	629	890	1 290	1 702
Affordable Housing	160	270	382	554	731

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Middle Income	169	285	403	585	772
High Income	23	38	54	78	103
Total	**1 565**	**2 634**	**3 725**	**5 401**	**7 517**

The housing market is growing and there is a demand for new residential development. The greatest demand in the primary market area for bonded housing is subsidised and FLISP housing.

The following table provides a breakdown of the demand and requirements for rental housing.

	2021	**2023**	**2025**	**2028**	**2031**
CRU	135	228	322	467	617
Social Housing Primary Market	168	283	401	581	767
Social Housing Secondary Market	108	183	258	374	494
Affordable Housing	86	145	205	298	393
Middle Income	92	154	218	316	417
High Income	13	21	30	44	58
Total	**603**	**1 014**	**1 434**	**2 080**	**2 745**

There is a greater demand for CRU and social housing and is expected to increase to increase to 617 in 2031.

The following table provides a breakdown of the NED for student housing.

	2021	**2022**	**2025**	**2028**	**2030**
Number of beds	4 873	4 873	4 873	4 873	4 873
Interceptor factor	15%	15%	15%	15%	15%
NED (number of beds)	3 703	3 810	4 140	4 497	4 751
Number of beds per unit	4	4	4	4	4
Demand (number of units)	926	953	1 035	1 124	1 188

Based on a 15% interceptor factor, the NED for student housing is expected to increase from 3 703 beds in 2021 to 4 751 beds in 2030. By calculating the number of units required for student accommodation, it is recommended that each unit accommodate four students. The projected demand for units is 926 for the year 2021 and is expected to grow to 1 188 units by 2030.

The following table provides a breakdown of the number of social amenities required for each year, given the number of housing.

Year of Full Potential	**2021**	**2023**	**2025**	**2028**	**2031**
Crèche/nursery	3	5	7	10	7
Primary Schools	3	5	8	11	8

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Year of Full Potential	2021	2023	2025	2028	2031
High School	2	3	4	6	4
Clinic	1	2	3	5	4
Libraries	1	2	3	5	4
Community Centre	1	2	3	5	4
Religious Centre	4	6	8	12	9
Post Office	1	1	2	2	2
Police Station	1	1	2	2	2

The following table indicates the retail and office space requirements for each respective year until 2031.

	2021	2023	2025	2028	2031
Total retail space demand	16 294	19 122	22 006	26 441	30 995
Total office space demand	1 354	2 773	7 292	8 880	12 182

It is recommended that the retail and office space is student-orientated to ensure that the student housing development is supported by the necessary retail and office services.

Scenario Two

The residential demand and requirements for scenario two exclude CRU and subsidised housing. The following table provides a breakdown of the projected residential demand.

BONDED					
	2021	**2023**	**2025**	**2028**	**2031**
FLISP	374	629	890	1 290	1 702
Affordable Housing	160	270	382	554	731
Middle Income	169	285	403	585	772
High Income	23	38	54	78	103
Total	**726**	**1 222**	**1 729**	**2 507**	**3 308**

The greatest demand is FLISP and affordable housing. The demand for FLISP housing is expected to increase to 1 702 by 2031 and the demand for affordable housing is expected to increase to 731 by 2031.

The following table provides a breakdown of the demand and requirements for rental housing.

RENTALS					
	2021	**2023**	**2025**	**2028**	**2031**
Social Housing Primary Market	168	283	401	581	767
Social Housing Secondary Market	108	183	258	374	494

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RENTALS					
	2021	**2023**	**2025**	**2028**	**2031**
Affordable Housing	86	145	205	298	393
Middle Income	92	154	218	316	417
High Income	13	21	30	44	58
Total	**467**	**787**	**1112**	**1613**	**2129**

The greatest demand in terms of rental housing is social housing. The demand for social housing in the primary market area is expected to increase to 767 by 2031.

The following table indicate the demand for student accommodation in the market area, based on a 15% interceptor factor.

	2021	**2022**	**2025**	**2028**	**2030**
Number of beds	4 873	4 873	4 873	4 873	4 873
Interceptor factor	15%	15%	15%	15%	15%
NED (number of beds)	3 703	3 810	4 140	4 497	4 751
Number of beds per unit	4	4	4	4	4
Demand (number of units)	926	953	1 035	1 124	1 188

The NED for student housing is expected to increase from 3 703 beds in 2021 to 4 751 beds in 2030. It is recommended that each unit accommodate four students. Therefore, the projected demand for units is 926 for 2021 and is expected to grow to 1 188 by 2030.

The following table provides a breakdown of the number of social amenities required for each year.

Year of Full Potential	**2021**	**2023**	**2025**	**2028**	**2031**
Crèche/nursery	1	2	3	5	7
Primary Schools	1	3	4	6	8
High School	1	1	2	3	4
Clinic	1	1	1	2	3
Libraries	1	1	1	2	3
Community Centre	1	1	1	2	3
Religious Centre	2	3	4	6	8
Post Office	1	1	1	1	1
Police Station	1	1	1	1	1

The following table indicates the retail and office space requirements for each respective year until 2031.

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	2021	2023	2025	2028	2031
Total retail space demand	16 294	19 122	22 006	26 441	30 995
Total office space demand	1 354	2 773	7 292	8 880	12 182

The three retail categories identified as those in highest demand include food and non-alcohol beverages (24.1%), clothing and footwear (10.5%), and recreation and culture (38.1%)

The percentages provided above indicate the suggested share of GLA that each of these retail facilities can contribute to the total retail space in the market area. In order to support and effectively establish a student oriented living space, it is recommended that retail is aimed at providing to the needs of students.

The top three office space categories as calculated using the office demand model include wholesale and retail trade, catering and accommodation (25.68%), finance, insurance, real estate and business services (18.15%), and community, social and personal services (18.92%). With the development of a student-orientated living space, it is recommended that office space are mainly focused on providing essential services to students and thereby creating a student-friendly environment.

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1. Introduction

Phumaf Consulting Engineers appointed Urban-Econ Development Economists to undertake market studies for the highest and best mixed-use development for Unitas Park Extension 16 in Vereeniging, Gauteng Province. It is understood that the proposed development is intended to consist of residential units and additional developments complementing the proposed residential development. The research should confirm the demand for the proposed product and guide the developers towards the best-suited typology mix.

The proposed site is approximately 151 hectares in extent and is planned to include 7 250 high-density residential units. Unitas Park Extension 16 is currently owned by the Gauteng Provincial Government and is zoned as farmland.

The site has a township layout with 2 680 erven which was approved but not proclaimed or registered due to constrained wastewater treatment capacity and electricity upgrades required. The site is in a dolomitic zone and further tests will be undertaken to confirm the risk category.

1.1. Project Brief

The brief of the study reveals a specialised analysis to determine the capacity of the local market to absorb a new residential development with complementary developments. It is understood that this study will be used to calculate the current demand for, and market feasibility of a new residential development located in Vereeniging, Gauteng Province.

Any development is strongly linked to the geographic attributes of the proposed site, as well as the demographic and economic characteristics of the target market. The outcome of this study will include the following components:

- Spatial analysis of the larger region
- A macro-economic perspective of South Africa
- A socio-economic analysis of the target market
- A market trend analysis (market perspective)
- A market opportunity analysis
- A market potential analysis
- Determination of supplementary land uses demand factors

1.2. Methodology

The research, which is based on Urban-Econ's extensive modelling of the target market and access to various datasets, is supported by primary research in the form of site visits. Secondary data, such as published documents, also inform the findings of this study.

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1.3. Report Outline

This sub-section provides an overview of the report and how each section contributes to the concluding recommendations provided in the final section. The following structure is followed to ensure that each aspect is explored and analysed to yield maximum benefits from potential opportunities.

Section 1: Introduction

- This section provides a brief description of the purpose of the study, the approach, and methodology that is followed. This framework provides a clear understanding of the expected outcome of the study.

Section 2: Spatial Analysis

- The spatial analysis provides an analysis of the proposed site and the areas surrounding it, highlighting essential factors influencing potential development.

Section 3: Macro-Economic Analysis

- Various macro-economic aspects are analysed to provide a clear understanding of the key economic sectors and economic trends in the area.

Section 4: Socio-Economic Analysis

- This sub-section provides an overview of the socio-economic and demographic trends of the market area.

Section 5: Market Perspectives

- In this section, the local market dynamics related to the intended use of the development are investigated. This is done to obtain a holistic perspective on key trends that could potentially affect the success of the proposed development.

Section 6: Market Opportunity Analysis

- The market opportunity analysis assesses the potential of each property type, as identified in the previous section, by considering prevalent economic and other market trends within the primary and secondary market areas. The findings of the preliminary opportunity analysis identify the property types with the highest development potential for further analysis. This section eliminates properties that may not be well-supported by the local market and highlights those that are considered the best use for the proposed development site.

Section 7: Supplementary Land Uses

- This section uses industry standards and population density related requirements to identify and guide complementary land uses for the proposed development site.

Section 8: Conclusions and Recommendations

- The final section provides the key recommendations from the previous sections. Additionally, this section makes recommendations for the highest and best use of the proposed development site along with other auxiliary land uses to be considered for future development.

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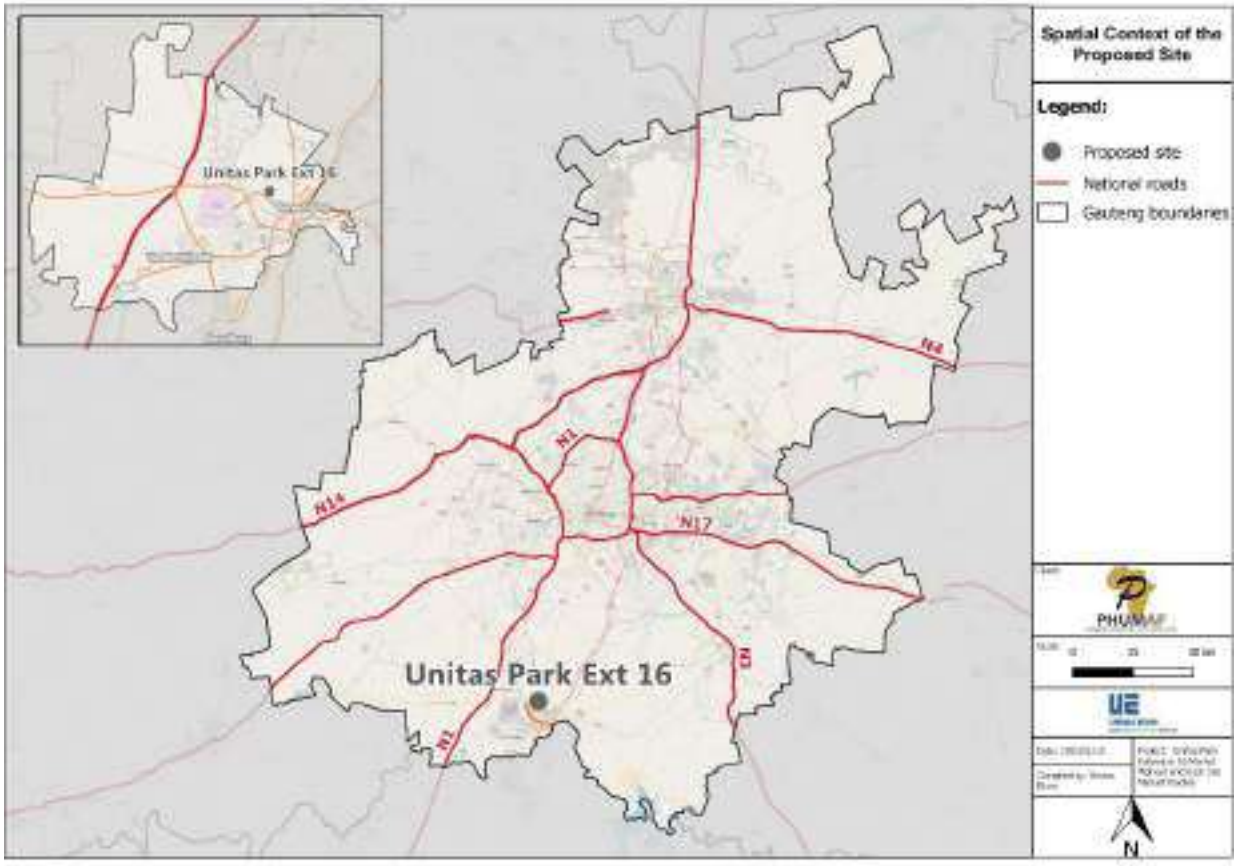
2. Spatial Analysis

The spatial analysis provides an analysis of the site and the area surrounding it. This section also unpacks the macro and micro spatial elements associated with the site and the area surrounding the proposed development site.

2.1. Macro-Level Analysis

The analysis of the site in the macro context highlights the proposed site in relation to the greater spatial environment in which it exists. The objective of this section is to establish connections and linkages from the site to the rest of the surrounding areas and to illustrate the expected movement of people both to and from the proposed site. The following map provides a macro perspective of the proposed development site within the context of the Gauteng province.

Map 1: Macro-Level Analysis



Source: QGIS, 2019

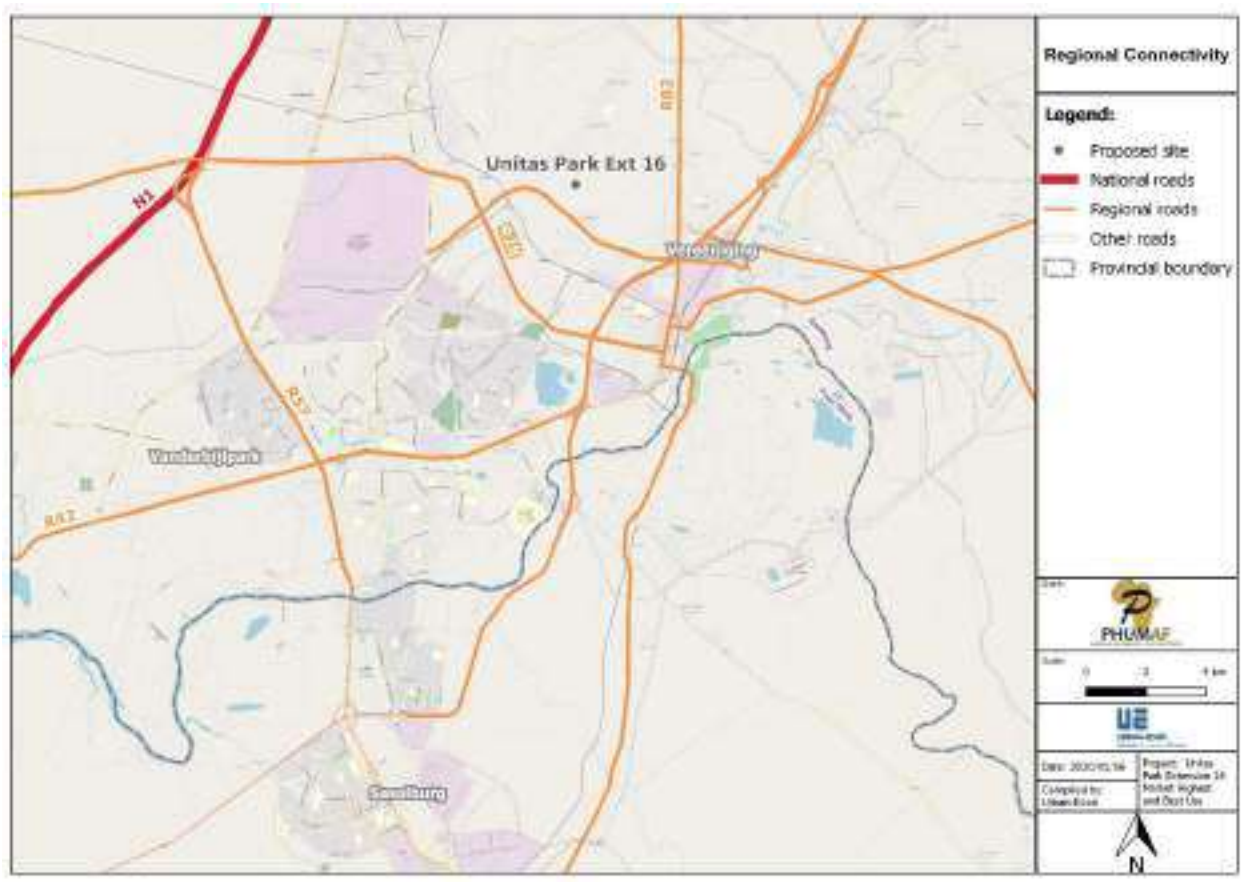
The proposed development is located in Vereeniging, in the western part of Emfuleni Local Municipality. Vereeniging is located approximately 60 km south of Central Johannesburg, 120 km from Tshwane. Vereeniging is located approximately 12 km from the Free State provincial boundary[3].

[3] Distance to the Free State border was measured from the proposed development site in Vereeniging to the nearest point on the Free State boundary accessed by road.

2.2. Regional Connectivity

Regional connectivity assesses the connections of the proposed development site in relation to the rest of the province; it also illustrates the important national and regional routes that grant access to the site and the rest of the province. The regional connectivity of the proposed development site is illustrated in the map below.

Map 2: Regional connectivity



Source: QGIS, 2019

The N1 national road is located approximately 12 km from the proposed site. Other major towns within close proximity include Vanderbijlpark (approximately 17 km), Sasolburg (approximately 32 km), and Meyerton (approximately 17 km). The R59 road facilitates traffic between Vereeniging and Sasolburg, while the R42 provides access to Vanderbijlpark.

2.3. Micro Context

The micro-level analysis aims to provide a more detailed perspective on the proposed development site by assessing the site's location in terms of local access routes and its surroundings. The following map depicts the local access and other routes providing access to the site.

Map 3: Site-level analysis

Source: QGIS, 2019

The proposed development is located in Unitas Park along the R54 road, which connects with the R26 road as well as the N1 national road. It should be noted that there is no direct access from the R54. Large areas surrounding the proposed site are vacant, while other land uses also include agricultural holdings and residential land use, amongst others. The surrounding land uses are discussed in more detail in sub-section 2.4.

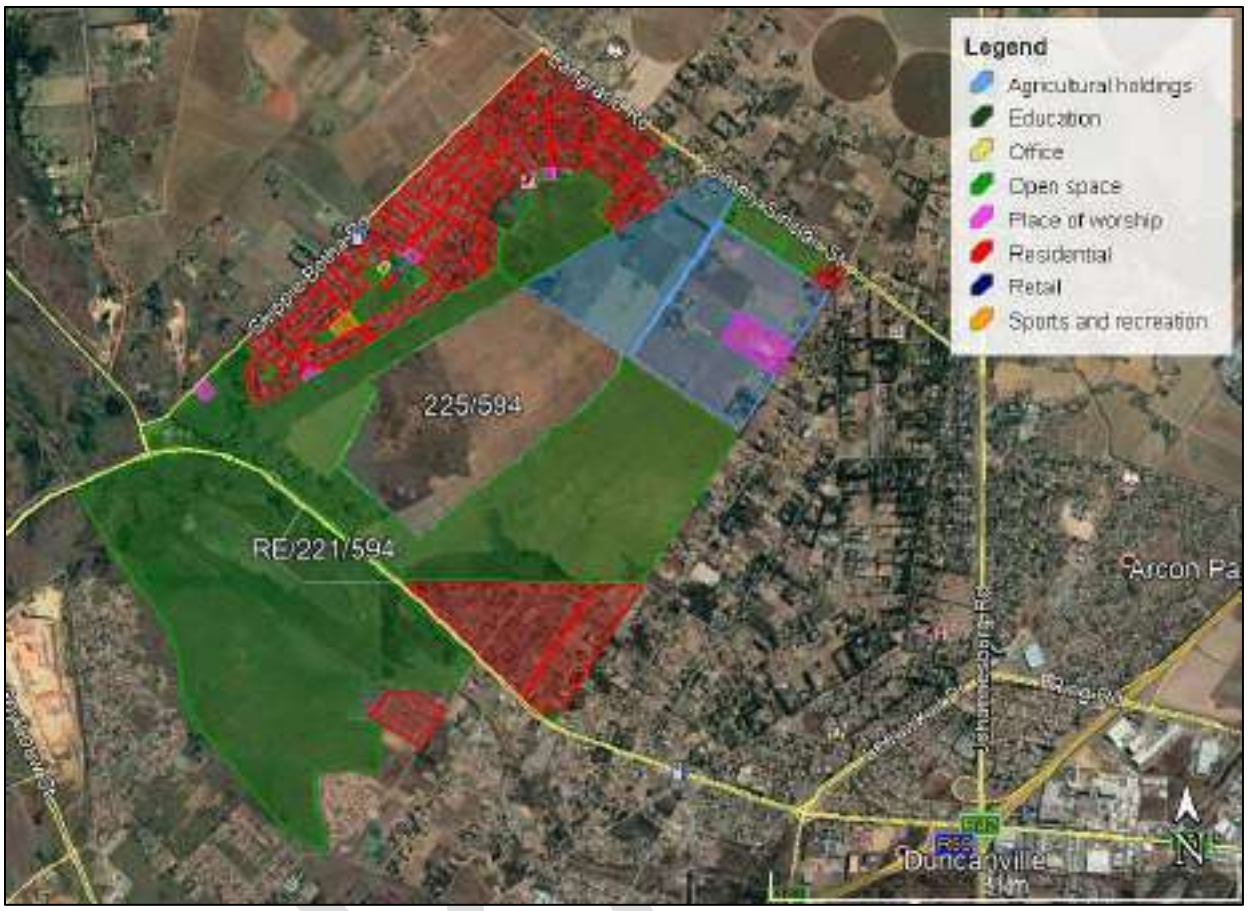
The map above shows some of the main suburbs within close proximity to the site. These suburbs are Steelpark (located towards the south of the proposed development), Sonlandpark (located towards the north of the proposed development), Waldrif, Arconpark (both located east of the proposed development), and Duncanville (situated southeast of the proposed development).

The proposed site can not be access from any regional or other major roads, but only from smaller roads within the neighbourhood. Additional access points from other roads can be considered to improve access to the proposed site.

2.4. Surrounding Land Uses

Analysing the surrounding land uses is essential to assess the appropriateness of the site and whether the proposed development will fit into the existing urban fabric. The following maps present the land uses surrounding the proposed development site.

Map 4: Surrounding land uses



Source: Google maps, 2020

A site visit was conducted in which the major land uses surrounding the proposed site were identified. The major land uses surrounding the proposed development site include open spaces, residential development, and agricultural holdings. A few churches exist in the area, along with some small retail facilities and a sports and recreational space.

The proposed development will be a mixed-use development with the potential to add significant value to the area. The proposed mixed-use development will complement the existing urban fabric by providing supplementary services, activities, and other complementary land uses.

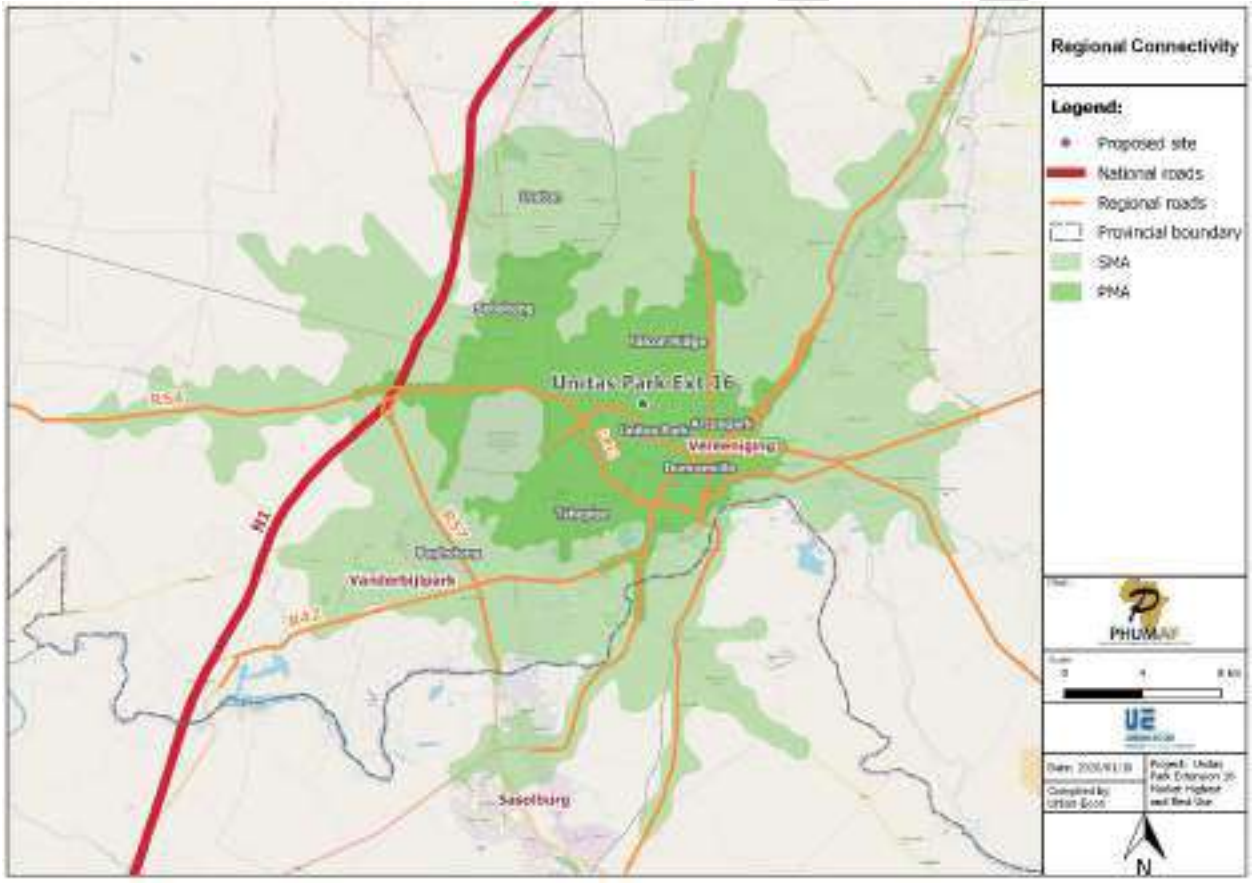
2.5. Market Area Delineation

The market area delineation makes use of several factors to derive an appropriate market area that is used to calculate the demand for housing and complementary land-uses. The market area delineation highlights the expected boundaries of the market area from which the proposed development may draw potential demand. Therefore, the market area is used to extract the necessary demographic and socio-economic data collated to simulate a demand scenario for the proposed development.

Two market areas were delineated for the proposed residential development. These market areas were based on 15-minutes' drive time for the primary market area and 25-minutes' drive time for the secondary market area.

The primary market area consists of Sebokeng, Falcon Ridge, Duncanville, Arcon Park, and Tshepiso. These areas represent the demographics of potential residents. The secondary market area consists of other outlying areas from which people may want to relocate. This market area includes a large part of the Vanderbijlpark and northern areas of Sasolburg. The primary and secondary market areas are illustrated in the map below.

Map 5: Market area delineation



Source: QGIS, 2019

Based on the drive time analysis, the location of the proposed site has the ability to attract potential market from far-reaching areas such as Vanderbijlpark and some areas of Sasolburg.

3. Macro-Economic Analysis

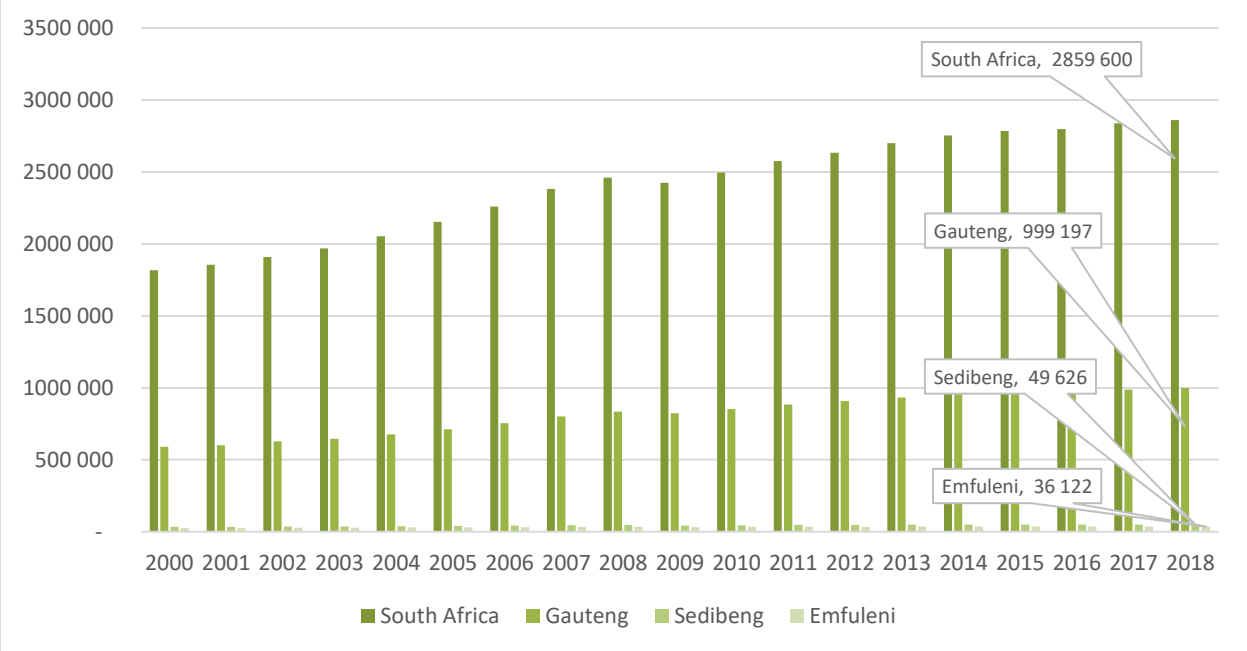
The macro-economic profile provides a detailed assessment of the composition and stability of the national and regional economies. The objective of the macro-economic analysis is to highlight significant economic trends that are likely to influence the development potential of the proposed development. The economic indicators determine specific economic trends that are used to assess the future potential growth of the local economy. In brief, the macro-economic profile covers the following components:

- National and provincial economic production
- Economic sector contribution
- Interest rate trends
- Inflation rate trends

3.1. GDP / GVA

A country's performance is measured by the growth of the gross domestic product (GDP) for each of its economic sectors. Gross domestic product is defined as the total value of goods and services that were produced within a specific geographical area during a particular period. The following figure represents the GVA growth for South Africa, Gauteng, Sedibeng District Municipality, and Emfuleni Local Municipality.

Figure 1: Gross Value Added (Constant Prices in R million) 2000 - 2018



Source: Stats SA Census 2011 Data via Quantec Easy Data, 2020

According to the data displayed in the figure above, the GVA output of South Africa in 2018 was approximately R2.85 billion. From this trend, the national economy has experienced positive growth since 2 000, which is expected to continue. A notable decline in the South African GVA in from 2008 to 2009 can be identified, due to the Global Recession. The economy of South Africa also experienced stubborn growth since 2015.

The annual growth rates of the national, provincial, and local economies are presented in the figure below.

Figure 2: GVA Growth Trend 2000 - 2018

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
South Africa	2.1%	2.9%	3.0%	4.3%	4.9%	4.9%	5.4%	3.3%	-1.4%	2.9%	3.2%	2.2%	2.6%	1.9%	1.1%	0.5%	1.5%	0.7%
Gauteng	1.9%	4.3%	3.0%	4.8%	5.3%	5.8%	6.2%	4.2%	-1.3%	3.3%	3.7%	2.7%	2.8%	2.5%	1.0%	1.3%	1.0%	1.1%
Sedibeng	1.5%	3.8%	4.2%	4.4%	5.1%	4.5%	6.2%	3.7%	-6.8%	3.5%	3.6%	1.5%	2.8%	1.4%	-0.5%	0.1%	0.7%	0.5%
Emfuleni	1.5%	3.5%	4.6%	4.4%	4.8%	4.3%	6.1%	3.3%	-7.5%	3.2%	3.6%	1.1%	2.6%	1.1%	-0.9%	-0.1%	0.4%	0.2%

Source: Stats SA Census 2011 Data via Quantec Easy Data, 2020

The local and district GVAs have experienced similar growth rate trends, whereas generally, provincial and national GVAs experienced similar growth trends. Based on the data, the local and national economies have in recent years experienced a downturn in their annual growth rates. After the 2008/09 recession, the South African economy recovered from negative economic growth to approximately 2.9% GVA growth in 2010.

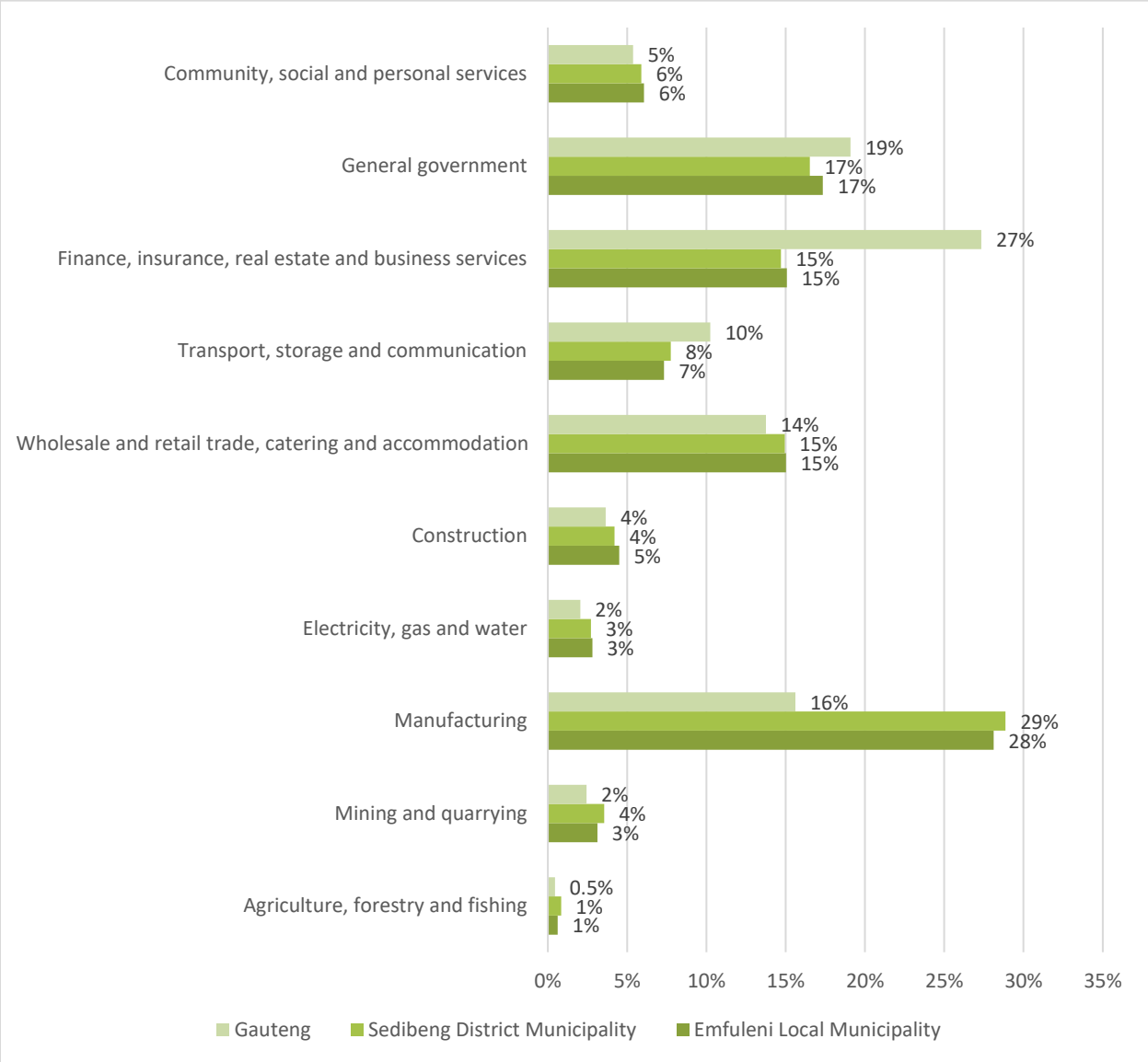
However, since 2011, the South African economy has experienced an incremental decline, with a reported GVA growth of 0.7% in 2018. At a provincial level, the GVA growth increased slightly from 1% in 2015 to 1.3% in 2016. The growth rate decreased in 2017, followed by a slight increase again in 2018 opposing the national trend. The GVA growth in 2018 for Gauteng was recorded at 1.1%, the Sedibeng District Municipality at 0.5%, and 0.2% in the Emfuleni Local Municipality. Recently, the GVA has grown by 3.1% quarter-on-quarter growth was recorded from quarter one to quarter two in 2019, with an annual growth of 0.9% from 2018 to 2019.

Generally, GVA for Emfuleni Local Municipality (LM) experienced a slowed economic growth trend from 2001 to 2018. The GVA growth trend shown in the figure above indicates little growth since 2015 – an indication that the economy of Emfuleni LM is stagnant. A stagnant growth trend also indicates that other economic indicators such as the unemployment rate are increasing. This may have further implications where people will seek job opportunities in neighbouring areas such as Johannesburg, and travel between their place of residence and areas of economic activity or where new job opportunities arise.

3.2. Economic Sector Contribution

Analysing the various economic sectors allows us to determine the overall economic contribution made by each sector and how they relate to each other. The following figure illustrates the contribution made by each sector to the respective geographical area.

Figure 3: GVA contribution per sector

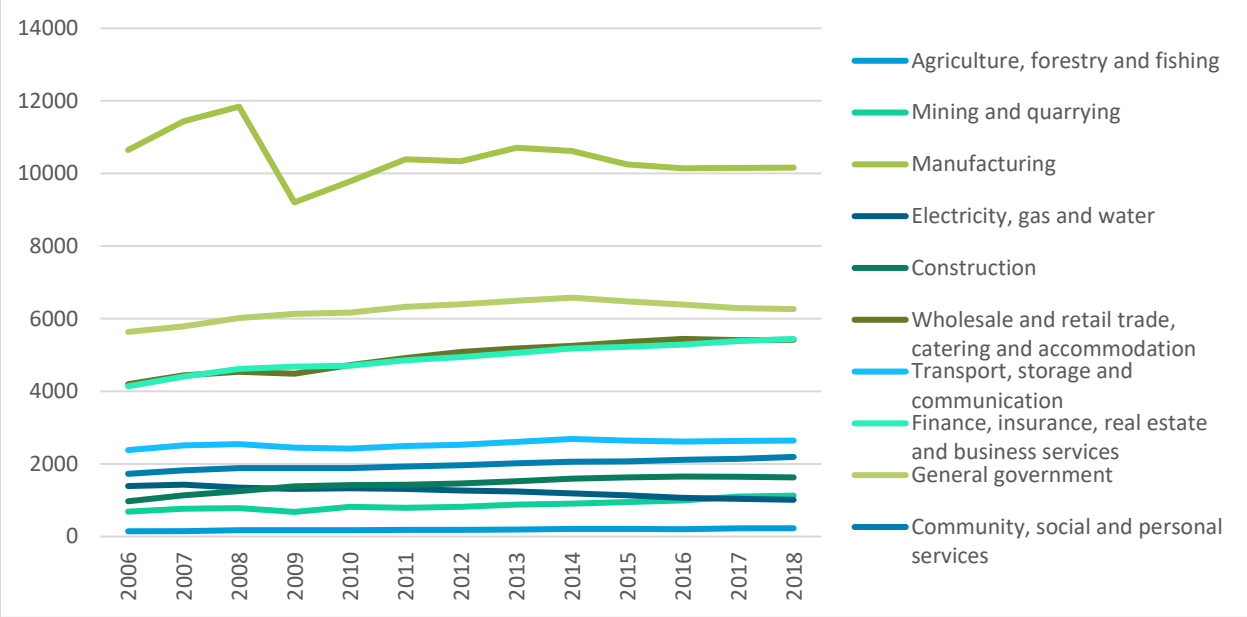


Source: Stats SA Census 2011 Data via Quantec Easy Data, 2020

The figure above provides the contributions made by economic sectors on the provincial, district, and local levels. The manufacturing sector makes the largest contribution (28%) to the total GVA of Emfuleni LM, followed by general governance contributing 17% to the total GVA of the local municipality.

The following figure shows the sectoral growth trends for Emfuleni Local Municipality.

Figure 4: Sectoral growth in Emfuleni Local Municipality (2006 – 2018)



Source: Stats SA Census 2011 Data via Quantec Easy Data, 2020

The trends provided above indicate that general government, finance, insurance, real estate and business services, and wholesale and retail trade, catering and accommodation experienced growth from 2006 to 2018. Manufacturing (the largest contributor to the municipality's GVA) has shown a notable decline indicating that the industry is struggling. This will affect the local economy and also employment opportunities within the industry.

ArcelorMittal, a major supplier and manufacturer of steel products, is based in Vereeniging and created many job opportunities for people in Vereeniging and surrounding areas. However, lacklustre performance, increasing electricity prices and increasing costs of other raw materials have had a major impact on this industry, resulting in a 30.5% decrease in share price in the past year, large-scale job losses and a significant drop in headline earnings[4]. Moving forward, this will continue to have a major impact on employment and the unemployment rate in the area and will also affect the household income of people employed in the area.

These impacts will also affect the GVA of the local municipality and result in a further decline in one of the municipality's leading economic sectors.

Manufacturing makes the largest contribution (28%) to the total GVA of Emfuleni LM. However, this leading economic sector is expected to decline as a result of increasing electricity prices and the increasing costs of other raw materials. The local economy will be affected in terms of employment, and the revenue generated through manufacturing and other industries and sectors, depending on this sector.

[4] Eye Witness News: Arcelormittal Layoffs May Be the First Of Many, Solidarity Warns. July, 2019. Available at: https://ewn.co.za/2019/07/11/arcelormittal-layoffs-may-be-the-first-of-many-solidarity-warns.

Another sector making a significant contribution to the GVA of the local municipality is the general government sector. This sector contributes 17% to the total GVA of Emfuleni LM. With this said, potential land uses for the general government sector could be considered and incorporated into the proposed development.

3.3. Interest and Inflation Rates

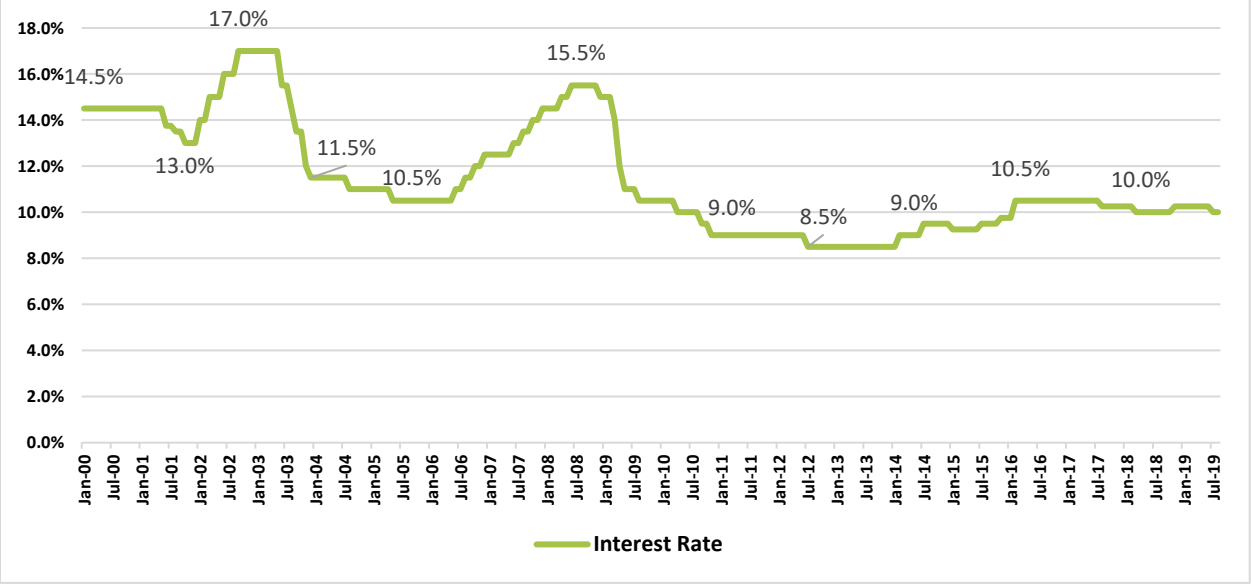
This sub-section provides an overview of the national interest and inflation rates over a period of 20 years (from January 2000 to January 2020).

3.3.1. Interest Rate

The interest rate is an additional market indicator that influences household expenditure and home affordability. Interest rates are directly linked to the level of consumer credit; thus, lower interest rates may result in higher disposable income for consumers with more credit facilities available. Additionally, interest rates have a direct effect on the housing market since a higher interest rate will have a negative impact on a homeowner's ability to secure a home loan and their ability to repay a home loan.

The real interest rate can be defined as the interest an investor expects to receive after allowing for inflation. It can be described more formally by the Fisher equation, which states that the real interest rate is approximately the nominal interest rate minus the inflation rate.

Figure 5: Interest rate



Source: South African Reserve Bank, 2015 - 2019

The most recent published statistics on the prime interest rates indicate that the interest rate has been decreasing since 2008, with a slight upward trend since 2013, seeing an increase to 10.5% in 2016. The current interest rate stands at 9.25%, which is down by 0.75% since the beginning of 2019. This is a good indication of home affordability since a decline in the interest rate enables better bond affordability and household expenditure.

Consumers are expected to have better access to capital due to the anticipated Repo rate reaching 6.25% in 2020, which is down from the average 6.5% repo rate as recorded in December 2019[5].

3.3.2. Inflation Rate

Inflation has a contributory effect on the level of disposable income within a country, which in turn influences the ability of households to gain access to home loans and credit facilities. An inflation rate can be broadly defined as the increase in prices of goods and services within a country, as presented in the national Consumer Price Index (CPI).

In terms of the residential market, inflation acts as a precursor of the prime interest rate since a rise in the inflation rate causes interest rate trends to follow suit. Thus, inflation can act as an indicator of the potential increase or decrease in the prime interest rate.

Figure 6: Inflation rate

Source: South African Reserve Bank, 2015 - 2019

The inflation rate experienced a drastic downward trend from 13% in the fourth quarter of 2002 to 0.2% in 2003, with a steep increase in 2008 to 13.7%. The inflation rate stabilised after the recession in 2008, with an inflation rate of 3.2% apparent in 2010.

Since 2011, the inflation rate has remained relatively stable, and the current inflation rate stands at 3.7%. A lower inflation rate decreases financial pressure on households, which bodes well for home affordability as households have increased disposable income. Economic analysists expected an average of 4.5% for headline inflation in 2019. The projection for 2020 is 4.8% and 5.0% for 2021[6].

[5] Business Tech: What to expect from the South African Reserve Bank in 2020. 23 December 2019. Available at: https://businesstech.co.za/news/finance/363032/what-to-expect-from-the-south-african-reserve-bank-in-2020/

[6] Bureau for Economic Research (BER): Survey of Inflation Expectations. 4th Quarter 2019.

4. Socio-Economic Analysis

The aim of the socio-economic profile is to provide an overview of the population characteristics of the market area. The profile elaborates on information that will be used to inform the demand calculation model for housing in the delineated market area. This will establish whether the proposed development can be absorbed by the demand in the market area. The following aspects are investigated in this section:

- Population and household profile
- Age profile
- Employment profile
- Employment per industry
- Household income profile
- Education profile

The data used in this section are primarily based on secondary statistical data which inform Urban-Econ's calculations and model. The socio-economic profile plays an essential role in establishing the viability of any development as it provides an understanding of local socio-economic trends, issues, and dynamics.

4.1. Population and Households

The population of the market forms the cornerstone of any residential development since it directly influences the demand for housing. A historic five-year average growth rate is utilised to project the future population size, which in turn is incorporated into the demand calculation model to calculate the future demand for residential development. The current and projected populations of the direct and indirect market areas are provided in the table below.

Table 1: Population and household profile

	2020	2021	2025	2030
Primary Market Area Population	318 195	319 531	324 932	331 812
Primary Market Area Household	98 875	99 855	103 872	109 123
Secondary Market Area Population	513 824	515 982	524 704	535 814
Secondary Market Area Household	163 698	165 320	171 971	180 663

Source: Stats SA Census 2011 Data via Quantec Easy Data, 2020

The population and household profiles are based on data from the National Census of 2011. The population growth projections are based on a five-year historic growth rate of 0.42% per annum and a household growth rate of 0.99%. These growth rates were used for both the primary and secondary market areas. The growth rates were applied to the population and household figures to project the future population growth using 2011 as the base year. Based on the findings of the population projections, approximately 318 195 people currently reside within the primary market area, comprising 98 875 households.

The projected population for 2021 is estimated at 319 531 people, comprising 99 855 households in the primary market area whereas 515 982 people and 165 320 households are expected in the secondary market area.

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The population of the primary market area is expected to increase to 331 812 people and 109 123 households by 2030.

Population growth is a good indication of the demand for housing. The projected increase in the population figures and the number of households shows that the demand for housing in the demarcated market area is growing. As the population increases, the labour pool also increases; thus, more people are situated near various employment opportunities.

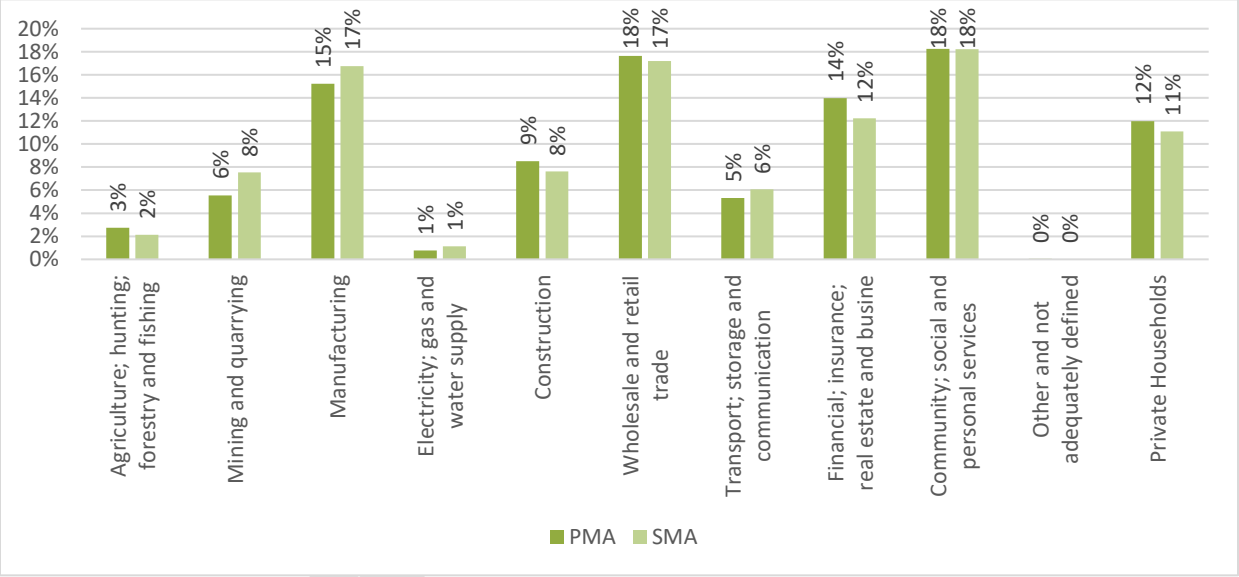
4.2. Employment

This sub-section relays information and data relating to employment within both the primary and the secondary market areas. The key topics discussed in this sub-section are the employment per industry and the employment profile, which looks at the employed and unemployed population within each market area.

4.2.1. Employment per Industry

The figure below indicates the employment per industry (provided in percentages for the respective market areas).

Figure 7: Employment per industry



Source: Stats SA Census 2011 Data via Quantec Easy Data, 2020

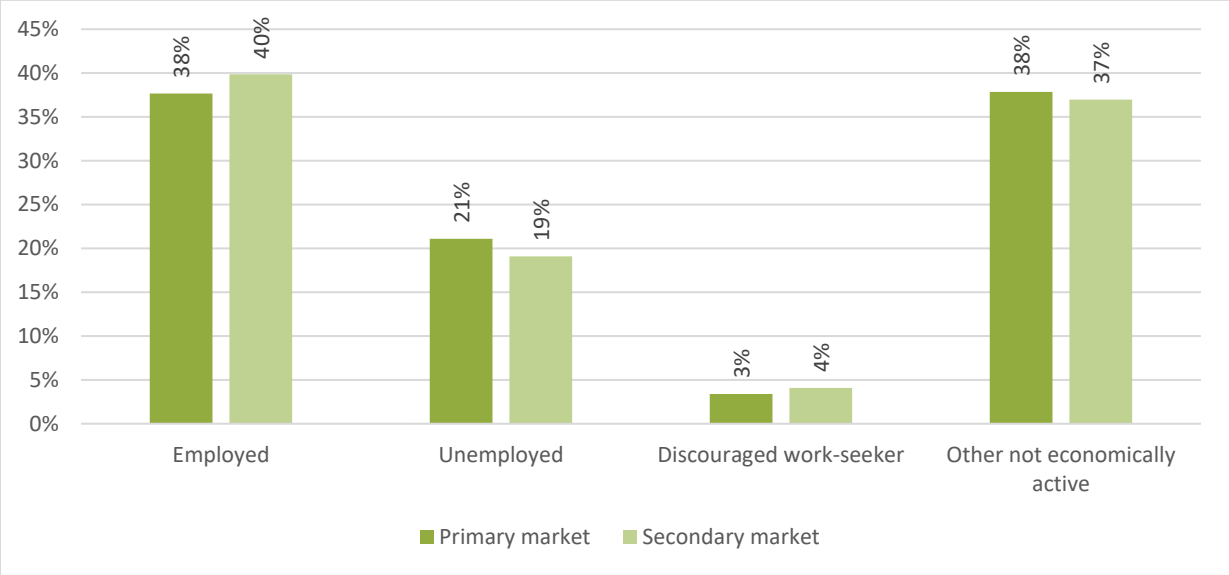
From the data provided in the figure above, it is evident that community, social and personal services, and wholesale and retail trade make the largest contribution towards employment in both the primary and the secondary market areas. Community, social and personal services contribute 18% to the employment of both the primary and the secondary market areas (respectively) whereas wholesale and retail trade contributes 18% to the primary market area employment and 17% to the secondary market area employment.

The industries making the largest employment contribution in the primary and secondary market areas are community, social and personal services, and wholesale and retail trade. This indicates that these are the most prominent industries in the area – therefore, additional land uses related to these industries can be considered for the proposed mixed-use development. Some of these facilities include offices for public administrative services, human health activities, and educational support services.

4.2.2. Employment Profile

The employment profile aims to provide a detailed breakdown of the activity status of the local population. The data used for the employment profile were derived from Stats SA. The employment profile of the market areas is provided in the figure below.

Figure 8: Employment profile



Source: Stats SA Census 2011 Data via Quantec Easy Data, 2020

Of the total population in the primary market, 38% are employed, 21% are unemployed, 3% are discouraged work-seekers and 38% are other not economically active population. These figures indicate that of the working-age population, most are not employed or economically active. Thus, a large portion of the population has a low disposable income, and therefore, does not have access to capital to buy a home.

4.2.3. Unemployment Rate

The following table provides the unemployment rate of the Emfuleni Local Municipality (LM) from 2008 to 2018.

Table 2: Unemployment rate of Emfuleni Local Municipality (provided in percentages)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Emfuleni LM	29.3	30.0	30.9	30.5	30.6	30.2	30.3	30.6	31.8	32.1	31.5

Source: Stats SA Census 2011 Data via Quantec Easy Data, 2020

The data provided in the table above show that the unemployment rate in Emfuleni LM increased from 29.3% in 2008 to 31.5% in 2018. An increasing unemployment rate results in a decrease in average household income, resulting in less disposable income for the population.

The unemployment rate is increasing, which means that people have less disposable income. The impact on the housing market is that people have less money available and, therefore, may not be able to purchase a house or may encounter bond repayment issues.

4.3. Age Profile

An age group classification is conducted to determine the percentage of the potentially economically active (PEA) population in relation to the not economically active (youth and retired) population. This illustrates the percentage of the population that will make up the majority of the potential target market. The following table presents an explanation of the age group classifications.

Table 3: Age group classification

Age	Category	Socio-Economic Contribution	Dependence
Younger than 19 years	Junior population	Non-working population who do not generate any form of income	Dependent on an adult to provide to their needs
Between 19 to 64 years	Potentially economically active (PEA) population	The working population and main generators of income	Independent/usually provide for the other groups
65 years and older	Senior population	Retired population who are no longer productive within the working environment	Dependent on government or relatives to provide for their needs

Source: Stats SA Census 2011 Data via Quantec Easy Data, 2020

The age profile of the market area is indicated in the figure below.

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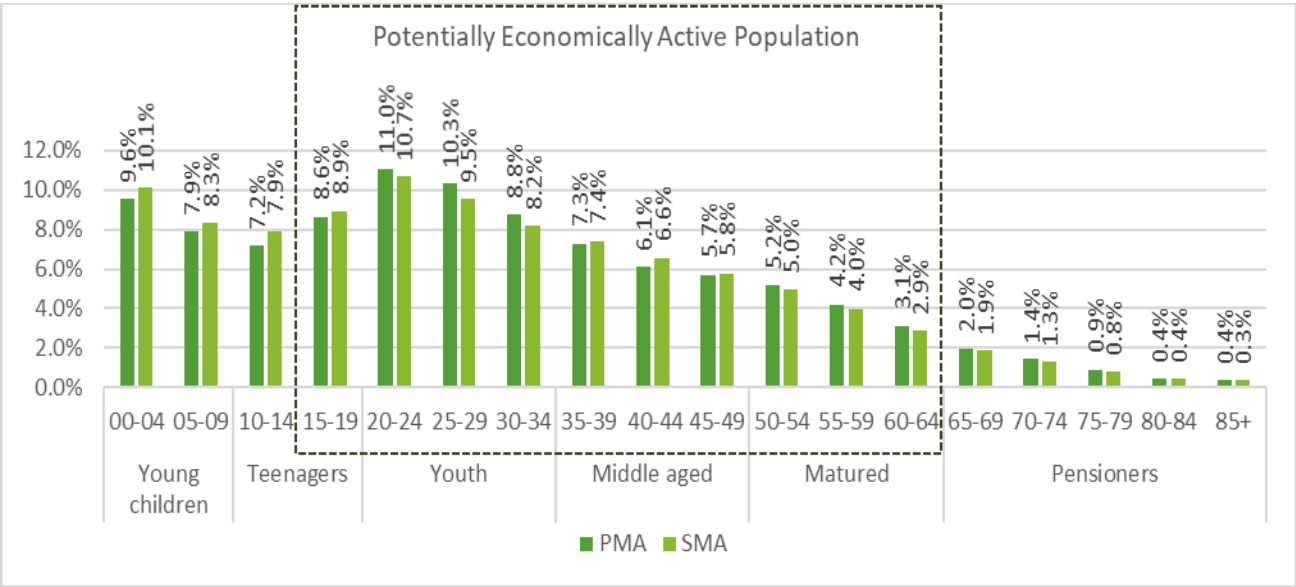
Figure 9: Age profile



Source: Stats SA Census 2011 Data via Quantec Easy Data, 2020

The primary market area consists of approximately 70% of the total potentially economically active (PEA) population, whereas 69% of the secondary market area is potentially economic active population. Based on this data, it is assumed that most of the population within the delineated market area can contribute to both the national and local economies. Both the primary and secondary market areas have a moderate number of young dependents relying on the support of the economically active population.

The total PEA population accounts for approximately 70% of the total population. Due to this high percentage of PEA population, a large portion of the population is open to employment and to generate personal income. In turn, this generates a higher disposable income, which increases housing (bonded and / rental housing) affordability in the area.

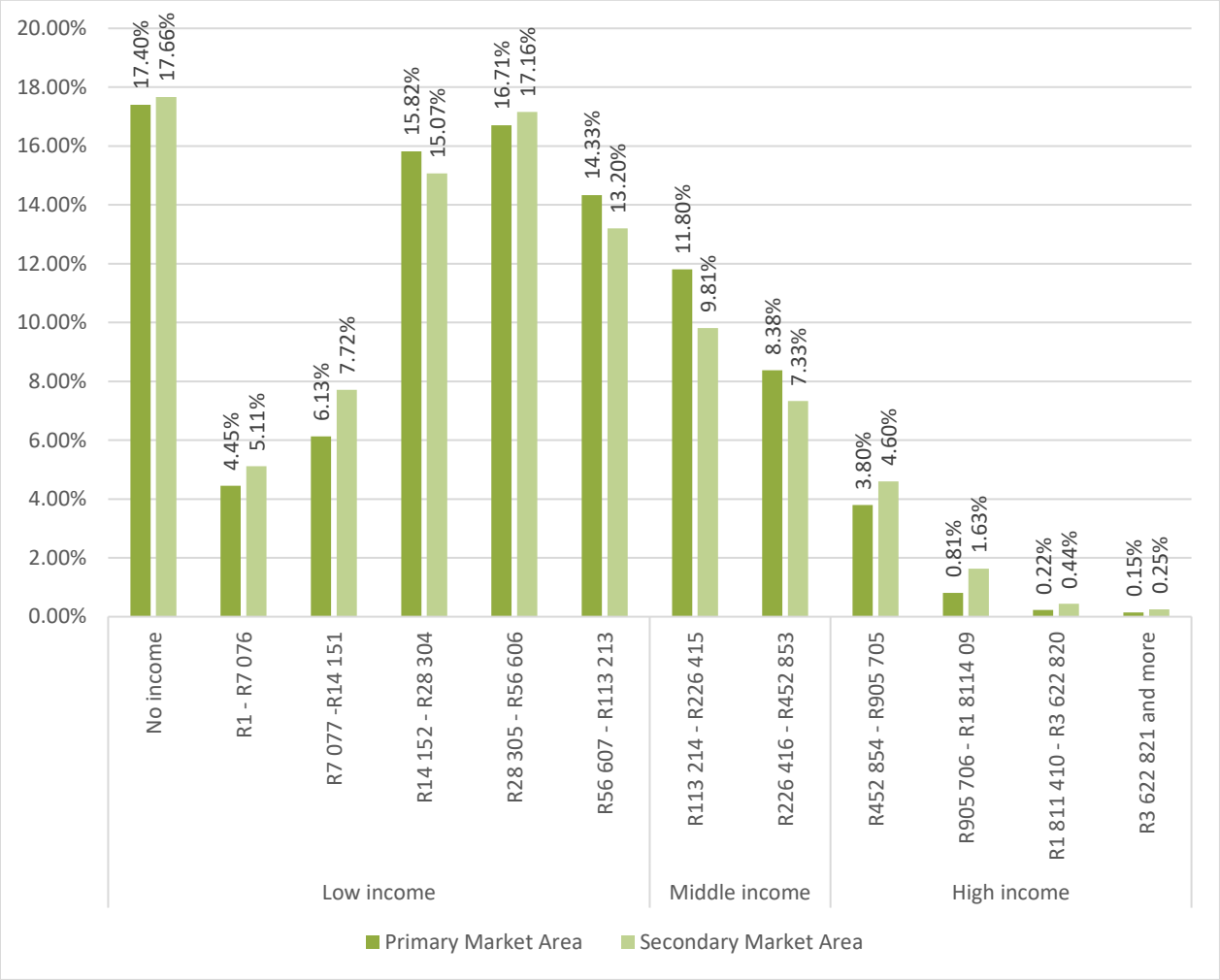
It should be noted that a moderate portion of the population is below the age of 15 years and therefore it can be assumed that the demand for various goods and services will continue to exist as the younger portion of the population become economically active. A large number of the population are economically active meaning that a large portion of the population can potentially spend money on housing and goods and services at retail facilities. However, as indicated in sub-section 4.2.2. the unemployment rate in the market area is increasing and thereby indicating that people have less disposable income. This could also indicate the need for additional employment opportunities.

4.4. Household Income

The household income profile assesses key factors that determine the viability of residential developments. Household income illustrates the overall prosperity of the local population and is a measuring tool to calculate the demand for housing across all income brackets.

The household income reflects the total amount of income available in the direct market area. Higher disposable household income is a good indication for any prospective development. The percentage distribution of household income in the market areas is presented in the figure below.

Figure 10: Household income profile



Source: Stats SA Census 2011 Data via Quantec Easy Data, 2020

The figure above shows the distribution of households in the market areas according to household income. Most households in both the primary (75%) and the secondary markets (76%) fall within the low-income band and earn R113 213 per annum or less. Approximately 17% of both the primary and secondary markets have no income. Approximately 20% of the primary market and almost 17% of the secondary market fall within the middle-income band, earning between R113 214 and R452 853 per annum.

A small proportion of the population in the primary market (5%) and in the secondary market (7%) fall within the high-income band. The largest portion of the population (16.7%) of the primary market area earns between R28 305 and R56 606, with a significant proportion of the primary market population (almost 16%) earning between R14 152 and R28 304.

A large portion of the population falls within the low-income brackets, indicating that residents do not have necessarily have access to capital to purchase a house.

4.4.1. Weighted Average Income

Weighted average income indicates the annual and monthly income per household within the primary and secondary market areas. The affordability of housing options is made apparent by calculating the average household income. The weighted average income of households within the primary and secondary market areas is indicated in the table below.

Table 4: Weighted average income

	Annual Weighted Income	Monthly Weighted Income
Primary Market Area	R132,466.37	R11,038.86
Secondary Market Area	R152,837.01	R12,736.42

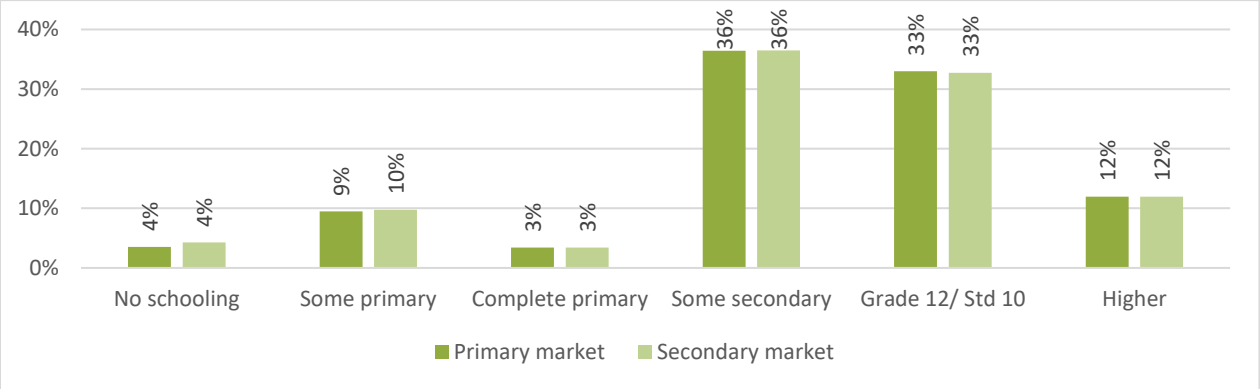
The annual weighted average household income of the primary market area is R132 466.37 per annum. The secondary market area's annual weighted household income is higher, at an average of R152 837.01 per annum. This suggests that the secondary market area's households have a higher disposable income.

Overall, the delineated market area consists of low-income households which may limit disposable income of households. This means that households have less people will be able to purchase a house. This also indicates the need for affordable retail options in the delineated market area.

4.5. Education

The sub-section aims to analyse the highest level of education of the two identified market areas. The level of literacy and levels of education are generally related to the level of income and hence also the disposable income of a market area. The following figure indicates the highest level of education in both the primary and the secondary market areas.

Figure 11: Highest level of education



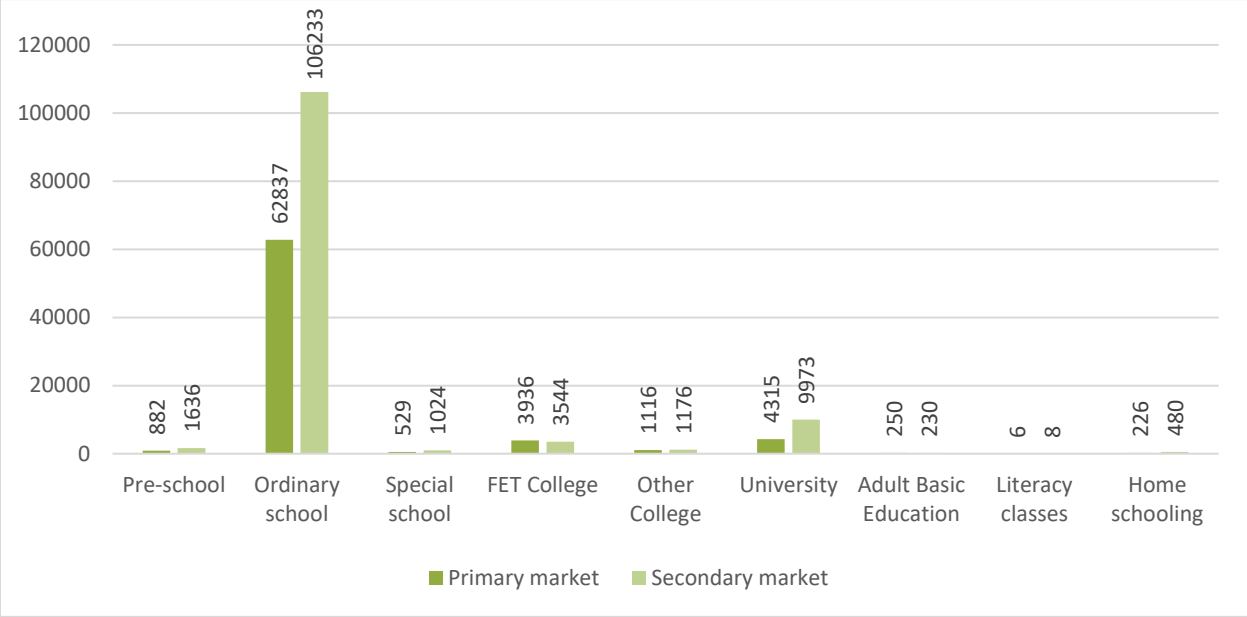
Source: Stats SA Census 2011 Data via Quantec Easy Data, 2020

The figure above indicates that the largest portion of both the primary (36%) and the secondary (36%) market areas completed some level of secondary education. A large proportion of the primary and secondary market areas (33% respectively) completed Grade 12. Furthermore, 12% of both the primary and the secondary market areas respectively completed some level of tertiary education.

The primary market area's education profile indicates that at least 45% of the population have completed high school or have studied further towards a tertiary qualification. A moderate to low education level results in a decrease in household income and reduces the ability of households to gain access to capital to purchase a house or that households are more likely to live in more affordable accommodation types.

The following figure illustrates the number of people (in both the primary and the secondary market areas) attending various educational institutions.

Figure 12: Attendance at an educational institution



Source: Stats SA Census 2011 Data via Quantec Easy Data, 2020

The data provided in the figure above shows that most of the population (of those who attended educational institutions) attended an ordinary school. A total of 62 837 people in the primary market and 106 233 people in the secondary market attended ordinary schools. Other educational institutions attended by the population in the market areas include FET colleges, universities, adult basic education, pre-schools, and special schools.

FET colleges are at the centre of skills delivery to drive the South African economy, thereby reducing unemployment and improving the livelihoods of millions of South Africans. Government has invested resources in public FET colleges to ensure that they deliver quality higher education and become institutions of choice for learners, parents and employers.

4.6. Living Standard Measure (LSM)

Living Standards Measure (LSM) categorises a population according to their living standards by using various classification such as ownership of cars and other major appliances etc. LSM 10 is considered the highest level of living standard. The following table provides the living standard measure (LSM) for each category within the primary market area.

Table 5: Living standard measure

Living Standard Measure (LSM)		Percentage of population
LSM 5		17%
LSM 6		31%
LSM 7	Low	4%
	High	25%
LSM 8	Low	9%
	High	3%
LSM 9	Low	6%
	High	4%

Most of the population (31%) falls within the LSM 6 category, whereas the second largest portion of the population (25%) falls within the LSM 7 (high) category. The majority of the population falls within the lower LSM groups.

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5. Market Perspective

The local market dynamics related to the intended use of the development are investigated by way of market analysis to obtain a holistic market perspective on key trends that could impact the potential success of the proposed development. The market perspective section will collectively look at the various suburbs that surround the proposed development site, which include the following:

- Falcon Ridge
- Acronpark
- Duncanville
- Tshepiso
- Sebokeng
- Bophelong
- Evaton

5.1. Residential

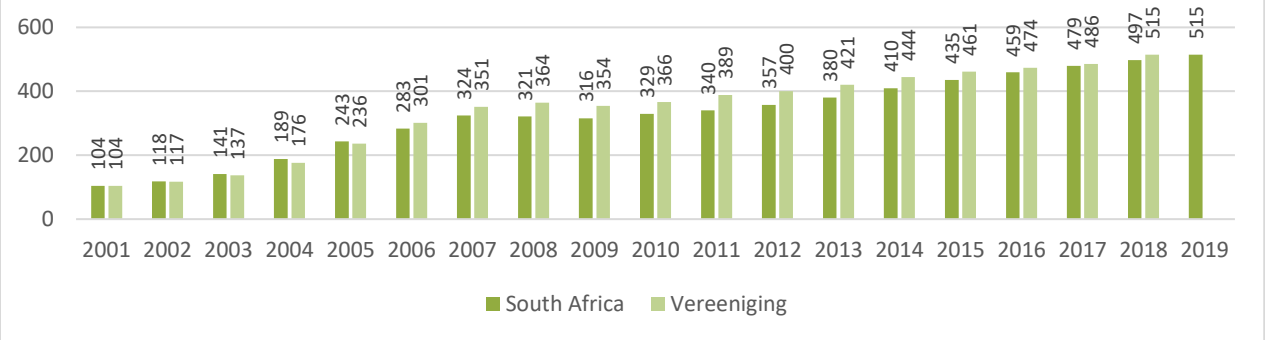
This sub-section provides a market perspective for residential developments in Vereeniging and key suburbs surrounding the proposed development site. An overview is provided on the following:

- House price index
- House market stock
- Period of residential property ownership
- Average house price
- The housing typologies
- Tenure status

5.1.1. House Price Index

The house price index (HPI) provides data on historical house price trends. Apart from serving as an indicator of house price trends, the house price index provides an analytical tool for estimating changes in the rates of mortgage defaults, re-payments, and housing affordability. The HPI is used to analyse historical and current market trends, which may be used to predict the performance of the housing market. The analysis of the housing market will provide a better understanding of housing trends and the potential success of the proposed development under current market trends. The following figure represents the First National Bank (FNB) HPI for South Africa and Vereeniging.

Figure 13: FNB House Price Index



Source: Stats SA Census 2011 Data via Quantec Easy Data, 2020

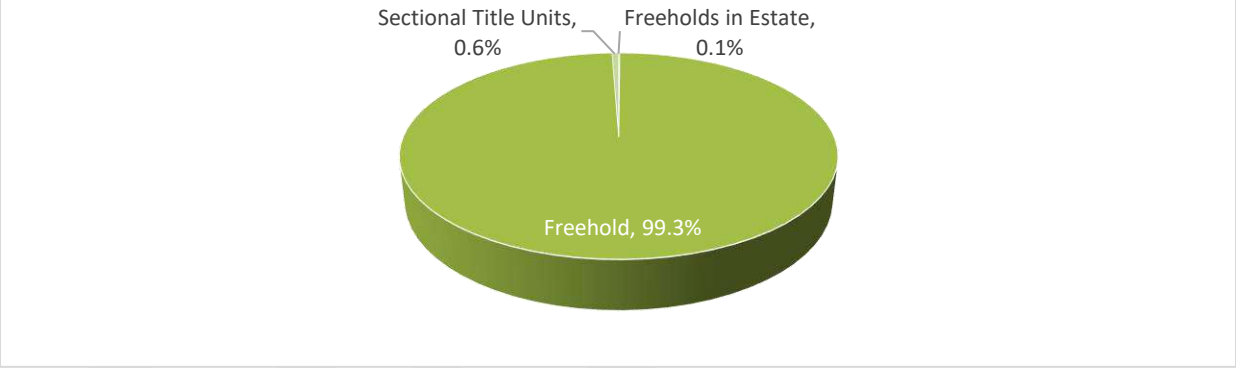
Based on the data provided in the table above, it is apparent that since 2001, the South African housing market experienced an upward trend to 324 points by 2007. From 2008, a brief decline is seen reaching 316 points in 2009. Thereafter, the housing market experienced a rise since 2010 and reached 515 points in 2019. The housing market in Vereeniging followed a similar trend compared to the housing market of South Africa[7]. A slight decline is also seen in 2008, after which the housing market experienced a continuous increase from 329 points in 2010 to 515 points in 2018.

The data provided in the figure above indicates that the performance of the housing market is increasing and, therefore, may be an indication that the demand for housing is also increasing.

5.1.2. House Market Stock

This section provides an overview of the residential market stock in areas surrounding the proposed development site, which mainly includes the suburbs Sonland Park and Unitas Park. The housing stock analysis will consider the number of registered residential units as well as the dominant residential typology within the defined area.

Figure 14: Residential market stock



Source: Lightstone Property Database, 2020

As indicated in the figure above, the residential market stock in areas surrounding the proposed development site consists of 99.3% freehold, 0.1% freehold in estates, and 0.6% sectional title units. This is an indication that freehold stock is most in-demand in the surrounding neighbourhoods.

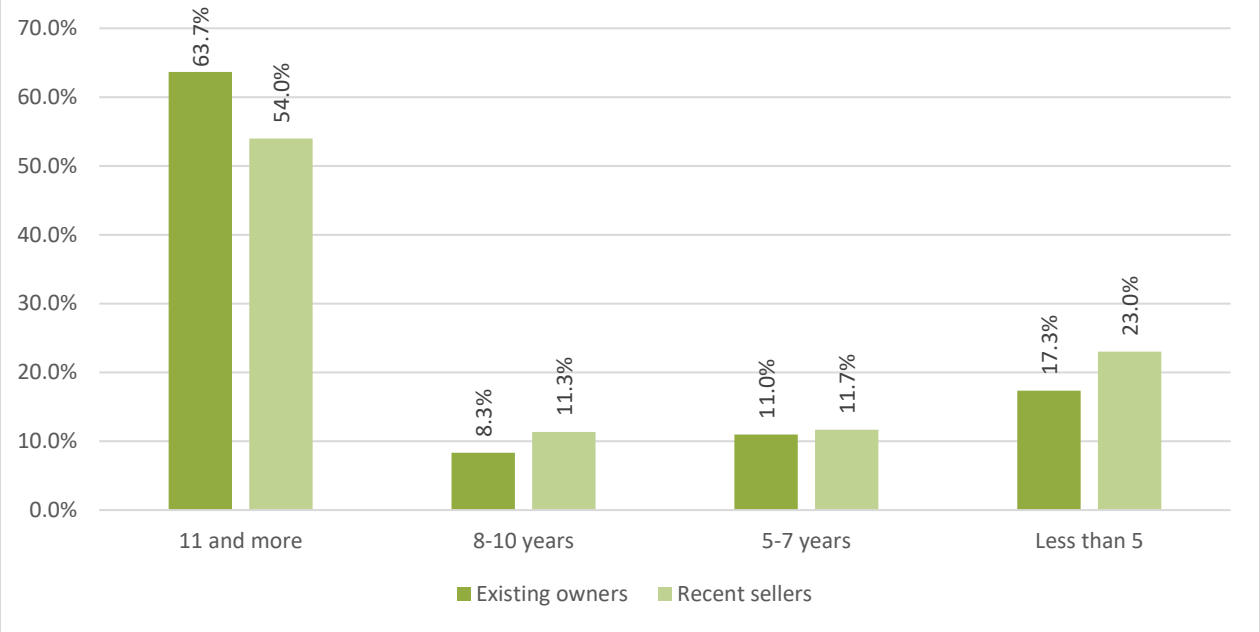
Freehold properties are highest in demand, but this could also be an indication of a market that requires higher densities.

5.1.3. Period of Ownership

The period of ownership refers to the number of years that residents have been residing in a specific area. Ownership is a good indication of the influx of people into and from the adjacent residential areas. The figure below illustrates the period of ownership of residents in the neighbouring residential areas.

[7] Data for the housing market in Vereeniging is only provided until 2018, as further data are not yet available.

Figure 15: Period of ownership (January 2019 to December 2019)



Source: Lightstone Property Database, 2020

The figure above indicates that 63.7% of existing owners in areas surrounding the proposed development site have lived in the area for 11 years or more, whereas 11% of existing owners lived in the same area for five to seven years, another 17.3% lived in the area for less than five years, and 8.3% of homeowners lived in the area for eight to ten years.

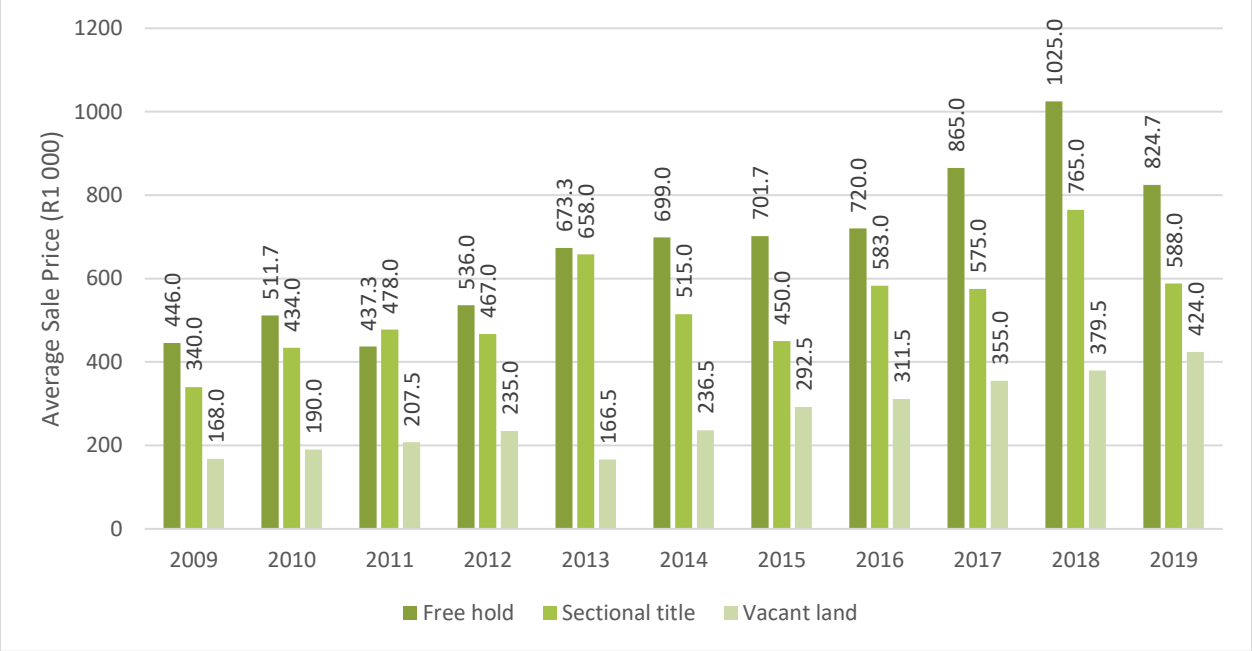
The population in the areas surrounding the proposed development site own their homes for longer, but recent sellers of 11 years and more may be an indication of a market that is moving out. One reason that might cause the population to move out is the declining local economy leading to fewer job opportunities available. Therefore, people may seek job opportunities in other areas, neighbouring towns, or cities.

5.1.4. Average House Price

The average sales price indicates the average number of households paying for a residential unit in the areas surrounding the proposed development site. These sales prices are important factors to analyse as they are an indication of the affordability of houses in the area.

The average sales prices of freeholds, sectional schemes, and vacant units from 2009 to 2019 (a period of ten years) are indicated in the figure below.

Figure 16: Average sale prices



Source: Lightstone Property Database, 2020

The data provided in the figure above provide the average residential price trend for the area surrounding the proposed development site and show the trends for different types of residential properties. A general increase in the average sales price for freehold units is evident. The average house price for freehold units increased from R446 000 in 2009 to R1 025 000 in 2018. The average sales price decreased with almost 20% to from the R1025 000 in 2018 to R824 700 in 2019.

The average sales price for sectional title schemes also increased from R340 000 in 2009 to R658 000 in 2013, after which it experienced a slight decrease, reaching R515 000 in 2014 and R450 000 in 2015. Since 2016, the average sales price for sectional title schemes continued to increase to R 765 000 in 2018, after which it experienced a decrease in the average sales price, reaching R588 000 in 2019.

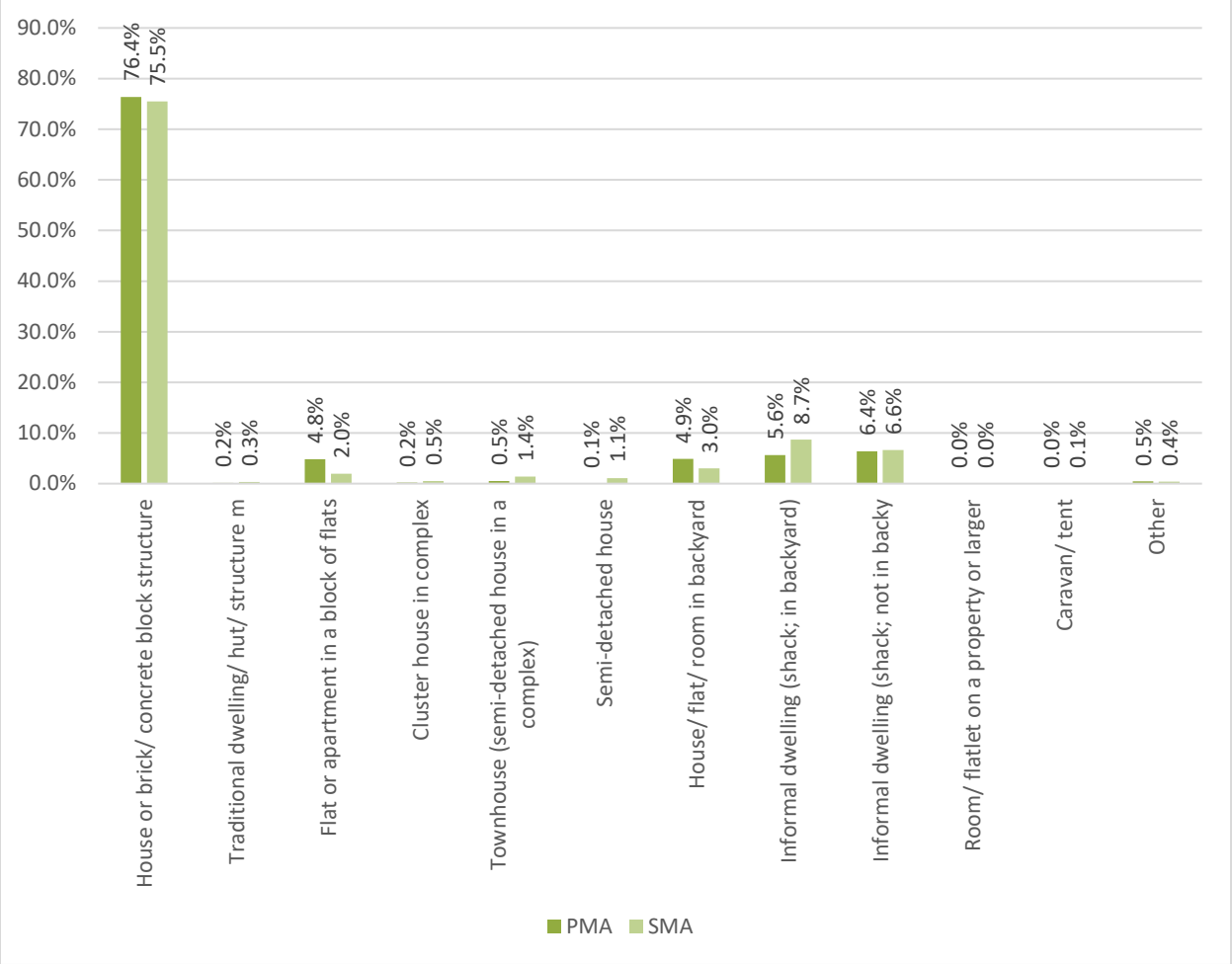
Generally, an increase in the average sales price for vacant land is evident over the past ten years. The average sales price for vacant land increased from R168 000 in 2009 to R235 000 in 2012, after which it decreased to R166 500 in 2013. The average sales price for vacant land continued to increase from R166 500 in 2013 to R424 000 in 2019.

Declining house prices (evidently seen in 2018/19) can be an indication of a residential market that is in an oversupply of houses to buy.

5.1.5. Housing Typologies

This sub-section provides an overview of the various dwelling typologies within the study area and their prominence within the market. The distribution of dwelling typologies within both the primary and secondary market areas are illustrated in the figure below.

Figure 17: Housing typologies in primary and secondary market areas



Source: Stats SA Census 2011 Data via Quantec Easy Data, 2020

The most prominent dwelling typology in both the primary (76,4%) and secondary (75.5%) market areas area is a house (brick or concrete block structure). Other typologies making a smaller contribution to the housing typology of the identified market areas include (1) informal dwelling type (shack, not in a backyard), (2) informal dwelling (shack, in a backyard), and (3) house, flat or room in a backyard.

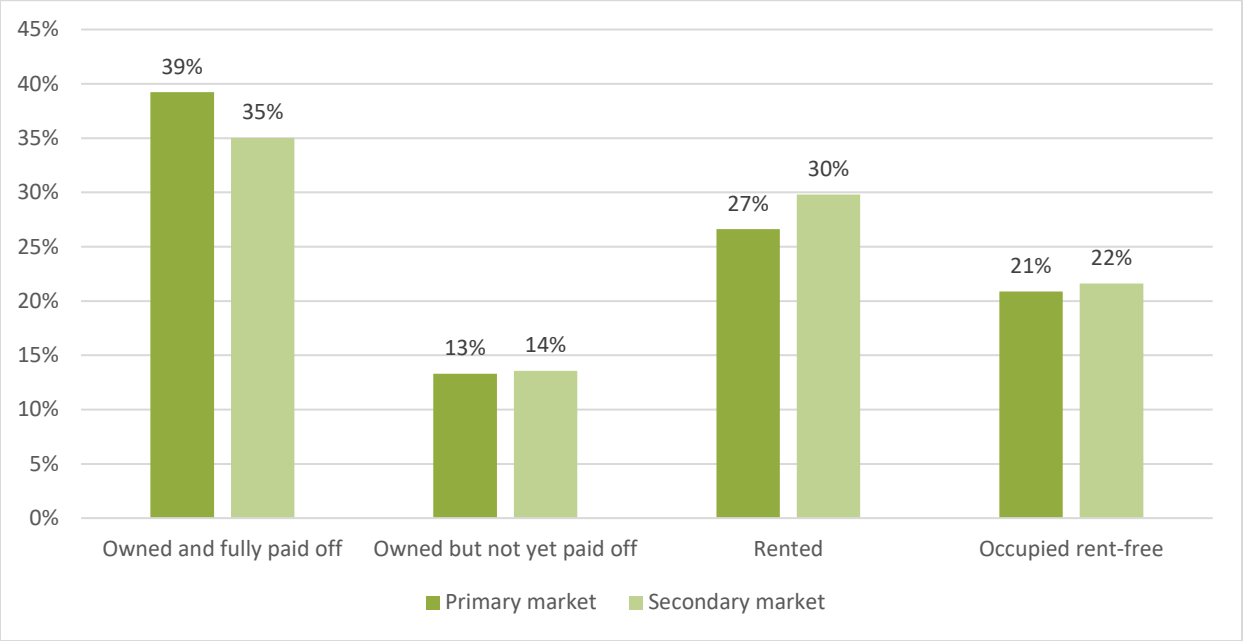
Informal dwelling types (shack, not in a backyard) contributes 6.4% to the housing typology in the primary market area and 6.6% in the secondary market area. Informal dwelling (shack, in a backyard) contributes 5.6% to the housing typology in the primary market area and 8.7% in the secondary market area. Houses, flats or rooms in a backyard contributes 4.9% to the housing typologies in the primary market area and 3% to the housing typology in the secondary market area.

The dominant housing types include a house or brick structure, which indicates that this type of housing is most in demand.

5.1.6. Tenure Status

Tenure refers to the extent of homeownership within the study area and the conditions under which land or buildings are occupied. The tenure status aims to present the distribution of tenure within the primary and secondary market areas. The tenure profile and status of the primary and secondary market areas are illustrated in the figure below.

Figure 18: Tenure status



Source: Stats SA Census 2011 Data via Quantec Easy Data, 2020

Most of both the primary (39%) and secondary (35%) market areas consist of homeowners with fully paid off homes. The second-largest portion of the primary (27%) and secondary (30%) market areas consist of rented homes, followed by 21% of the primary market and 22% of the secondary market with rent-free occupancy. The smallest portion of both the primary (13%) and the (14%) secondary market area consists of homes that have not yet been paid off.

The tenure profile indicates that fully paid homes currently make up the largest portion of the primary market area (39%). However, rental tenure is also popular, which presents an opportunity to provide a mix of tenure types within the proposed development as rental orientated developments are expected to be well received in the primary market area.

5.1.7. Similar Projects in the Region

This sub-section focusses on similar projects in this area, particularly looking at the Savanna City development.

Savanna City is a R24.9 billion development project of mixed housing development which focusses on affordability. This development includes fully bonded units, Finance Linked Individual Subsidy Programme housing, high-density apartments, and fully subsidised housing. Savanna City is a 1 462-hectare

development envisioned to include 16 schools, eight churches, nine business, and retail facilities, public parks, and 400 hectares of environmental area[8].

The development of Savanna City started in 2013 but struggled to get off the ground due to a number of challenges. The main issue related to the challenges experienced by this development is funding[4].

Other key factors that had an impact on the struggles of the development were mainly related to socio-economic issues such as rising interest rates, continued high unemployment, and limited household incomes[9].

Figure 19: Savanna City RDP houses

Source: Sedibeng Ster, 2019

The following table provides the average sales prices, average erf and floor size for various houses (categorised as per number of bedrooms and bathrooms.

Table 6: Savanna City average sales prices

	Price	Erf Size (m2)	Floor Size (m^2)
2 bedrooms, 1 bathroom	R 501 308	210	44
2 bedrooms, 1,5 bathrooms	R 526 380	215	50
2 bedrooms, 2 bathrooms	R 580 230	300	50
3 bedrooms, 1 bathroom	R 605 731	255	60
3 bedrooms, 1.5 bathrooms	R 611 439	200	55
3 bedrooms, 2 bathrooms	R 669 135	290	73

Source: Property 24, 2020

Based on information found on Property 24, most sales listings within Savanna City are units with two bedrooms and one bathrooms, and units with three bedrooms and two bathrooms. The average sales price for units with two bedrooms and one bathroom is R501 308 with an average erf size of 210m^2 and an average floor size of 44m^2. The average price of units with three bedrooms and two bathrooms is R669 135 with an average erf size of 290m^2 and an average floor size of 73m^2.

[8] Creamer Media's Engineering News: Basil Read enters new avenue with Savanna City residential development. June 2018. Available at: http://m.engineeringnews.co.za/article/basil-read-enters-new-avenue-with-savanna-city-residential-development-2018-06-07

[9] Creamer Media's Engineering News: Basil Read records R820m loss in challenging market. March 2015. Available at: http://www.miningweekly.com/article/basil-read-reports-r820m-loss-2015-03-27

These figures provide an indication of sales prices, popular housing types (based on number of bedrooms and bathrooms), and average size houses and can also be used as guidelines for housing development at the proposed site.

The map shows the spatial context of Savanna City and its proximity to the proposed development site.

Savanna City is located approximately 25 km from the proposed development site in Unitas Park, Vereeniging. The demarcated market area faces similar economic challenges than that of Savanna City.

Therefore, it is important to take note of these challenges and the potential impacts on the proposed development.

Map 6: Savanna City

Source: QGIS, 2020

5.2. Retail

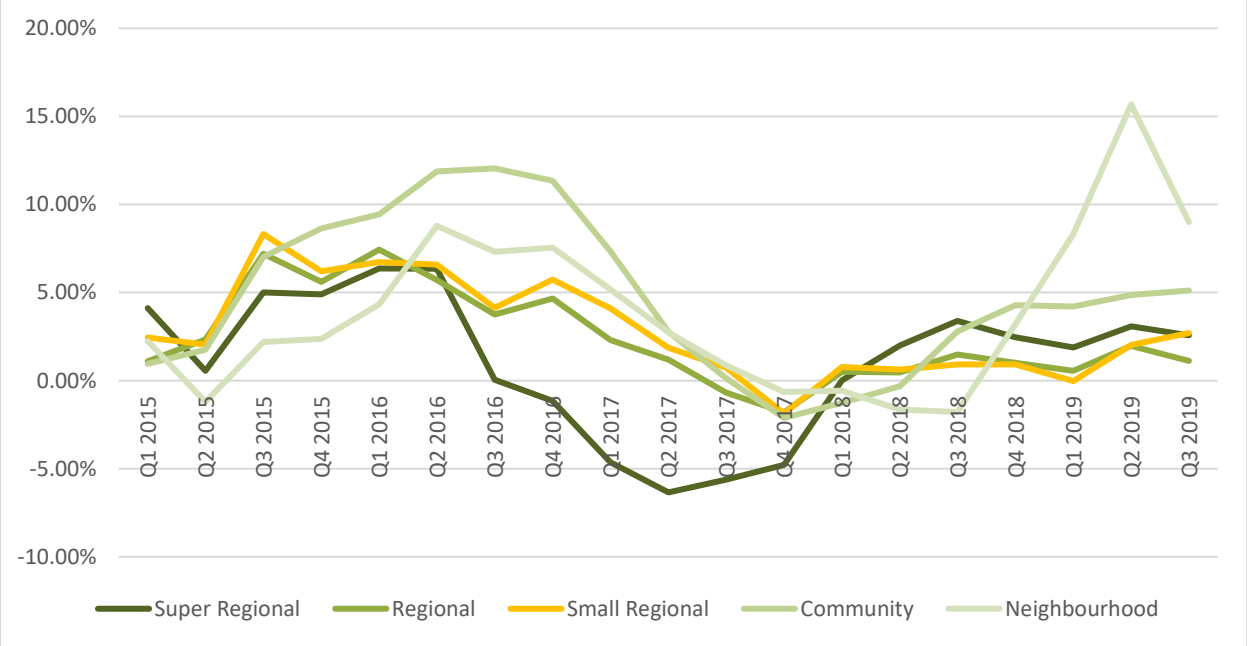
The trading density growth (as recorded in September 2019) increased with 4.3% over a period of one year in current price terms. The Retail Trading Density Index is based on sales performance along with other retail performance metrics and is recorded for 24 merchandise categories in more than 100 retail centres extending over 5 million square metres[10].

The growth of 4.3% consisted of 5.5% growth in sales and a 1.2% increase in the trading area. The per capita spent increased with 1.7% while foot count increased with 2.5%, also contributing to the increase in trading density. Smaller retail formats (such as neighbourhood retail centres) are mainly responsible for trading density growth. The largest merchandise categories include electronics, food (grocery and supermarket tenants) and department stores[2].

This sub-section provides an overview of retail market trends in the primary market area and will mainly look at the number of retail centres in the primary market area, the gross leasable area (GLA) of each identified retail centre and the anchor shops within each centre. The following figure provides an overview of the retail trading densities in South Africa for super-regional, regional, small regional, community, and neighbourhood retail facilities.

[10] SAPOA: SAPOA's Retail Trends Report, 2019

Figure 20: Retail trading densities growth rates

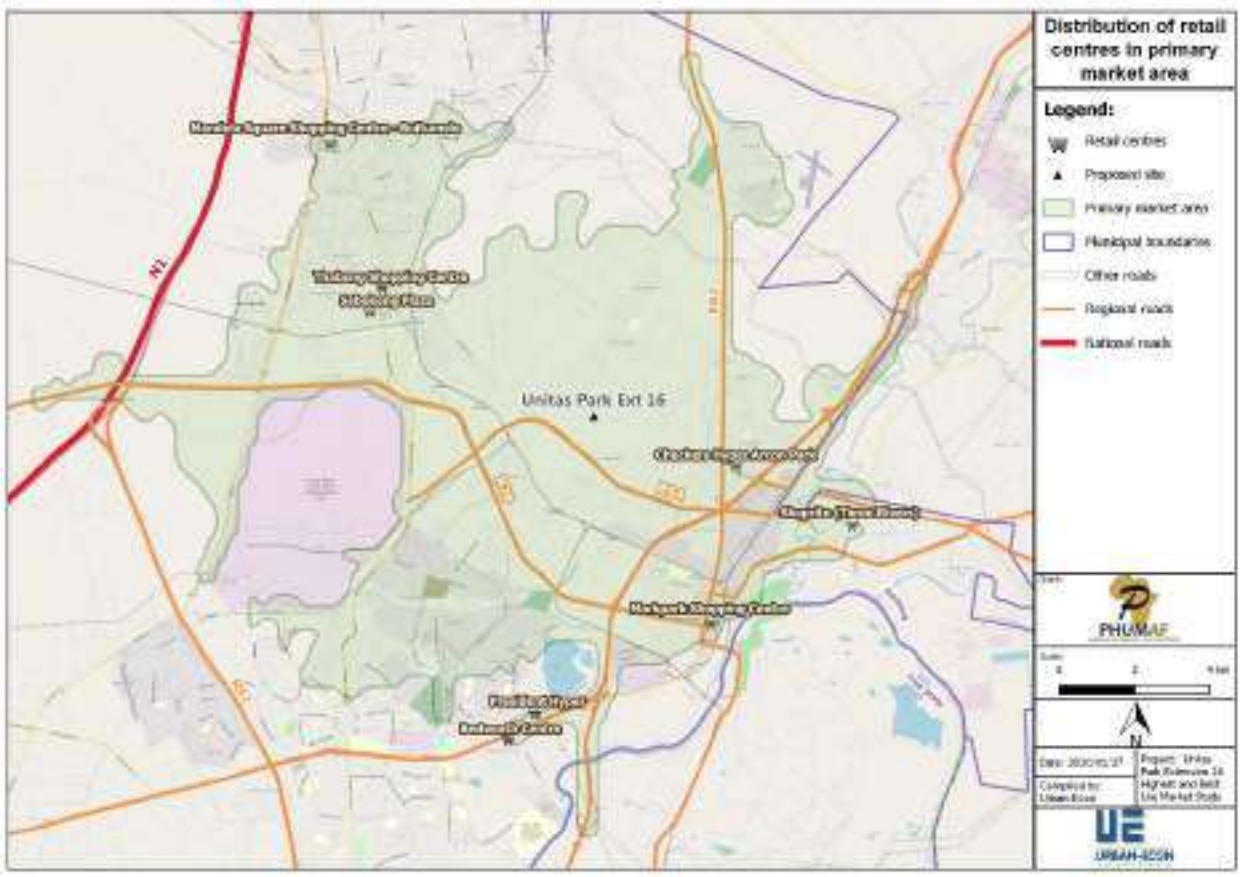


The data presented in the figure above show the trading density growth rates for various retail facilities. Regional and small regional follow a similar trend from 2015 to 2019, both experiencing growth in trading densities since the first quarter of 2019 with small regional continued to increase in the second quarter. The growth rate for super-regional retail trading densities experienced a decline between the second quarter of 2016 to the same quarter in 2017.

The growth rates for trading densities for super-regional facilities experienced a significant upward trend from the third quarter in 2017 to the third quarter of 2018. A general decline is evident in super regional trading densities from the third quarter of 2018 to the third quarter of 2019.

The trading density growth rates for neighbourhood retail spaces experienced a rapid increase from the third quarter in 2018 to the second quarter in 2019, after which the growth rate declined with almost 6% from the second quarter of 2019 to the third quarter of 2019. The following map depicts the distribution of retail centres within the primary market area.

Map 7: Distribution of retail centres



Source: Data derived from Leo Lightstone modified with QGIS, 2020

The map illustrates the distribution of retail centres in the primary market area. There are eight shopping centres or malls identified in the primary market area, with most of these located close to the primary market area borders. The shopping centre closest to the proposed development site is Checkers Hyper Arcon Park and is approximately 5.5 km from the proposed site.

There is no retail centre within 5 km from the proposed development site in Unitas Park, indicating the need for a retail centre to serve the population of Sonland Park, especially the local market within the boundaries of the market area.

The following table provides a list of all the retail centres within the primary market area, the key anchor stores, the gross leasable area (GLA) of each centre and distance of each of these facilities from the proposed development site.

Table 7: Retail stores in the primary market area

Name	Anchor stores[11]	Distance from the proposed site (km)	GLA (m^2)
Mandela Square Shopping Centre (Boitumelo)	• Pick n Pay	15.4	6 399[12]
Checkers Hyper Arcon Park	• Checkers	5.5	10 573
Thabong Shopping Centre (Sebokeng)	• Pick n Pay • Spar • Mr. Price • Pep • Clicks	15.2	41 145
President Hyper Vanderbijlpark	• President Hyper Vanderbijlpark	14.2	26 000
Sebokeng Plaza	• Shoprite Checkers	12.5	11 422
Shoprite Checkers Centre - Three Rivers	• Shoprite Checkers • Pep	10.5	6 164
Bedworth Park Value Centre	• Pick n Pay • Builders Warehouse	13.8	83 942
Markpark	• Shoprite • Pep • Ackermans • Jet • Clicks	9.6	22 355
			208 000

Source: Data derived from Leo Lightstone, 2020

The primary market area consists of approximately 208 000 m^2 gross leasable area (GLA) or retail space. Bedworth Park Value Centre (83 942m^2 GLA) and Thabong Shopping Centre in Sebokeng (41 145 m^2 GLA) are the two largest retail centres in terms of GLA. From the data provided in the table above, the major anchor shops are Shoprite Checkers, Pick n Pay, and PEP.

Eight shopping centres/malls are identified in the primary market area; most are located close to the primary market area borders. Checkers Hyper Arcon Park is the shopping centre located closest to the proposed development (5.5 km). This indicates that there is a need for a retail centre within the demarcated area to serve the population of Unitas Park and Sonland Park. The primary market area consists of approximately 208 000 m^2 gross leasable area (GLA) or retail space. The major anchor shops are Shoprite Checkers, Pick n Pay, and PEP. This indicates the presence of stores that capture and appeal to the local market and could be considered as anchor stores for a newly developed retail centre.

[11] South African Council of Shopping Centres: Shopping Centre Directory, 2019
[12] Ikon Property Group. Available at: http://ikongroup.co.za/properties/mandela-square-shopping-centre-sebokeng/

5.3. Office

This sub-section will analyse office market trends in the demarcated market area. This analysis is used to help identify the demand for offices in the identified area and help to inform decision-making for developers. This sub-section will focus on the following key topics:

- Vacancy rates
- Rental rates
- Capitalisation rates

5.3.1. Vacancy Rates

The identified area is not popular in terms of office space. Due to the low number of offices in the primary market area, there are limited data regarding vacancy rates.

5.3.2. Rental Rates

This sub-section provides insight into the rental rates in areas close to the proposed development site. Office rental rates in Duncanville, Vereeniging Central, and Three Rivers were investigated. The following table provides the average rental rates for each of the aforementioned areas.

Table 8: Average rental rates (Rand per square meter per month)

Area	Average rental rate (R / m^2 / month)
Vereeniging Central	R61.52
Three Rivers	R68.58
Duncanville	R14.29

Source: Property 24, 2020

The average rental price in Three Rivers is higher compared to other areas. The average rental rate in Three Rivers is R68.58 per square meter per month, whereas the average rental rate for Central Vereeniging is R62.52, and R14.29 in Duncanville.

5.3.3. Capitalisation Rates

The capitalisation (cap) rate indicates the rate of return of real estate property investments. It is measured by dividing the net income by the property's asset value. The capitalisation rate is the expected operating income for year 1. The rate is expressed as a percentage. The following table indicates the capitalisation rate of office buildings within the Vaal Triangle.

Table 9: Capitalisation rate of office buildings

Location	Quarter	Grade A: Multi-tenant			Grade A: Leaseback			Grade B: Multi-tenant			Grade C: Multi-tenant		
		Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N
Vaal Triangle	3/2019	11.3	0.7	2	10	-	1	11.1	-	1	11.7	1	1

Source: Rode's report, 2020

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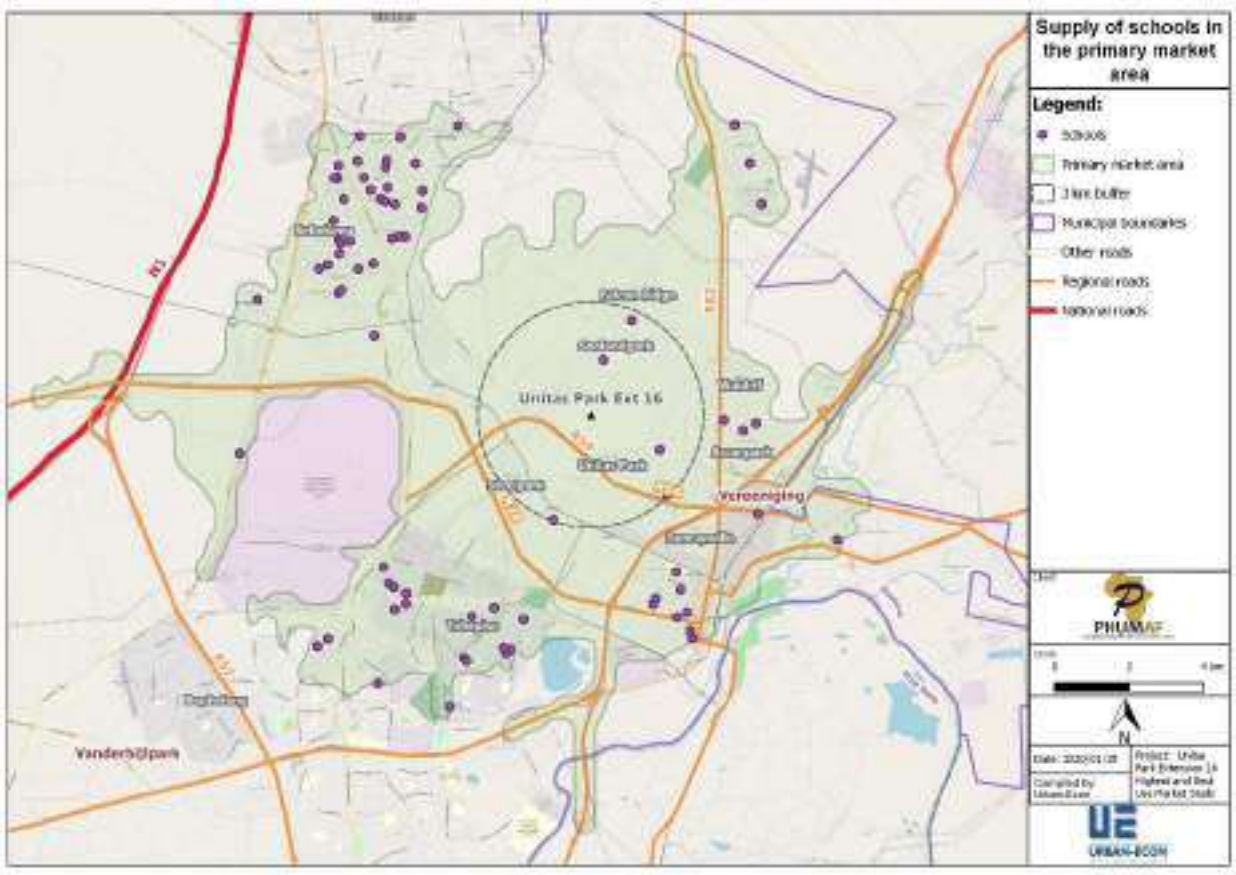
Because the area is not popular for office development, it is recommended that office space only be considered as an auxiliary land use and should target small businesses or consider office space for government departments.

5.4. Education

5.4.1. Schools

This sub-section provides an overview of schools within the study area. The map below illustrates the distribution of schools within the primary market area and also highlights the schools within 3 km from the proposed development site.

Map 8: Distribution of schools in the primary market area



Source: Data derived from the Department of Basic Education modified with QGIS, 2020

The data used for the compilation of the map above were obtained from the School Master List as provided by the Department of Basic Education. Sonlandpark Primary is the school closest to the proposed development site and is approximately 3.5 km from the site.

Additionally, a total of 77 schools are situated within the primary market area. The schools provided in the map above include both public and independent schools as well as primary, secondary, and intermediate schools.

The following table provides a breakdown of schools in the primary market area.

Table 10: Schools located in the primary market area

Schools	Learners	Educators	Number of schools	Ownership	
				Independent	Public
Primary schools	39 723	1 240	50	5	45
Secondary schools	17 811	704	22	1	21
Combined schools	1 664	110	4	4	0
Intermediate school	83	15	1		
	59 281	**2 069**	**77**		
Learner-educator ratio	**28:1**				

Source: Department of Basic Education, 2020

There are currently 50 primary schools, 22 secondary schools and four combined schools within the primary market area. In total, there are 77 schools, 2 069 educators and 59 281 learners within this market area. Moreover, there are ten independent (private) schools and 66 public schools when looking at the primary, secondary, and combined schools. Based on the data provided in the table above, the average learner-educator ratio of all schools within the primary market area is 28.1. This means that on average, there are 28 learners for each educator.

The following table provides a breakdown of the average learner-educator ratio of the different schools within the primary market area as well as the average learner-educator ratio based on the OECD Indicators. The OECD Indicators are used to provide an indication of expected learner-educator ratios.

Table 11: Learner-educator ratio (LER)

Schools	Learner-educator ratio (LER)	Average OECD Indicators[13]
Primary schools	32:1	19:1
Secondary schools	25:1	28:1
Combined schools	15:1	

The data provided in the table above show that the learner-educator ration of primary schools in the market area is higher than the average OECD indicator, whereas the learner-educator ratio for secondary schools is lower compared to the average OECD Indicators.

Based on the findings provided in this sub-section, most schools in the primary market area are primary schools. It is also evident that the demand for primary education is high due to the learner-educator ratio being higher than the average as per the OECD Indicators.

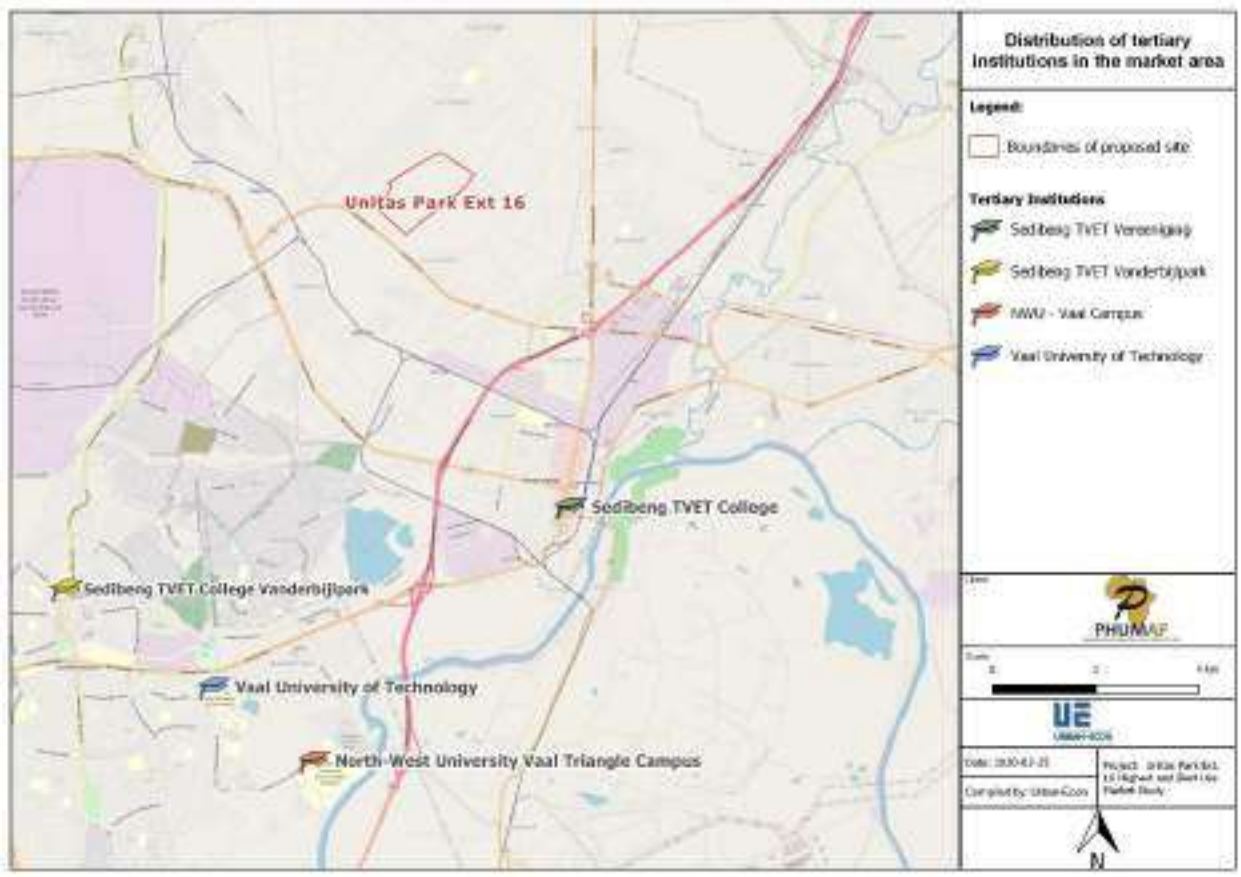
[13] OECD, Education at a Glance 2014 OECD Indicators: OECD Indicators, p. 446-452

5.4.2. Tertiary Education and demand for student housing

5.4.2.1. Locations of Tertiary Educational Institutions

This sub-section aims to provide an overview of student enrolment trends and student accommodation for various tertiary institutions within the market area. The map indicates the distribution of tertiary educational facilities within the market area.

Map 9: Distribution of tertiary institutions in the market area



Source: QGIS, 2020

The map above indicates the location of the main tertiary institutions within the market area. Two of these institutions, the Vaal University of Technology and the North-West University Vaal Campus are located in Vanderbijlpark, whereas Sedibeng TVET College has two campuses; one in Vanderbijlpark and the other in Vereeniging. The following table provides the four main tertiary institutions within the market area and the distance of each of these institutions from the proposed development site.

Table 12: Tertiary institutions and distances from the proposed development site

Tertiary Institutions	Distance from the proposed site
Vaal University of Technology	Approximately 16 km
North-West University (Vanderbijlpark Campus)	Approximately 17 km

Tertiary Institutions	Distance from the proposed site
Sedibeng TVET College (Vereeniging Campus)	Approximately 10 km
Sedibeng TVET College (Vanderbijl Campus)	Approximately 16 km

Tertiary institutions are located within reasonable proximity to the proposed development, indicating that the proposed development site could include student housing as part of the mixed-use development.

5.4.2.2. Enrolment and Student Accommodation

This sub-section elaborates on the number of full-time students enrolled at each of the tertiary institutions and the number of beds provided. Further, additional student accommodation facilities are also identified and included as part of the supply.

North-West University (NWU) – Vaal Campus

The following table shows the student growth for the NWU Vaal Campus over a period of five years. It should be noted that only full-time contact students were included in this study as they are the key drivers of student housing demand.

Table 13: Enrolment at NWU Vaal Campus

	2014	2015	2016	2017	2018
Number of student enrolments	6 353	6 507	6 748	7 123	7 365
Percentage growth		2%	4%	6%	3%

Source: Management Information Report: Student Statistics of the NWU Vaal Triangle Campus, 2017

The data provided in the table above indicates that the number of full-time contact students increased with almost 16% from 6 353 in 2014 to 7 365 in 2018. The average annual growth for this period is 4%. NWU Vaal Campus has 877 beds available on campus for students in Vanderbijlpark. These units are currently 100% occupied[14].

Vaal University of Technology

The following table shows the student growth for the Vaal University of Technology (VUT). It should be noted that only contact students were included in this study as they are the key drivers of student housing demand.

Map 10: Vaal University of Technology number of student enrolments

	2014	2015	2016	2017	2018
Number of students enrolled	19 096	17 489	19 079	19 218	19 250
Percentage growth		-8%	9%	1%	0.2%

Source: Quantec, 2020

[14] Communication with Mr. Steyn from NWU Vaal Campus (Director Business and Enterprise Development).

The number of students enrolled at the Vaal University of Technology increased with 0.8% from 19 096 in 2014 to 19 250 in 2020. The average annual growth for this period is 0.4%.

The Vaal University of Technology provides student accommodation for approximately 1 000 students through accommodation facilities situated around the campus. It is expected that the Vaal University of Technology will contribute an additional 1 800 student accommodation in Vanderbijlpark by 2021[15]. This means that the projected total supply of student accommodation provided by this institution adds up to 2 800 beds.

Sedibeng TVET College

Sedibeng TVET College has two campuses in the demarcated market area: the Vanderbijlpark Campus, and Vereeniging Campus. The following table shows the number of students enrolled at Sedibeng TVET College.

Table 14: Number of students enrolled at Sedibeng TVET College

	2013[16]	**2016**	**2020[17]**
Number of student enrolments	9 941	11 000[18]	10 598
Average annual growth rate		4%	-1%

Sedibeng TVET College experienced a slight decrease of 1% from 11 000 registered students in 2016 to 10 598 in 2020. However, in general, the average annual growth rate (from 2013 to 2020) is 1%. Sedibeng TVET College does not provide any accommodation facilities on campus for students.

Considering the student growth trends of all the above-mentioned institutions, there is a general increase in the number of students within the market area, which indicates that there is a growing demand for student housing.

Additional Student Housing Supply

The following table provides additional student housing supply and the number of units for each of these accommodation facilities.

Table 15: Additional student housing supply

Student Accommodation	Number of units
Bedworth Lake Student Accommodation	Approximately 700
Five Star Student Accommodation	Approximately 16

[15] New Student Residence Vaal Univiersity of Techonlogy. Available at: https://www.l2b.co.za/Project/New-Student-Residence-Vaal-University-of-Technol/14822
[16] Data for 2013 were obtained from the 2013/14 Sedibeng TVET College Annual Report. Available at: http://www.sedcol.co.za/wp-content/uploads/2016/09/Sedibeng-TVET-College-Annual-Report-for-2014.pdf
[17] Data for 2020 were obtained through personal communication with Mrs. Seipati from Sedibeng TVET ollege.
[18] Data for 2016 were obtained from Sedibeng TVET College website. Available at: http://www.sedcol.co.za/college-profile/

Student Accommodation	Number of units
Granada Student Accommodation	Approximately 30
Buhle student houses	Approximately 450
	Approximately 1 196

It should be noted that only some of the major student accommodation facilities within the study have been listed above and does not represent all available accommodation in the study area.

The working of NSFAS

NSFAS is a government entity under the Department of Higher Education, Science and Technology established according to the NSFAS Act (Act no. 56 of 1999) to provide financial support to disadvantaged students who wish to futher their studies at public universities or TVET colleges.

The NSFAS bursary covers student expenses on the following categories:

- Accommodation
- Transport
- Living allowance
- Personal care

This differs for Universities and TVET Colleges.

The qualification metrics for NSFAS is as follows:

- All South African citizens
- All SASSA grant recipients qualify for funding
- Appllicants whose combined households income is not more than R350 000 per annum
- A person with a disability: combined household income must not be more than R600 000 per annum
- Students who started before 2018 whose household income is not more than R122 000 per annum.

Funding students are either provided directly to the student via NSFAS Waller or via the respective institution to the student.

The Department of Higher Education and Training released the latest guidelines for the allocation of NSFAS grants in January 2020. The following table indicates the guidelines for NSFAS grants.

Table 16: NSFAS Grant Allocation

Item	Cost
Travel (60% if bursary beneficiaries)	R7 350 per annum
Personal Care (100% of bursary beneficiaries)	R2 900 per annum
Accommodation (40% of bursary beneficiaries)	R15 750 (rural) per annum R18 900 (peri-urban) per annum R25 200 (urban) per annum

For the purposes of this study, the cost of accommodation will fall within the urban category (R25 200 per annum) due to the location of the proposed development.

Generally, there is an increase in the number of student enrolments. Based on the data provided above, it appears that there is a shortage of supply for student accommodation, which indicates that there is a growing demand for student housing.

5.5. Health Care

This sub-section provides an overview of the hospitals and clinics identified in the primary market area. According to the Emfuleni Integrated Development Plan (IDP) 2019/20, primary health care services provide comprehensive health care services to residents of the local municipality.

The local municipality currently has 18 clinics, of which five are structurally suitable to provide comprehensive health care services. The remaining 13 clinics are limited by structural constraints and are therefore not able to provide comprehensive primary health care services, as set out by the National Health Norms and standards.

The main issue experienced is overcrowded clinics, which makes infection control problematic. The department has identified a need to address structural constraints and has, therefore also prioritised the upgrading of health care clinics.

The following map illustrates the distribution of hospitals and clinics within the primary market area.

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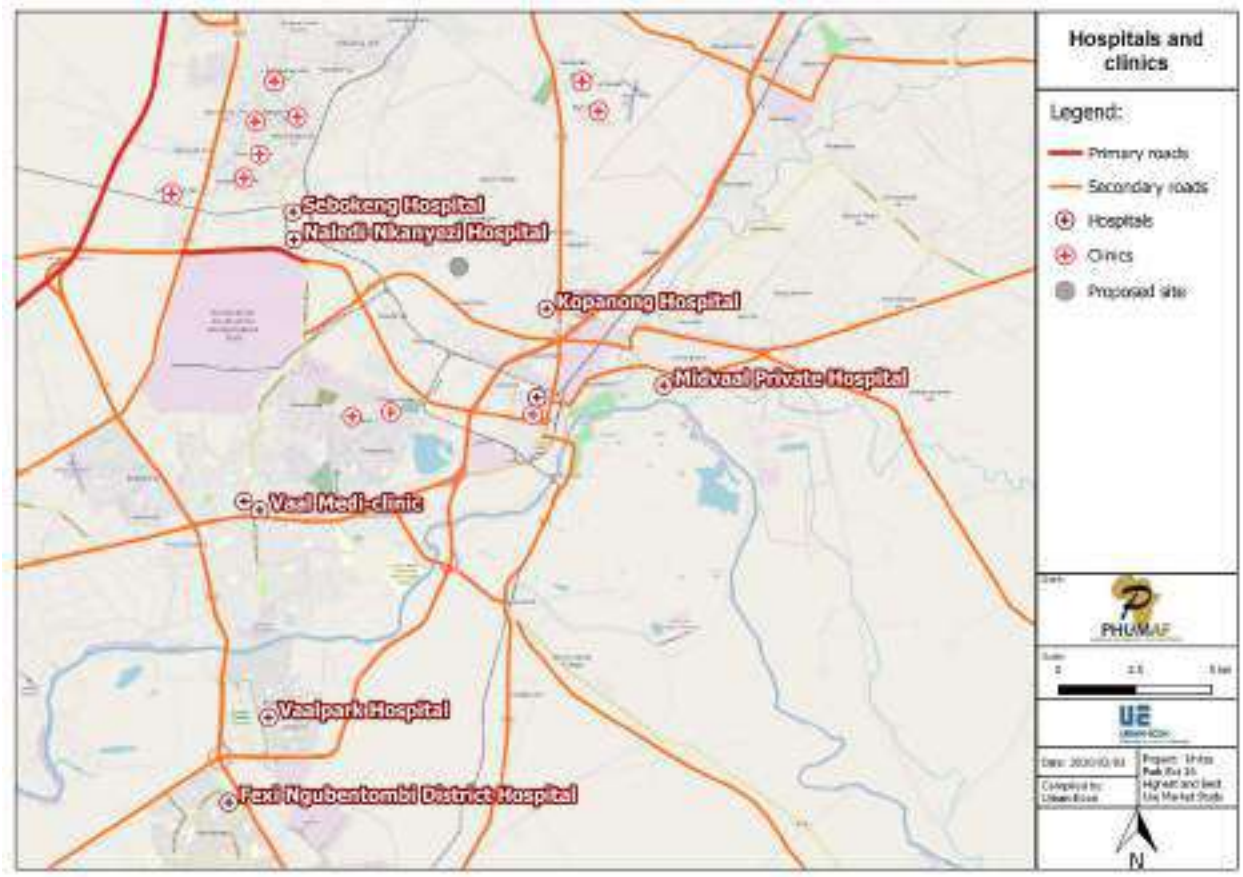
Map 11: Distribution of key health care facilities



Source: Data derived from Mapable and modified in QGIS, 2020

The majority of clinics are located near the borders of the primary market area. A total of 11 clinics are identified in this market area, with most of these clustered in Sebokeng. Other areas with clinics include Tshepiso, Dickonsonville, Duncanville, and Roshnee.

The clinic closest to the proposed development is the Vaal Men and Women's clinic in Duncanville and is located approximately 8.6 km from the proposed development site. Rust Ter Vaal clinic in Roshnee is located approximately 9.6 km from the proposed site and Tshepiso clinic approximately 10.5 km from the site.

A total of seven hospitals are identified in the market area. The closest hospital is Kopanong Hospital and located approximately 4.3 km from the proposed site.

The lack of clinics within 8 km of the proposed development site indicates the need for a clinic to serve the population, especially in Unitas Park and Sonland Park. The nearest hospital is located approximately 4.3 km from the proposed site.

5.6. Innovation and Inubation Hub

This sub-section dicusses the potential for developing an innovation and incubation hub as a central point of the proposed development. In addition to this, two The opportunities associated with this type of development are also explored.

5.6.1. Innovation Hub

An Innovation Hub can be seen as a concentration of innovative enterprises that enable each other in a mutually beneficial way. These hubs can also be used to address issues of unemployment and other socio-economic issues. Innovation hubs can also be defined as cluster systems with complimenting services dedicated to innovation. These centres are usually a reflection of the human and social capabilities of the communities in which they thrive. They function as a supporting structure for development throughout the community, providing knowledge and industry capacity valuable to start-up businesses, educational institutions and innovators alike. This is achieved by the concentrated information sharing space provided by these centres. The guiding principles for these centres are:

- Innovation
- Collaboration
- Community revitalization
- Economic growth
- Sustainable development
- Entrepreneurship

These principles are realised in the interactions, application, expertise and diversity of networks involved in innovation for the community. These networks usually include specific role players and features that ensure the effective functioning of the system.

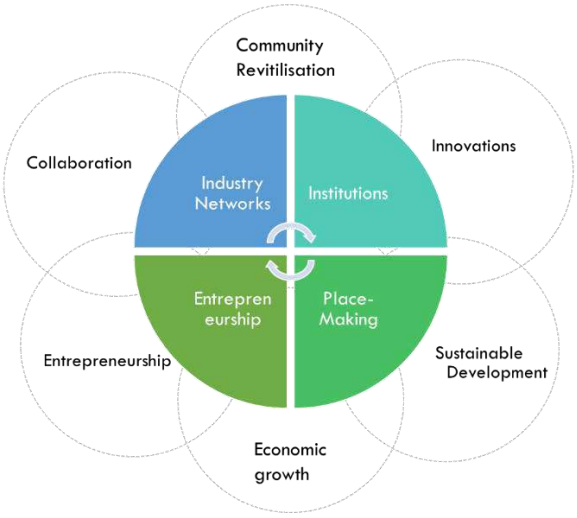
The science park network is based on relationships with the governments, universities, large and medium-sized firms, venture firms and associated institutes (endogenous networking). Cooperative networking between the local government and the park management helps to enhance the park's performance and it is, therefore, crucial that these relationships are also prioritised.

There are several key characteristics common to innovation-centred developments.

The key characteristics of innovation centres are the following:

- Institutions
- Industry Networks
- Entrepreneurship
- Place-making

Figure 21: Innovation Hub



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Institutions have the ability to attract and support talent in the community. In the context of innovation centres there has to be a relationship between the existing and desired institutional services.

Industry networks are represented in multi-disciplinary teams that are responsible for the support and growth of innovation in the community. They encourage partnerships and information-sharing in a variety of sectors, all inclined by the principles, to support and grow the use and value of the centre. These networks usually include well-established professionals as well as local young talent that encourages interaction amongst users and helps develop specialized services that will support local business and encourage cross-industry partnerships.

Entrepreneurship fosters the business and commercial aspects of innovation. Entrepreneurship allows for opportunities that develop markets and business through ideas and therefore develop the economy. These skills can be nurtured both within the training and knowledge aspects of the centre as well as in the exhibition and sales of products, thereby having potential influence in the science and technology market.

Altogether the synergy of these components allow for exchanges in critical and diverse services that can effectively attract and support investment in the community. To capture the use of these services and maximize the shared value in the public realm, there are key spatial attributes synonymous with innovation centres. These include the walkability of the space, the mixture in land use and activity, and the imagery and availability of public spaces.

5.6.2. Case Studies

This section provides more detail on two South African case studies which include Pretoria Innovation Hub and Riversand Incubation Hub. The case study approach discuss fundamental attributes defining innovation centres of various kinds. The local case studies of Pretoria's Innovation Hub and Riversand Incubation Hub are specifically investigated as applicable best practice examples.

5.6.2.1. The Innovation Hub (Pretoria)

The Innovation Hub of Pretoria is a wholly owned subsidiary of the Gauteng Growth and Development Agency (GGDA), which was established by the Gauteng Provincial Government through its Department of Economic Development (DED) to encourage and support innovation. It is strategically located in Pretoria East, Tshwane, Gauteng.

With Tshwane as South Africa's executive capital and Gauteng as the 'smart' province, The Innovation Hub has become a regional centre of innovation and knowledge creation in the surrounding communities. Its locational advantages can, therefore, be categorised locally and provincially, with a cumulative regional influence. Established in 2001, the science and technology park has since then supported the growth of innovative companies across the Biosciences, smart industries and green and sustainable energy sectors. As an agglomeration of successful, innovative companies, the Innovation Hub, is Southern Africa's first internationally accredited Science and Technology Park.

VISION

To model a science park and the innovation agency of choice for fostering socio-economic development and competitiveness in Gauteng.

STRATEGIC OBJECTIVES

- **Skills Development**

Drive focused skills development to address skills deficit and industry needs

- **Enterprise Development**

Accelerate enterprise development to support the establishment and growth of knowledge based enterprises

- **Innovation**

Strengthen multi-helix collaboration and foster innovation

- **Enabling Spaces**

Establish and manage enabling innovation spaces and targeted value added services

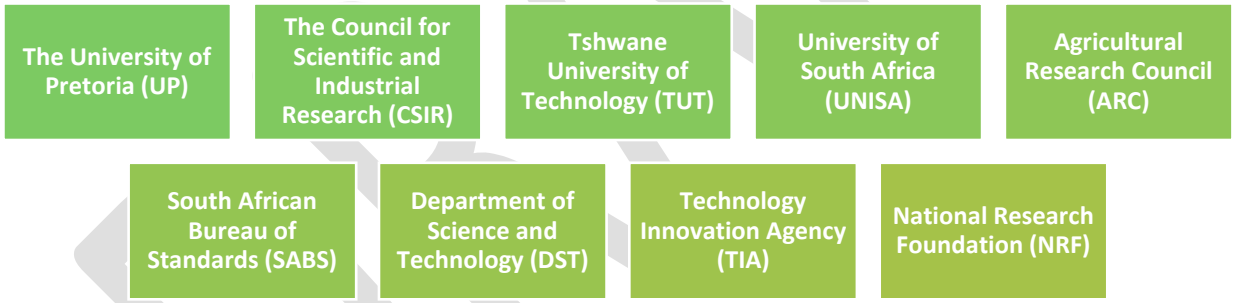
- **Organisational**

Be a value based sustainable organisation with a distinctive brand; that is an employer of choice.

5.6.2.1.1. Links to Surrounding Uses

The Innovation hub is well located on a provincial and city-scale to contribute to the business and information networks that are already prevalent. Some of its key advantages is the surrounding uses that include information-based activities. As the business and administrative capital of the country, Pretoria is synonymous with commercial and industrial development. Some of the key land uses indicative of this sectoral dominance include the following government, education and research institutions:

Figure 22: Key facilities surrounding Pretoria's innovation hub



In respect of the surrounding uses, the Innovation Hub is, therefore, a well-located connective agent for government, research and educational activity. It is able to integrate these sectors and their respective values for innovative purpose. Furthermore, the Hub has the ability to connect the intellect of these sectors into profitable revenue for community revitalisation. There is a clear market for its unique services.

The services offered are that of value-added business support and development, intellectual property management, innovation programs, innate collaboration and networking, and office space.

5.6.2.1.2. Services

The services promote business support and development, intellectual property management, innovation programs, collaboration and networking, and office space.

Business Support and Development

These services enable residents to focus on innovative activities, free entrepreneurs from back-office and administrative tasks and provide access to a business centre and provide access to conference venues and advisory services.

Intellectual Property Management

The objective of the Intellectual Property (IP) office is to provide leadership in IP related issues and services ensuring effective IP management and commercialisation of technology innovations. It is essential for all businesses to have knowledge of IP to run your business successfully.

Innovation Programs

Innovation programs are used to increase collaboration across all economic sectors. These programs include:

- Maxum Business Incubation
- CoachLab
- Green and Sustainable Development Projects
- Climate Innovation Centre
- mLab
- OpenIX (Innovation Exchange)

Collaboration and Networking

The Hub has a well-developed program of events and initiatives designed to enhance synergy between industry, government, funders, academic and research institutions.

Office Space

High-quality office space is provided to knowledge-based enterprises in a number of multi-tenant buildings. Communal facilities, such as a reception and meeting rooms, are available for all residents to use.

5.6.2.1.3. Sectors

The active partnerships with the business, government, research and education sectors are integral to its success and is part of an ongoing program to leverage investment, technical capacity, marketing, expertise and information value that can support both local and provincial economies.

The Hub's criteria require resident companies to operate in the technology-led and research-based sectors of Biosciences, Information and Communication Technology (ICT), Green Technologies and Industrials. Some of the existing accommodated sectors include the following:

- Biosciences
- Industrial and Engineering
- Information and Communication Technology (ICT)
- Business (Incubators)
- Service (Professional)
- Research and Development

The variety of resident companies displays positively on the commitment to collaboration and innovation, as well as financial investment in the Innovation Hub as a professional business model.

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5.6.2.1.4. Design and Place-Making Attributes

Creating spaces that are visually and functionally supportive to the purpose of the structure is essential. The Innovation Hub provides high-quality interior design and supporting exterior for both residents and visitors. The development is 121,000m² in size, accommodating businesses like information and communication technology, electronics, life sciences, and advanced materials and manufacturing.

The hub provides shared facilities useful for the intention of collaboration and interaction of the public. These facilities include:

- A knowledge centre
- Post office
- Auditoria
- Restaurants
- Boardrooms
- Meeting rooms
- Video conferencing
- Exhibition spaces

This analysis points to a fair interaction between the primary function of the building and aesthetic function. The interaction space both private and public allows for users that can be translated into opportunities for new ties.

With its provision of a competitive mix of knowledge and business opportunities, as well as a resourceful revenue stream in the leasing of space, the hub is able to integrate innovation and business sustainably. Some of the key strengths that can be analysed in the success of the Innovation hub include its strategic location, complimenting sectors and viable services. Furthermore, the extensive design of the Hub displays a high-quality enterprise along with innovative office and public spaces that promote interaction. There still exists an opportunity for higher levels of influence on regional, national and inclusion into the continental innovation market.

5.6.2.2. Riversands Incubation Hub

The Riversands development already encapsulates an existing Incubation hub, which is a starting point for a variety of entrepreneurs. The light industrial/mini-factories would provide a place for their businesses to continue to grow after the Incubation Hub was used as a stepping stone.

The Riversands Incubation Hub is set to generate entrepreneurial activities and will become an important link between small businesses and the corporate environment in Midrand. The development is a large-scale business incubator established in 2015 through a partnership between Century Property Developments and The Jobs Fund. The Hub is home to 150 small businesses when at full capacity, where 300 additional entrepreneurs are supported through business development and offered support services. It is located at the centre of the Riversands Commercial Park. The primary intention of the incubator is to create a strong, enabling ecosystem that fosters the development of high-potential enterprises.

Vision	Mission	Value Proposition
•A South African economy growing and thriving through successful small businesses, whose ownership reflects SA's population demographics, creating jobs and opportunity for all.	•To provide and facilitate access to a rich range of entrepreneur development and business growth support services that talented committed entrepreneurs can access to help them create and grow their businesses.	•Entrepreneurial training, business incubation and job creation with the Riversnads Commercial Park and broader commerce industry.

There are 150 mini-factories, retail, office spaces and horticultural and landscaping training space available for SME businesses and partner companies. These spaces provide an integrated manufacturing, training, commercial and retail environment in which SMEs have ample opportunity to trade.

The backbone of the Hub is the extensive learning centre, which offers the following facilities:

- Library for research;
- Two 98-seat lecture halls;
- A 480-seat auditorium;
- Fully equipped skill-specific training workshops;
- Meeting rooms and mentor rooms;
- Fully connected and enabled hot desks;
- Back-up marketing and printing facilities;
- State of the art IT and telephony;
- Business centre;
- Restaurant; and
- An amphitheatre with a capacity of for up to 4 000

The hub has the potential to create a number of job opportunities and play an essential role in economic growth and development.

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6. Market Opportunity Analysis

To identify the most viable opportunities for Unitas Park Extension 16, Vereeniging, a preliminary opportunities analysis is conducted based on the findings provided in the previous section, Market Perspectives.

The preliminary opportunity analysis assesses the potential of each of the identified property types by considering prevalent economic and market trends in the study area. The findings of the preliminary opportunity analysis identify the property types with the highest development potential for further analysis. The opportunity analysis acts as a fatal flaw assessment to identify key factors that may have a direct negative impact on the development potential of a specific land use. Therefore, opportunity analysis acts as an elimination tool for properties that may not be well-supported by the local market. The preliminary opportunity analysis will investigate the following land uses:

- Residential
- Office
- Industrial
- Retail
- Educational
- Hotel
- Community amenities

The performance of various economic sectors drives each property sector. The performance of each economic sector will thus influence different property markets in the study area. Therefore, it is important to analyse each economic sector as a means of identifying property market trends specific to the study.

6.1. Opportunity Analysis

The preliminary opportunity analysis considers the findings of the macro-economic and socio-economic property market trends and spatial analysis. This enables the identification of land uses with the highest development potential under current market conditions. The table below presents an overview of the preliminary opportunity analysis and indicates which land uses will be further investigated by this market research report.

Table 17: Preliminary Opportunity Analysis Matrix

Land Use	Market Indicator	Positive	Negative	Total Score	%
Office	**Office space availability** • Limited offices available • Area not considered a conducive environment for office development		√	3/5	60%
	Quality of existing stock • No stock in the immediate vicinity	√			
	Socio-economic indicators • Job creation	√			

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Land Use	Market Indicator	Positive	Negative	Total Score	%
	Economic growth • Slow economic growth		√		
	Surrounding land uses • Residential and agricultural holdings	√			
Residential	**Existing residential stock** • Large number of stock in immediate area • Most homeowners in area own house for 11 years / more • Additional land uses could increase demand for housing	√		3/5	60%
	Quality of existing stock • Mostly old houses in the immediate vicinity • Need for new stock		√		
	Socio-economic indicators • Moderate population growth rate	√			
	Economic growth • Low economic growth		√		
	Surrounding land use • Residential and agricultural holdings	√			
Retail	**Existing retail stock** • Small retail facilities exist in immediate area • Limited medium to larger retail facilities operates in the immediate area. • The nearest retail centre is approximately 4 km from the proposed site.		√	5/6	83%
	Quality of existing stock • Small existing retailers in the immediate vicinity of poor quality	√			
	Socio-economic indicators • Job creation	√			
	Location of site	√			

DRAFT

Land Use	Market Indicator	Positive	Negative	Total Score	%
	• Surrounded by residential units and agricultural holdings				
	Economic growth • Generate revenue	√			
	Surrounding land use • Residential and agricultural holdings	√			
Education	**Existing educational stock** • Four schools within 3 km radius • High learner-educator ration for primary schools	√		4/4	100%
	Location of site • Ideally located in residential area	√			
	Socio-economic indicators • Increasing population	√			
	Surrounding land use • Residential and agricultural holdings	√			
Student Housing	**Existing tertiary education institutions** • Sedibeng TVET College located in Vereeniging • NWU (Vanderbijl Park Campus) and Vaal University of Technology is located in Vanderbijl Park.	√		4/4	100%
	Location of site • Ideally located for students of Sedibeng TVET College • Majority of students located in Vanderbijl Park. • Could also serve students studying in Vanderbijl Park.	√			
	Existing student accommodation stock • Insufficient student housing stock in Vereeniging	√			
	Economic Growth • Generate revenue • Facilitate local economic growth	√			

DRAFT

Land Use	Market Indicator	Positive	Negative	Total Score	%
Hospitals and Clinic	**Existing stock** • No clinics within the immediate vicinity, only on further ends of primary market area • Overcrowded	√		4/5	80%
	Location of site • In a residential neighbourhood	√			
	Socio-economic indicators • Job creation	√			
	Economic growth • Slow economic growth		√		
	Surrounding land use • Residential and agricultural holdings	√			

6.2. The Way Forward

The land uses identified with the highest development potential include the following:

- Residential
- Student housing
- Retail
- Clinic
- School
- Office

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7. Market Potential Analysis

The market potential analysis of the different land uses is done separately since the drivers of each land use differ. The following sub-section relays the calculations for the residential models and the key findings for residential demand.

7.1. Residential

This sub-section elaborates on the market potential analysis for residential development for the proposed site. The development gap within the market area is calculated using the Net Effective Demand (NED). The following figure illustrates the equation used to calculate residential demand. The NED indicates the potential of the local market to support additional residential development within the given area.

Figure 23: Residential Net Effective Demand

The residential demand model uses population projections, the number of households, and income distribution trends to quantify the demand for residential development. The market demand assessment considers the following important demand drivers:

- Growth in the number of households
- Household income
- Affordability of residential units

An equilibrium demand modelling technique is used, which assumes that the demand for bonded and rental housing in the market area is null in the base year (2019) as the local population is fully served in terms of bonded and rental accommodation. Although it is known that the population is not fully served at the base year, the equilibrium model enables the calculation of the starting point for the demand generation due to the immeasurable supply and the large market area. For this study, 2019 is used as the base year, which enables the determination of the bonded and rental housing demand for 2020 onwards.

7.1.1. Household Features

The projected household figures for both the primary and secondary market areas are used as a basis for the demand equilibrium model. The population growth projections are based on a five-year historic growth rate of 0.42% per annum and a household growth of 0.99% for both the market areas.

Table 18:Population and household growth

	2020	2021	2025	2030
Primary Market Area Population	318 195	319 531	324 932	331 812
Primary Market Area Household	98 875	99 855	103 872	109 123
Secondary Market Area Population	513 824	515 982	524 704	535 814
Secondary Market Area Household	163 698	165 320	171 971	180 663

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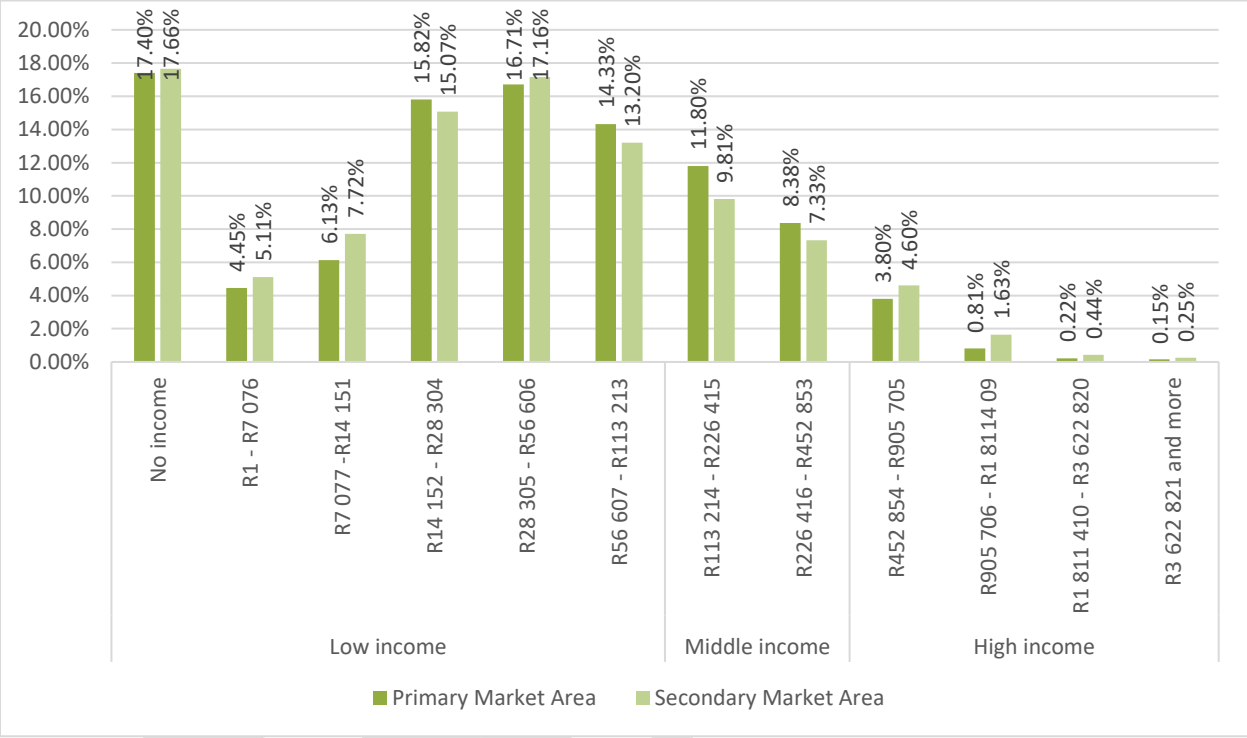
Tel: 012 342 8686

Source: Stats SA Census 2011 Data via Quantec Easy Data, 2020

7.1.2. Household Income

The viability of any development depends on the household income levels of the market area. The household income profile provides an indication of disposable income and property of the local population and is used to measure and calculate the demand for housing.

Figure 24: Annual household income



Source: Stats SA Census 2011 Data via Quantec Easy Data, 2020

As indicated earlier in the report, a large portion of the population falls within the low-income brackets, indicating that residents in both the primary and secondary market areas, do not have necessarily have access to capital to purchase a house.

7.1.3. Affordability Ranges

This sub-section provides a breakdown of the housing qualification bands for bonded and rental developments. The following table indicates the housing qualification categories for subsidised, FLISP, affordable, and middle- and high-income housing.

Table 19: Income categories for bonded developments

Income categories for bonded development		
	Min	**Max**
Subsidised	-	R 42 000
FLISP	R 42 000	R 264 000

Income categories for bonded development		
	Min	**Max**
Affordable Housing	R 108 000	R 264 000
Middle Income	R 264 000	R 600 000
High Income	R 600 000	+

The table below illustrates the average rental ranges for each rental housing qualification category as well as the average rental rates for middle- and high-income rental housing.

Table 20: Income categories for rental units

Income categories for rental developments		
	Min	**Max**
CRU	R 9 600	R 42 000
Social Housing Primary Market Area	R 18 000	R 66 000
Social Housing Secondary Market Area	R 66 000	R 180 000
Affordable Housing	R 108 000	R 264 000
Middle Income	R 264 000	R 600 000
High Income	R 600 000	+

7.1.4. Net Effective Demand

The demand for new residential development was determined by applying a set of residential indicators to the demand calculation model. This sub-section illustrates the effective demand for various housing typologies within the market area across all income categories until 2030. The household income ranges and the projected household numbers were used to calculate and project the demand for both bonded and rental development in the market area. The Net Effective Demand (NED) calculates the market gap for new housing development in the demarcated market area. The NED indicates the potential of the local market to absorb additional bonded and rental housing.

7.1.4.1. Injection Factor

An injection factor refers to the potential tenants who would relocate to the direct market area if an opportunity to do so was presented. To calculate a realistic and conservative demand estimate for a new residential development, a 20% injection factor was applied to the effective demand of the indirect market area.

7.1.4.2. Leakage Factor

A leakage factor refers to the net outflow of households from within the direct market area. Leakages are therefore potential tenants who would live within the direct market area and be willing to move to areas outside of these boundaries. To calculate a realistic and conservative demand estimation, a 35% leakage factor was applied to the direct market area to compensate for the migration of households from the direct market area to other neighbourhoods.

DRAFT

7.1.4.3. NED

The NED presents the development potential (market gap) for residential development within the demarcated market area in Vereeniging (see table below).

Table 21: NED for bonded housing

YEAR	BONDED					
	Subsidised	FLISP	Affordable Housing	Middle Income	High Income	Total
2020	535	248	106	112	15	1 017
2021	839	374	160	169	23	1 565
2022	1 238	501	215	227	30	2 211
2023	1 412	629	270	285	38	2 634
2024	1 702	759	326	344	46	3 177
2025	1 996	890	382	403	54	3 725
2026	2 293	1 022	439	463	62	4 278
2027	2 592	1 155	496	524	70	4 837
2028	2 895	1 290	554	585	78	5 401
2029	3 200	1 426	612	646	86	5 971
2030	3 509	1 564	671	709	95	6 547
2031	4 209	1 702	731	772	103	7 517

The data presented in the table above show the predicted demand for bonded housing from 2020 to 2031 and show that the housing market is growing and that there is a demand for new residential development. The greatest demand in the primary market area for bonded housing is subsidised and FLISP housing.

The following table shows the rental demand in the demarcated market area in Vereeniging, from 2020 to 2031.

Table 22: NED for rental housing

RENTAL							
YEAR	CRU	Social Housing		Affordable Housing	Middle Income	High Income	Total
		Primary Market	Secondary Market				
2020	90	112	72	57	61	8	400
2021	135	168	108	86	92	13	603
2022	181	226	145	115	123	17	807
2023	228	283	183	145	154	21	1 014

DRAFT

RENTAL							
YEAR	CRU	Social Housing		Affordable Housing	Middle Income	High Income	Total
		Primary Market	Secondary Market				
2024	275	342	220	175	186	26	1 223
2025	322	401	258	205	218	30	1 434
2026	370	460	297	236	250	35	1 647
2027	418	521	335	266	283	39	1 863
2028	467	581	374	298	316	44	2 080
2029	516	643	414	329	349	48	2 300
2030	566	705	454	361	383	53	2 521
2031	617	767	494	393	417	58	2 745

The data in the table above indicates that there is a greater demand for CRU and social housing. The demand for primary market social housing is estimated at 168 units in 2021 and is expected to increase to 767 units in 2031. The demand for CRU housing is 135 in 2021 and is expected to increase to 617 in 2031.

The majority of the population of both the primary (75%) and secondary (71%) market areas fall within the low-income household income category. The low household income category ranges from no income to R113 213 per annum. Based on these income categories for rental housing, there is a demand for CRU and social housing. The demand for CRU housing is expected to increase to 566 by 2030, whereas the demand for Social Housing (primary market) is expected to increase to 705 by 2030.

Given the income categories for bonded housing, there is a demand for subsided and FLISP housing. The demand for subsided housing is expected to reach 3 509 by 2030. The demand for social housing in the primary market area is expected to reach 705 by 2030.

7.2. Retail

This sub-section provides an analysis of the market potential of the proposed retail facility based on the market area delineation.

7.2.1. Methodology

The methodology used to calculate the market potential of a new retail development was developed based on a residual analysis technique that considers the demand and supply factors associated with the market area.

This process compares the relevant supply to the total demand within the market area. Both the supply and demand are measured in terms of floor area (square metres) and refers to the gross leasable area (GLA). This process calculates the net effective demand (NED) or market gap in terms of the GLA for the proposed retail component within the demarcated market area which informs the feasibility of the

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proposed retail development. The figure below demonstrates the methodology followed in order to calculate the NED for additional retail space in the market area.

Figure 25: Retail Net Effective Demand

The purpose of the demand analysis is to calculate the market gap for a retail facility. The demand calculation model is based on the interaction between the following dynamics:

- Population growth rates
- Number of households
- Leakages and injections
- Household income

The result of the demand analysis presents an effective demand for the proposed development.

7.2.2. Population Profile

The population profile presents the household and population size in the demarcated market area. The population figures were used as a basis for the residual demand model. Annual population and household growth were calculated based on a five-year average growth rate.

Table 23: Population profile and growth

	2020	2021	2025	2030
Primary Market Area Population	318 195	319 531	324 932	331 812
Primary Market Area Household	98 875	99 855	103 872	109 123
Secondary Market Area Population	513 824	515 982	524 704	535 814
Secondary Market Area Household	163 698	165 320	171 971	180 663

The growth in the number of households in both the primary and the secondary market areas indicates a growth in the demand for retail space.

7.2.3. Trading Densities

Trading densities can be broadly defined as the annual turnover per square metre that an enterprise should receive to remain viable. Each retail category requires a certain amount of income per square meter to remain sustainable. The annual turnover required by a tenant to remain viable is determined by their profit margins and operational costs. Expenditure is a monetary value that needs to be converted to square metres to measure the potential effective demand for the proposed development. Therefore, trading densities are incorporated into the demand calculation model to calculate the desired GLA (m^2) for each retail category.

The appropriate trading densities were applied to the relevant expenditure categories to calculate the effective demand for retail floor space in the delineated market area.

7.2.4. Leakages and Injections

Leakage and injection factors were applied to the retail demand calculation model in order to avoid an overestimation of the potential consumer pool that would use retail facilities located within the primary market area.

Leakages

Leakages can be described as the outflow of purchasing power from the primary market area. Leakages are potential consumers who reside in the primary market area but prefer goods outside the primary market area.

The leakage factor is applied to the demand calculation model to calculate the effective demand for retail floor space within the primary market area based on the current spending patterns of households. A leakage factor of 40% is applied to ensure a realistic and conservative demand estimation. It is therefore assumed that 40% of the population in the primary market area will travel to retail facilities located outside the primary market area. However, due to the nature of the development, it is anticipated that the retail facility will be able to capture a large portion of the population in the primary market area.

Injection

Injection takes place when potential customers who do not reside in the primary market area opt to use retail facilities in the primary market area. An injection is an external contribution to the economy of the primary market area. A conservative approach is applied to ensure a realistic outcome that does not overestimate the significance of the proposed retail development. Therefore, an injection factor of 18% was applied to the retail model calculations.

The region outside the secondary market was not taken into consideration when calculating the external injections.

7.2.5. Supply Analysis

The supply analysis refers to the investigation of the existing and future supply of retail facilities of similar hierarchy in the market area that will act as potential market competitors to the proposed development. The purpose of the supply analysis is to get an understanding of the existing supply in the primary market area and in doing so, identify the potential competitors.

Competitive supply refers to retail facilities that are located in the primary market area. The table below represents all competitive retail facilities in the primary market area.

Table 24: Retail supply in the primary market area

Name	Anchor stores[19]	Distance from the proposed site (km)	GLA (m^2)
Mandela Square Shopping Centre (Boitumelo)	• Pick n Pay	15.4	6 399
Checkers Hyper Arcon Park	• Checkers	5.5	10 573
Thabong Shopping Centre (Sebokeng)	• Pick n Pay • Spar	15.2	41 145

[19] South African Council of Shopping Centres: Shopping Centre Directory, 2019

Name	Anchor stores[19]	Distance from the proposed site (km)	GLA (m^2)
	• Mr. Price • Pep • Clicks		
President Hyper Vanderbijlpark	• President Hyper Vanderbijlpark	14.2	26 000
Sebokeng Plaza	• Shoprite Checkers	12.5	11 422
Shoprite Checkers Centre - Three Rivers	• Shoprite Checkers • Pep	10.5	6 164
Bedworth Park Value Centre	• Pick n Pay • Builders Warehouse	13.8	83 942
Markpark	• Shoprite • Pep • Ackermans • Jet • Clicks	9.6	22 355
		Total:	**208 000**

From the data provided in the table above, it is clear that there are a number of retail supply in the market area. However, there are no retail centres within the immediate vicinity of approximately 5 km from the proposed development; this indicates the need and demand for a retail facility.

7.2.6. Demand Analysis

The factors mentioned above are applied to the demand calculation model in order to determine the effective demand for a new retail facility located in the demarcated market area. It should be noted that the effective demand calculations do not consider any supply factors and will be incorporated into the net effective demand (NED) calculations.

The demand calculation model calculated the total effective demand for retail floor space and is expressed as GLA (m^2). The demand model is based on the interaction between the following factors:

- Population and number of households
- Household income and expenditure
- Leakages and injections
- Trading densities

The following table presents the NED retail floor space in the primary market area.

Table 25: NED for retail space in the primary market area (cumulative demand in m^2)

	2020	2022	2025	2028	2030
NED	14 900	17 700	22 006	26 441	29 472

The table above shows that the NED is expected to increase to reach 22 006 m^2 by 2025 and 29 472m^2 by 2030.

7.3. Office

This sub-section provides an overview of the office market within the market area to determine the market gap for additional office space. The net effective demand (NED) for office space is calculated to express the potential for additional commercial facilities in terms of square metres. A variety of influential factors are analysed to assist in the determination of the total office space needed, which can ultimately be supported by the market population.

The demand calculation model assumes that the demand for office-related floor space increases annually based on the economic sector's annual employment growth rate. The growth projections are then applied to office standard industrial parameters, which allows for the calculation of the total increase in effective demand for office floor space required per annum to sustain the office sector's growth in the market area.

The following table provides the NED for office space in the primary market area.

Table 26: NED for office space (m^2)

	2020	2022	2025	2026	2028	2030
NED	1 354	2 773	7 292	8 880	12 182	15 662

The data presented in the table above show that the NED for the office space in the primary market is expected to increase to reach a demand of 15 662m^2 office space by 2030.

7.4. Education

7.4.1. Schools

This sub-section discusses the calculations for determining the demand for educational institutions in the demarcated market area. The main factors considered for determining the demand for schools are the supply of schools in the market area, the population numbers, and the learner-educator ratios. The following table provides the expected growth in population and the number of households in both the primary and secondary market areas.

Table 27: Population and household growth in the primary and secondary market areas

	2020	2021	2025	2030
Primary Market Area Population	318 195	319 531	324 932	331 812
Primary Market Area Household	98 875	99 855	103 872	109 123
Secondary Market Area Population	513 824	515 982	524 704	535 814
Secondary Market Area Household	163 698	165 320	171 971	180 663

The table indicates that the number of households and the population figures are expected to increase in both the primary and secondary market areas. The following map indicates the distribution and supply of existing schools in the primary market area.

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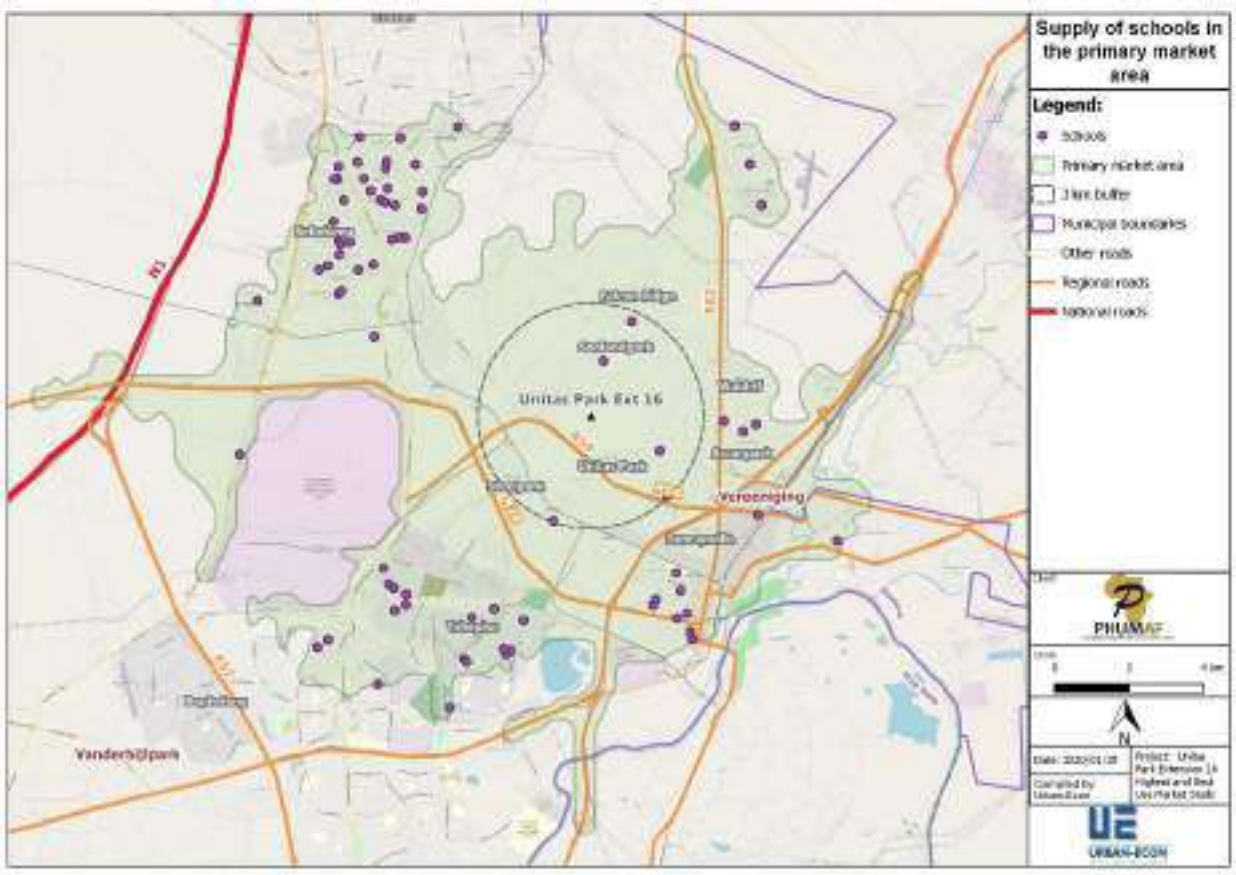
Map 12: Existing supply of schools in the primary market area



Source: Data derived from the Department of Basic Education modified with QGIS, 2020

The map above shows that the majority of schools are clustered in Sebokeng. Other areas where a large number of schools are clustered includes Tshepiso and Duncanville. The closest school is located approximately 3.5 km from the proposed site. The data presented in the table below indicate the average learner-educator ratio and the average OECD indicators.

Table 28: Learner-educator ratio

Schools	Learner-educator ratio (LER)	Average OECD Indicators[20]
Primary schools	32:1	19:1
Secondary schools	25:1	28:1

From the data presented above, it is clear that the learner-educator ratio for primary schools is higher compared to that of the OECD indicators, which, therefore, also indicates the demand for additional schools.

[20] OECD, Education at a Glance 2014 OECD Indicators: OECD Indicators, p. 446-452

The minimum norms and standards was used to identify the threshold population for determining the demand for both primary and secondary schools and nurseries / crèches.

Table 29: Threshold population

Educational facility	Threshold Population
Crèche/nursery	2 400 – 3 500
Primary Schools	2 200 – 6 600
High School	4 000 – 10 000

To calculate the demand and institutional capacity for various educational facilities, the expected total population was divided by the respective threshold population. The following table presents the calculated demand and the number of educational facilities for 2021, 2023, 2025, and 2028.

Table 30: Institutional capacity

Year of full potential	2021	2023	2025	2028
Crèche/nursery	3	5	7	10
Primary schools	3	5	8	11
Secondary / High school	2	3	4	6

The demand for nurseries is expected to increase from three nurseries in 2021 to ten nurseries in 2028. The demand projections for primary schools is three schools by 2021 and eleven schools by 2028 whereas the demand projections for secondary schools are two schools by 2021 and six schools by 2028.

7.4.2. Student Housing

The purpose of this sub-section is to determine and to quantify the need for student accommodation. The Net Effective Demand (NED) of student accommodation is calculated through the following model:

Figure 26: Student housing demand model

It is assumed that any growth in student enrolment in the market area is indicative of the growing demand for student accommodation.

7.4.2.1. Supply

The supply of student accommodation includes accommodation in Vereeniging as well as Vanderbijlpark as both falls within the demarcated market area. The supply for student accommodation considered accommodation on campus, accommodation provided off-campus by tertiary institutions, and other larger and popular student housing. Future developments for student accommodation are also included in the table below.

Table 31: Student housing supply

Student Accommodation	Number of units
NWU - Vaal Campus	877
Vaal University of Technology	1 000
	1 800[21]
Additional student accommodation supply	
Bedworth Lake Student Accommodation	700
Five Star Student Accommodation	16
Granada Student Accommodation	30
Buhle student houses	450
Total additional student accommodation supply	**1 196**
Total supply	**4 873**

The table above indicates that the Vaal University of Technology is expected to contribute an additional 1 800 student beds. The number of students enrolled at the campus is expected to reach 8 225 by 2021, indicating a demand for more beds.

The number of students enrolled at the Vaal University of Technology is expected to reach 19 346 by 2021. The current on-campus accommodation provides 877 beds, which indicate that there is a great demand for additional beds.

Other student accommodations within the market area include Buhle student houses, Five Star Student Accommodation, and Bedworth Lake Student Accommodation. This additional supply adds up to approximately 1 196 beds in the market area. It should be noted that due to time constraints, not all student accommodation facilities are included in this report. Based on the data provided above, the total supply of student accommodation in the market area adds up to **4 873 beds** within the market area.

7.4.2.2. Demand

The following table provides the estimated projected student enrolments at the various tertiary institutions.

[21] Additional future supply of 1 800 beds.

Table 32: Student accommodation demand

	2021	2022	2025	2028	2030
North-West University Vaal Campus	8 225	8 533	9 529	10 642	11 455
Vaal University of Technology	19 346	19 378	19 475	19 572	19 638
Sedibeng TVET College	10 756	10 918	11 417	11 938	12 299

The table above indicates that the number of students within the market area is expected to increase until 2030.

7.4.2.3. Interceptor Factor

The interception factor refers to the portion of demand within the market areas that the proposed student accommodation development will be able to capture.

A conservative approach is applied in order to ensure a realistic outcome that does not overestimate the significance of the proposed development. Therefore, an interceptor factor of 15% was used to calculate the effective demand in terms of the number of beds. The interception factor represents the students who study in the market area and willing to reside in the proposed student accommodation.

The following table provides the student accommodation demand based on a 15% interceptor factor.

Table 33: NED for student accommodation based on 15% interceptor factor

	2021	2022	2025	2028	2030
Number of students	38 327	38 829	40 421	42 152	43 392
Number of beds	4 873	4 873	4 873	4 873	4 873
Interceptor factor	15%	15%	15%	15%	15%
NED	3 703	3 810	4 140	4 497	4 751

Based on a 15% interceptor factor, the NED for student housing is expected to increase from 3 703 beds in 2021 to 4 751 beds in 2030.

7.4.2.4. Minimum Norm and Standards for Student Housing at Public Universities

There are minimum norms and standards for student housing at public universities as set by the Department of Higher Education and Training in the Gazette of 29 September 2015.

The following norms and standards must be adhered to:

- Site of residences:
  - The housing facility must preferably be situated within the campus security perimeter
  - Student housing sites must be within a radius of no more than 20 km of the campus
- Design of residences:
  - Designs must accommodate a maximum of two students per room
  - Single rooms no smaller than 8m^2 and double rooms not smaller than 14 m^2

- The minimum standards and norms for ablution facilities are presented in the table below:

Table 34: Minimum norms and standards for ablution facilities

Wash basins	1 per 4 student residents
Shower cubicle	1 per 7 student residents
Lavatories	1 per 5 student residents

- Shower and lavatory cubicles must be designed in such a way that individual privacy is provided
- Telephones and alarm bells must be placed in accessible and strategic locations so that students with disabilities are not disadvantaged
- Social spaces should be provided
- Residences should be designed to be either self-catering or non self-catering

- All health and safety certificates of compliance should be acquired
- The minimum furnishings and fittings required for each room type or area within a student housing facility are detailed in the Room Specification Manual.

According to the minimum norms and standards as set out by the Department of Higher Education and Training, student housing sites must be within a radius of no more than 20 km of the campus. The proposed development site is located within 20 km of various tertiary institutions (as discussed previously). It is suggested that an agreement is established with tertiary institutions in order to secure a sustainable number of students for the proposed student housing development.

7.4.2.5. Number of Units Required

This sub-section aims to calculate the number of units required for the development of Unitas Park Extension 16.

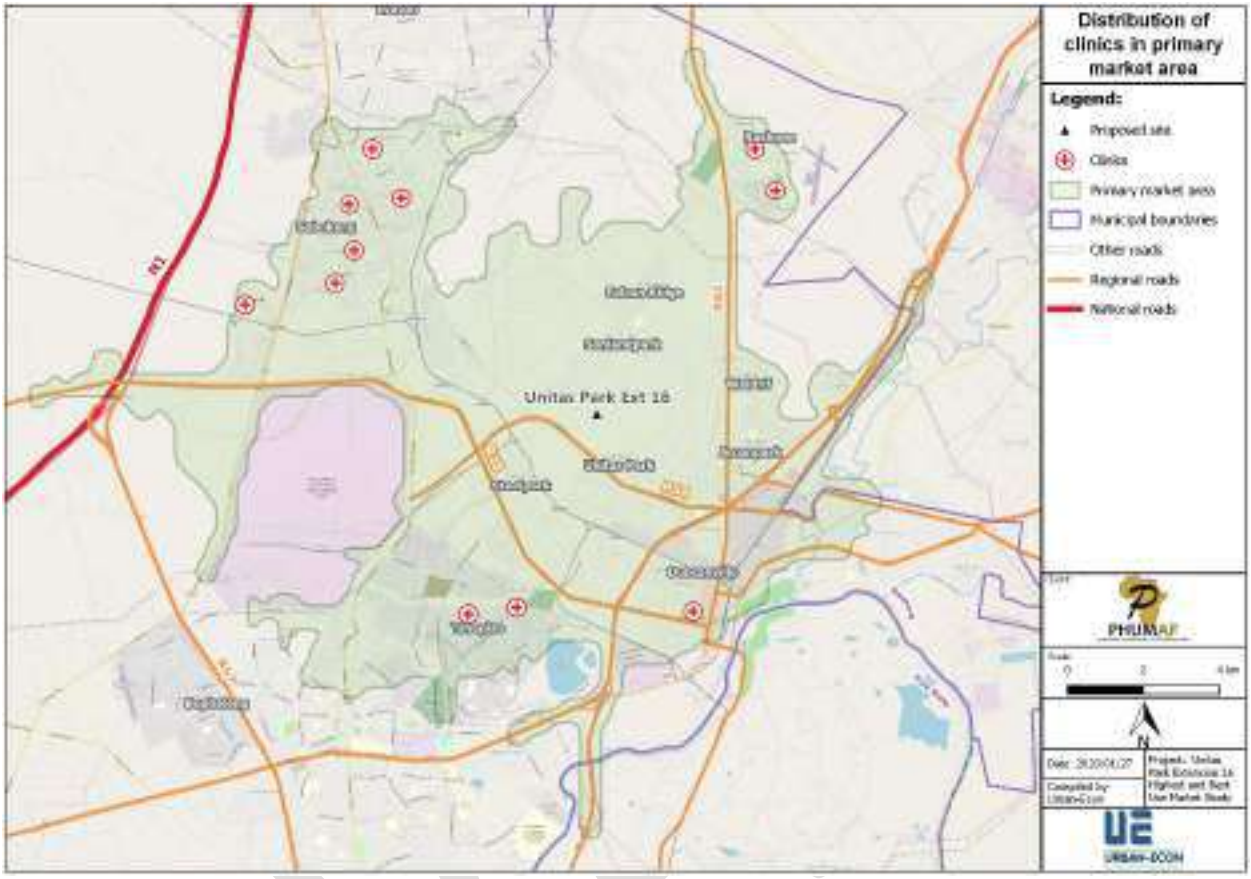
By calculating the number of units required for student accommodation, it is recommended that each unit accommodate four students (beds). The table below presents the future demand in terms of the number of units. This is based on the NED provided in sub-section 7.4.2.2.

	2021	2022	2025	2028	2030
Number of students	38 327	38 829	40 421	42 152	43 392
NED (number of beds)	3 703	3 810	4 140	4 497	4 751
NED (number of units)	926	953	1 035	1 124	1 188

7.5. Clinic

This sub-section discusses the calculations for determining the demand for clinics in the defined market area. The demand model considered the supply of existing clinics and the location of existing clinics and also highlighted discussions from the Emfuleni Integrated Development Plan 2019/20. The following map indicates the supply and distribution of clinics in the primary market area.

Map 13: Distribution of clinics in the primary market area



Source: Data derived from Mapable and modified in QGIS, 2020

The data provided in the map show that there are no clinics within the immediate area of the proposed development site. Most of the clinics are clustered in Sebokeng. The clinic closest to the proposed development is the Vaal Men and Women's clinic in Duncanville and is located approximately 8.6 km from the proposed development site. Rust Ter Vaal clinic in Roshnee is located approximately 9.6 km from the proposed site and Tshepiso clinic approximately 10.5 km from the site.

This illustrates the need for a clinic to serve the population in the primary market area (especially the population in Unitas Park and Sonland Park).

Table 35: Institutional capacity

Year of full potential	2021	2023	2025	2028	2031
Clinic	1	2	3	5	4

The table above indicates the anticipated demand for the number of clinics required in the primary market area. Based on this data, five clinics will be required by 2028 to serve the growing population in this area.

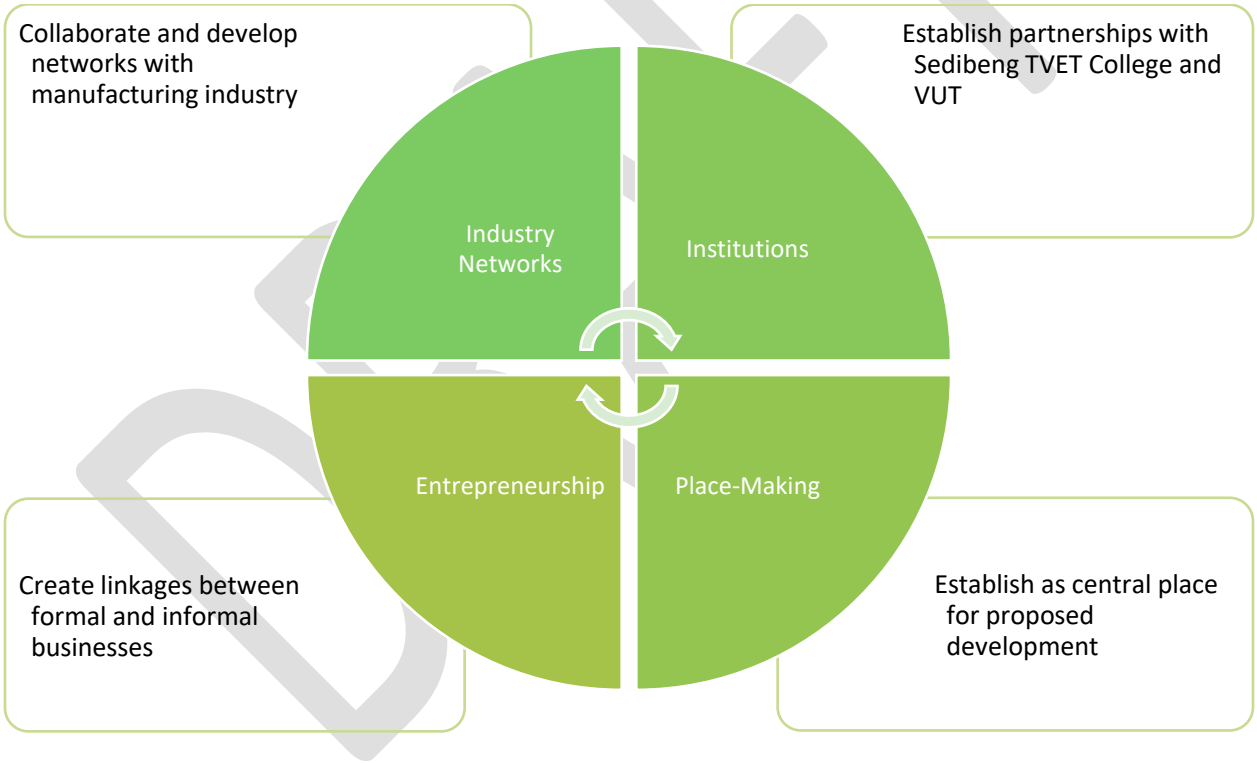
7.6. Unitas Park Innovation Hub Concept

The proposed innovation and incubation hub aim to stimulate growth in the local economy, through job creation, and creating more opportunities for innovation, businesses and networking. The hub is envisioned to incorporate the local workforce and to facilitate skills development related to various sectors and industries, and to create an enabling environment for SMMEs through linkages and networking.

As mentioned previously, the core components of an innovation and incubation hub includes the following:

- Institutions
- Industry networks
- Entrepreneurship
- Place-making

The following figure provides a summarises the core initiatives and objectives for the proposed incubation hub for Unitas Park Extension 16.



7.6.1. Institutions

It is suggested that the proposed innovation hub form partnership with existing tertiary institutions in the area (as identified earlier). These institutions could include the following:

- Sedibeng TVET College
- Vaal University of Technology
- NWU Vaal Campus

This proposed site for such a development is well located for forming these partnerships and can, therefore, make use of these educational and research institutions.

7.6.2. Industry Networks

Collaboration with larger industries such as the manufacturing industry could be considered for the proposed innovation hub. These collaborations could be used as part of mentorship programmes and for building relationships with other key industry role players.

7.6.3. Entrepreneurs

Partnerships between the formal and informal business sector could be facilitated through the innovation hub. Representatives of large-scale formal businesses could act as mentors and assist entrepreneurs of small and medium businesses. The hub could also provide a platform for skills development and could also create opportunities for networking sessions which allows various businesses to interact and establish potential partnerships and thereby creating a more dynamic and competitive business and entrepreneurial environment.

7.6.4. Place-Making

The proposed innovation hub could be developed in such a way to be the central place for Unitas Park Extension 16 mixed-use development and can be linked with student activities and services associated with the proposed development.

The innovation and incubation hub can play an important role in establishing networks, partnership and an integrated mixed-use development space. It can also facilitate economic growth and create job opportunities through skills development and mentoring programmes. These skills can be implemented and used in various small businesses and various industries. Partnerships with various institutional and educational facilities can be established in thereby driving research programmes, can provide innovative inputs within various programmes run by the hub.

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8. Supplementary Land Uses

This section relays the population threshold according to the minimum norms and standards. The population threshold provides an indication of the number of people required to sustain a particular facility. These threshold indicators are also used to identify additional land uses most suitable within the market area.

8.1. Thresholds

The following table provides the population threshold and access distances for schools and other social facilities[22].

Table 36: Threshold and access distances

Facility Type	Typical population threshold (number of people)
Early childhood development centres (such as day-care centres, nursery schools, playschools and after-school care facilities) • Number of children: 6 – 150 children • Ages: younger than 5 years	2 400 – 3 500
Primary schools • Education facilities for Grade R to 7 (aged 5 to 12) • Small schools required a population threshold of 1 000 people	2 200 – 6 600
Secondary schools • Education facilities for Grade 8 to 12 • Ages 13 to 17	4 000 – 10 000
Primary health care clinics: Permanent facilities (public or private) providing a range of primary health care services	5 000 – 60 000
Libraries	5 000 – 25 000
Community centres	5 000 – 60 000
Religious centres	2 000
Post office	10 000 – 20 000
Police station	10 000 – 60 000

[22] It should be noted that the minimum threshold population was used to determine the required demand for social amenities.

DRAFT

Facility Type	Typical population threshold (number of people)
Government departments' offices Government departments providing access to specified services for a particular department	
Department of Home Affairs	20 000 – 200 000
Department of Labour Offices	
SASSA Offices	30 000 – 120 000

Source: Department of Human Settlements: Minimum norms and standards, 2019

8.2. The Way Forward

This section uses the population threshold figures and the analysis of previous sections to identify the key land-use demands and requirements for the proposed development site. The following additional land uses have identified for the proposed development site of Unitas Park Extension 16, Vereeniging:

- Schools
- Clinics
- Government department offices

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9. Conclusion and Recommendations

This section provides concluding remarks for the key topics discussed in this report as well as the recommendations for future development on the proposed site.

9.1. Conclusion

This sub-section relays the key findings from each section presented in this report.

Spatial Analysis

- The proposed development is located in Vereeniging (Emfuleni Local Municipality) and situated 60 km south of Johannesburg.
- Some major towns within close proximity include Vanderbijlpark (approximately 17 km) and Sasolburg (approximately 32 km).
- The major land uses surrounding the proposed development site include residential development, open spaces, and agricultural holdings. There are also a number of churches in the area with some small retail facilities in the area.
- The proposed development will be a mixed-use development with the potential to add significant value to the area. The proposed mixed-use development will complement the existing urban fabric by providing supplementary services, activities, and other complementary land uses.

Macro-Economic Analysis

- The manufacturing sector makes the largest contribution (28%) to the total GVA of Emfuleni LM, followed by general governance contributing 17% to the total GVA of the local municipality.
- GVA trends indicate that general government, finance, insurance, real estate and business services, and wholesale and retail trade, catering and accommodation experienced growth from 2006 to 2018. Manufacturing (the largest contributor to the municipality's GVA) has shown a notable decline indicating that the industry is struggling. This will affect the local economy and also employment opportunities within the industry.
- The manufacturing sector, a leading economic sector in the LM, is expected to decline as a result of increasing electricity prices and costs of other raw materials. This already had a major impact on the local economy in terms of employment, revenue generated through manufacturing, and other industries depending on this sector.
- The General Government sector contributes 17% to the total GVA of Emfuleni LM. Potential land uses for the general government sector could be considered and incorporated into the proposed development.
- The current interest rate stands at 9.25%, which is down by 0.75% since the beginning of 2019. This is a good indication of home affordability since a decline in the interest rate enables better bond affordability and household expenditure.
- The current inflation rate stands at 3.7%. A lower inflation rate decreases financial pressure on households, which bodes well for home affordability as households have more disposable income.

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Socio-Economic Analysis

- The population in the market area is expected to increase in the next decade which is a good indication of the demand for housing.
- The total potentially active (PEA) population accounts for approximately 70% of the total population. Due to this high percentage of PEA population, a large portion of the population is open to employment and to generate personal income.
- A moderate portion of the population is below the age of 15 years; therefore, it can be assumed that the demand for various goods and services will increase as the younger portion of the population become economically active.
- The industries making the largest employment contribution are community, social and personal services, and wholesale and retail trade. These are the most prominent industries in the area; therefore, additional land uses related to these industries can be considered. Some of these facilities include offices for public administrative services, human health activities, and educational services.
- Of the total population in the primary market, 38% are employed, 21% are unemployed, 3% are discouraged work-seekers and 38% are other not economically active population. This indicates that the majority of the working-age population is not employed or economically active and therefore have a low disposable income and does not have access to capital to buy a home.
- The unemployment rate in the local municipality is increasing, which means that people have less disposable income. The impact on the housing market is that people have less money available and, therefore, may not be able to purchase a house or may encounter bond repayment issues.

Market Perspective

- Freehold properties are highest in demand, but this could also be an indication of a market that requires higher densities.
- The declining house prices in areas surrounding the proposed development site can be an indication of a residential market that is in an oversupply of houses to buy.
- The number of students within the given market area is expected to increase to 43 392 students by 2030. The estimated student accommodation supply within the market area is 3 873[23].
- Eight shopping centres and malls are identified in the primary market area, the majority of which are located close to the borders of the primary market area. The closest shopping centre is located 5.5 km from the proposed site and therefore indicates that there is no retail centre serving the population of Unitas Park and Sonland Park.
- The primary market area consists of approximately 208 000 m^2 gross leasable area (GLA) of retail space.
- The major anchor shops are Shoprite Checkers, Pick n Pay, and PEP. This suggests that these stores capture and appeal to the local market and could be considered as anchor stores for a newly developed retail centre.

[23] Student accommodation supply provided here includes only some of the major student accommodation facilities within the demarcated market area.

- The identified area is not popular in terms of office space, and due to the low number of offices in the primary market area, it is suggested that office space for the proposed mixed-use development be limited to a small portion of the development site.
- The majority of schools in the primary market area are primary schools. It is also evident that the demand for primary education is high due to the learner-educator ratio being higher than the average as per the OECD Indicators. The closest primary school are located approximately 3.5 km from the proposed site.
- The nearest clinic is located approximately 8.6 km from the proposed site. The lack of clinics within the immediate area of the proposed development indicates the need for a clinic to serve the population, especially in Unitas Park and Sonland Park.

Market Opportunity Analysis

- The various potential land uses were analysed to identify those with the highest development potential and the highest probability to succeed. These land uses include residential, student housing, retail, clinics, schools and office.

Market Potential

- The majority of the population of both the primary (75%) and secondary (71%) market areas fall within the low-income household income category.
- Based on the income categories for rental housing, there is a demand for CRU and social housing. Given the income categories for bonded housing, there is a demand for subsided and FLISP housing.
- The number of students along with the current and future supply of student accommodation in the market area were used to determine the NED for student accommodation in the market area.
- A 15% interceptor factor was applied to the student accommodation demand model. The interceptor factor represents the students who study in the market area and willing to reside in the proposed student accommodation.
- Based on the 15% interceptor factor, the effective demand for student beds are expected to reach 4 140 by 2025 and 4 751 by 2030.
- By calculating the number of units required for student accommodation, it is recommended that each unit accommodate four students. Therefore, the number of units required by 2025 is expected to be 1 035 and 1 188 by 2030.
- The Net Effective Demand (NED) for retail development is expected to increase to reach 22 006 m^2 by 2025 and 29 472m^2 by 2030.
- The NED for office space in the primary market is expected to increase to reach a demand of 15 662m^2 by 2030.
- The learner-educator ratio for primary schools is higher compared to that of the OECD indicators and, therefore, also indicates the need for additional primary schools.
- The threshold population figures suggest that primary schools are higher in demand in the market area, compared to crèches and secondary schools.
- Five clinics will be required by 2028 to serve the growing population in this area.
- The innovation and incubation hub can play an important role in establishing networks, partnership and an integrated mixed-use development space. It can also facilitate economic growth and create job opportunities through skills development and mentoring programmes.

DRAFT

These skills can be implemented and used in various small businesses and various industries. Partnerships with various institutional and educational facilities can be established in thereby driving research programmes, can provide innovative inputs within various programmes run by the hub.

The following table summarises the income categories and desired densities for each bonded housing type category. A ten-year housing demand forecast is also provided for each category.

Table 37: Bonded income categories, housing typologies, densities and forecasts

Income Categories	Housing Type	Density	2021	2023	2025	2028	2031
0 – R42 000	Subsidised	High	839	1 412	1 996	2 895	4 209
R42 000 – R108 000	FLISP	High	374	629	890	1 290	1 702
R108 000 – R264 000	Affordable Housing	Medium to high	160	270	382	554	731
R264 000 – R600 000	Middle Income	Medium to high	169	285	403	585	772
R600 000 +	High Income	Medium to low	23	38	54	78	103

The following table summarises the income categories and desired densities for each rental housing type category. A ten-year housing demand forecast is also provided for each category.

Table 38: Rental income categories, housing typologies, densities and forecasts

Income Categories	Housing Type	Density	2021	2023	2025	2028	2031
R 9 600 – R42 000	CRU	High	135	228	322	467	617
R18 000 – R66 000	Social Housing Primary Market	High	168	283	401	581	767
R66 000 – R180 000	Social Housing Secondary Market	Medium to high	108	183	258	374	494
R108 000 – R264 000	Affordable Housing	Medium to high	86	145	205	298	393
R264 000 – R600 000	Middle Income	Medium to low	92	154	218	316	417
R600 000 +	High Income	Medium to low	13	21	30	44	58

Supplementary Land Uses

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- In addition to housing development, the most viable supplementary land uses have been identified as student housing, retail, schools, clinics, and government department offices.

9.2. Recommendations

The recommendations provide two different scenarios that incorporate development potential and requirements for residential units, retail space, office space, and additional social amenities. Scenario one considers all residential units within a given year whereas scenario two excludes CRU and subsidised housing.

9.2.1. Scenario One

Scenario one looks at the requirements and the demand for various facilities for the proposed mixed-use development. The residential demand and requirements include all residential categories for both bonded and rental housing. The following table provides a breakdown of the residential demand and requirements for 2021, 2023, 2025, 2028, and 2031.

Table 39: Bonded requirements and demand for scenario one

BONDED					
	2021	**2023**	**2025**	**2028**	**2031**
Subsidised	839	1 412	1 996	2 895	4 209
FLISP	374	629	890	1 290	1 702
Affordable Housing	160	270	382	554	731
Middle Income	169	285	403	585	772
High Income	23	38	54	78	103
Total	**1 565**	**2 634**	**3 725**	**5 401**	**7 517**

The data presented in the table above show the predicted demand for bonded housing from 2021 to 2031. The housing market is growing and there Is a demand for new residential development. The greatest demand in the primary market area for bonded housing is subsidised and FLISP housing.

The following table provides a breakdown of the demand and requirements for rental housing.

Table 40: Rental requirements and demand for scenario one

RENTALS					
	2021	**2023**	**2025**	**2028**	**2031**
CRU	135	228	322	467	617
Social Housing Primary Market	168	283	401	581	767
Social Housing Secondary Market	108	183	258	374	494
Affordable Housing	86	145	205	298	393
Middle Income	92	154	218	316	417

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RENTALS					
	2021	**2023**	**2025**	**2028**	**2031**
High Income	13	21	30	44	58
Total	**603**	**1 014**	**1 434**	**2 080**	**2 745**

There is a greater demand for CRU and social housing. The demand for primary market social housing is estimated at 168 units in 2021 and is expected to increase to 767 units in 2031. The demand for CRU housing is 135 in 2021 and is expected to increase to 617 in 2031.

The NED for student housing was calculated using a 15% interceptor factor. The following table provides the number of students, existing supply of student accommodation (number of beds), the NED (number of beds and the demand for the number of units.

Table 41: NED for student accommodation based on 15% interceptor factor

	2021	**2022**	**2025**	**2028**	**2030**
Number of students	38 327	38 829	40 421	42 152	43 392
Number of beds	4 873	4 873	4 873	4 873	4 873
Interceptor factor	15%	15%	15%	15%	15%
NED (number of beds)	3 703	3 810	4 140	4 497	4 751
Number of beds per unit	4	4	4	4	4
Demand (number of units)	926	953	1 035	1 124	1 188

Based on a 15% interceptor factor, the NED for student housing is expected to increase from 3 703 beds in 2021 to 4 751 beds in 2030. By calculating the number of units required for student accommodation, it is recommended that each unit accommodate four students (beds). Therefore, the projected demand for units is 926 for the year 2021 and is expected to grow to 1 188 units by 2030.

It is suggested that an agreement is established with tertiary institutions in order to secure a sustainable number of students for the proposed student housing development.

The following table provides a breakdown of the number of social amenities required for each year, given the number of housing.

Table 42: Demand and requirements for social housing for scenario one

Year of Full Potential	**2021**	**2023**	**2025**	**2028**	**2031**
Crèche/nursery	3	5	7	10	7
Primary Schools	3	5	8	11	8
High School	2	3	4	6	4
Clinic	1	2	3	5	4

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Year of Full Potential	2021	2023	2025	2028	2031
Libraries	1	2	3	5	4
Community Centre	1	2	3	5	4
Religious Centre	4	6	8	12	9
Post Office	1	1	2	2	2
Police Station	1	1	2	2	2

The following table indicates the retail and office space requirements for each respective year until 2031.

Table 43: Future retail and office space demand (m^2) for scenario one

	2021	2023	2025	2028	2031
Total retail space demand	16 294	19 122	22 006	26 441	30 995
Total office space demand	1 354	2 773	7 292	8 880	12 182

It is recommended that the retail and office space is student-orientated to ensure that the student housing development is supported with the necessary retail and office services and thereby making the provision of student housing more sustainable.

9.2.2. Scenario Two

Scenario two looks at the requirements and the demand for various facilities for the proposed mixed-use development. The residential demand and requirements exclude CRU and subsidised housing. The following table provides a breakdown of the residential demand and requirements for 2021, 2023, 2025, 2028, and 2031.

Table 44: Bonded requirements and demand for scenario two

BONDED					
	2021	**2023**	**2025**	**2028**	**2031**
FLISP	374	629	890	1 290	1 702
Affordable Housing	160	270	382	554	731
Middle Income	169	285	403	585	772
High Income	23	38	54	78	103
Total	**726**	**1 222**	**1 729**	**2 507**	**3 308**

The greatest demand in the primary market area is FLISP and affordable housing. The demand for FLISP housing is expected to increase to 1 702 by 2031 whereas the demand for affordable housing is expected to increase to 731 by 2031.

The following table provides a breakdown of the demand and requirements for rental housing.

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Table 45: Rental requirements and demand for scenario two

RENTALS					
	2021	**2023**	**2025**	**2028**	**2031**
Social Housing Primary Market	168	283	401	581	767
Social Housing Secondary Market	108	183	258	374	494
Affordable Housing	86	145	205	298	393
Middle Income	92	154	218	316	417
High Income	13	21	30	44	58
Total	**467**	**787**	**1112**	**1613**	**2129**

The greatest demand in terms of rental housing is social housing. The demand for social housing in the primary market area is expected to increase to 767 by 2031.

The NED for student housing was calculated using a 15% interceptor factor. The following table provides the number of students, existing supply of student accommodation (number of beds), the NED (number of beds and the demand for the number of units.

Table 46: NED for student accommodation based on 15% interceptor factor

	2021	**2022**	**2025**	**2028**	**2030**
Number of students	38 327	38 829	40 421	42 152	43 392
Number of beds	4 873	4 873	4 873	4 873	4 873
Interceptor factor	15%	15%	15%	15%	15%
NED (number of beds)	3 703	3 810	4 140	4 497	4 751
Number of beds per unit	4	4	4	4	4
Demand (number of units)	926	953	1 035	1 124	1 188

Based on a 15% interceptor factor, the NED for student housing is expected to increase from 3 703 beds in 2021 to 4 751 beds in 2030. By calculating the number of units required for student accommodation, it is recommended that each unit accommodate four students (beds). Therefore, the projected demand for units is 926 for the year 2021 and is expected to grow to 1 188 units by 2030. It is suggested that an agreement is established with tertiary institutions in order to secure a sustainable number of students for the proposed student housing development.

The following table provides a breakdown of the number of social amenities required for each year, given the number of housing.

Table 47: Demand and requirements for social housing for scenario two

Year of Full Potential	**2021**	**2023**	**2025**	**2028**	**2031**
Crèche/nursery	1	2	3	5	7

Year of Full Potential	2021	2023	2025	2028	2031
Primary Schools	1	3	4	6	8
High School	1	1	2	3	4
Clinic	1	1	1	2	3
Libraries	1	1	1	2	3
Community Centre	1	1	1	2	3
Religious Centre	2	3	4	6	8
Post Office	1	1	1	1	1
Police Station	1	1	1	1	1

The following table indicates the retail and office space requirements for each respective year until 2031.

Table 48: Future retail and office space demand (m^2) for scenario two

	2021	2023	2025	2028	2031
Total retail space demand	16 294	19 122	22 006	26 441	30 995
Total office space demand	1 354	2 773	7 292	8 880	12 182

Based on the calculations done in the retail model, the three retail categories identified as those in highest demand and most likely to be viable include the following:

- Food and non-alcohol beverages (24.1%)
- Clothing and footwear (10.5%)
- Recreation and culture (38.1%)

The percentages provided above indicate the suggested share of GLA that each of these retail facilities can contribute to the total retail space in the market area. In order to support and effectively establish a student oriented living space, it is recommended that retail is aimed at providing to the needs of students. These can include retail shops with affordable clothing, footwear and assecories as well as student oriented recreational and cultural space.

The top three office space categories as calculated using the office demand model include the following:

- Wholesale and retail trade, catering and accommodation (25.68%)
- Finance, insurance, real estate and business services (18.15%)
- Community, social and personal services (18.92%)

The categories provided above, indicate the major industries within the market area and it is therefore also recommended that the office space developed for Unitas Park Extension 16 be used for these industries. With the development of a student-orientated living space, it is recommended that office space are mainly focused on providing essential services to students and thereby creating a student-friendly environment.

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