KLIPGAT RADIO MAST
GEOTECHNICAL REPORT

FEBRUARY 2020

Prepared for:

Eskom

Prepared by:

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KLIPGAT RADIO MAST
GEOTECHNICAL REPORT

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SYNOPSIS

Report presenting the results of a geotechnical investigation undertaken for the proposed construction of a radio mast at the Klipgat Radio Site.

KEY WORDS:s

Radio Mast, Geotechnical Investigation, Klipgat, Gauteng Province

QUALITY VERIFICATION

This report has been prepared under the controls established by a quality management system that meets the requirements of ISO9001: 2015 which has been independently certified by DEKRA Certification under certificate number 90906882

Verification	Capacity	Name	Signature	Date
By Author	Technical Director *Pr.Sci.Nat (400011/00)*	C. Canahai		19/02/2020
Checked by:	Engineering Geologist *Pr.Sci.Nat (400275/16)*	K. Naidoo		19/02/2020
Authorised by:	Technical Director *Pr.Sci.Nat (400011/00)*	C. Canahai		19/02/2020

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GEOTECHNICAL REPORT

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KLIPGAT RADIO MAST
GEOTECHNICAL REPORT

1 INTRODUCTION

This report presents the results of a geotechnical site investigation undertaken for the proposed construction of the Klipgat Radio Mast. The site is located at the Klipgat Substation (SS) site, in the Soshanguve area, within the Gauteng Province of South Africa.

The objectives of the investigation are to:

- Assess the suitability of the site from a geotechnical perspective.
- Provide a general overview of the geological and geotechnical conditions on site.
- Assess the material properties on site.
- Provide an overview of the founding conditions for the proposed radio mast.
- Identify areas of seepage and high-water table as well as recommended drainage measures.
- Identify the presence of problematic ground conditions as well as recommended mitigation measures.
- Assess the excavation conditions at the site.

The field investigation was carried out on the 21st of January 2020 and entailed the following:

- The excavation of one hand dug test pits.
- The excavation of one hand auger hole.
- Driving of two Dynamic Cone Penetration (DCP) tests.

It must be borne in mind that the overall interpretation of the subsurface geotechnical conditions is based upon point information derived from the respective test positions. Ground conditions between the investigation points are inferred by interpolation and extrapolation of the point information. The founding conditions exposed during the construction phase must be assessed by and approved by a competent person. Should conditions at variance from those described in this geotechnical report be encountered, the services of a geotechnical professional must be sought.

2 APPOINTMENT

JG Afrika was appointed by Eskom Holdings SOC to undertake a geotechnical investigation for the proposed radio mast under Purchase Order No. 4300345559.

- Project Name: Soshanguve Alternative Routes
- Project Number: C.TXT0453
- Project Manager: Morake Maboane

3 PROJECT DESCRITPION

It is understood that a 15 m high, self-supporting, lattice-type mast/tower will be constructed at the site to support telecommunications antennae.

4 SITE LOCATION

The site is reached via Main Road M44 from Mabopane, into an unnamed road leading west, to the Klipgat Village. Klipgat Substation is located approximately 6km west of Mabopane and some 10 km north west of Soshanguve, at the coordinates: 25°29'21"S, 28°0'31"E.

A Locality Map and a Site Layout Plan are provided in Figures 1 and 2.

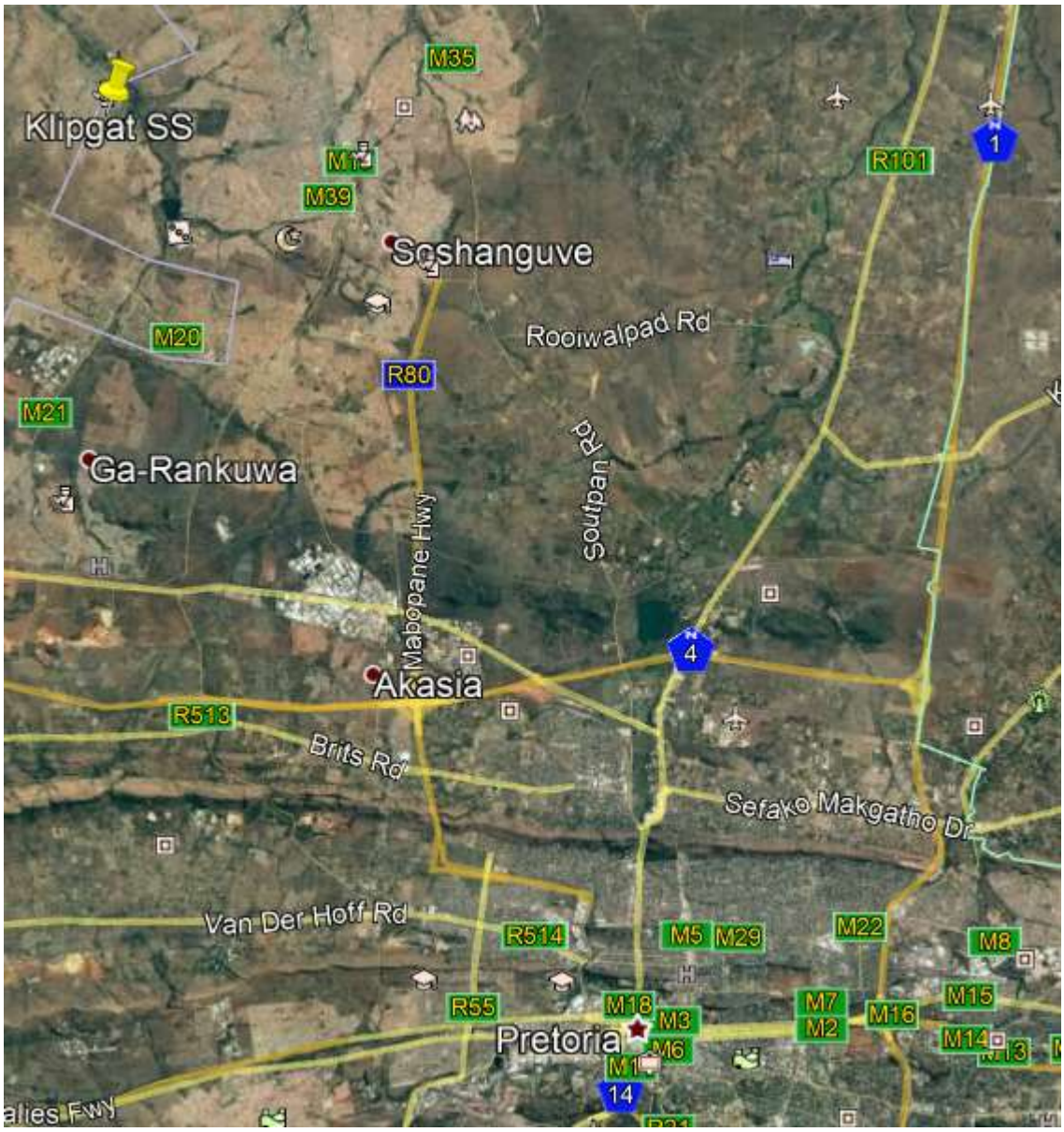


Figure 1: Locality Map

Figure 2: Site Layout Plan

4.1 Topography and Drainage

The site is located on a very gentle slope. The topography of the site is flat having been levelled for the construction of the existing Klipgat Substation. The surrounding area slopes gently to the east, towards Sandrivier River located some 800m to the east of the substation.

4.2 Groundwater

Groundwater seepage was not observed in the test pit undertaken at the site. Mention must be made of the fact that the fieldwork was undertaken during the rainy season and that the ground conditions were moist. Groundwater seepage may be expected during or after persistent rainfalls.

4.3 Vegetation, Land Use and Existing Infrastructure

The vegetation on site was non-existent. The substation area is covered with crushed rock or paving. The site is occupied by various infrastructure typical of a substation. The site is completely fenced and is accessed by locked gates.

The surrounding area – outside of the Klipgat Substation fenced site, is covered in grasslands with occasional trees.

4.4 Access

The site is accessed via Road M44 from Mabopane, turning west towards Klipgat onto an unnamed tarred road.

Movement of large plant may be hindered due to the existing substation infrastructure. The fence would probably need to be opened at the location of the proposed tower, to allow access to machinery onto the site.

5 GEOLOGY

According to the 1:250 000 scale Geological Series Map 2528 Pretoria, the site is expected to be underlain by granophyre bedrock of the Rashoop Granophyre Suite, of the Bushveld Igneous Complex, however, no bedrock was encountered during this investigation. The general geology of the site is depicted in Figure 3.

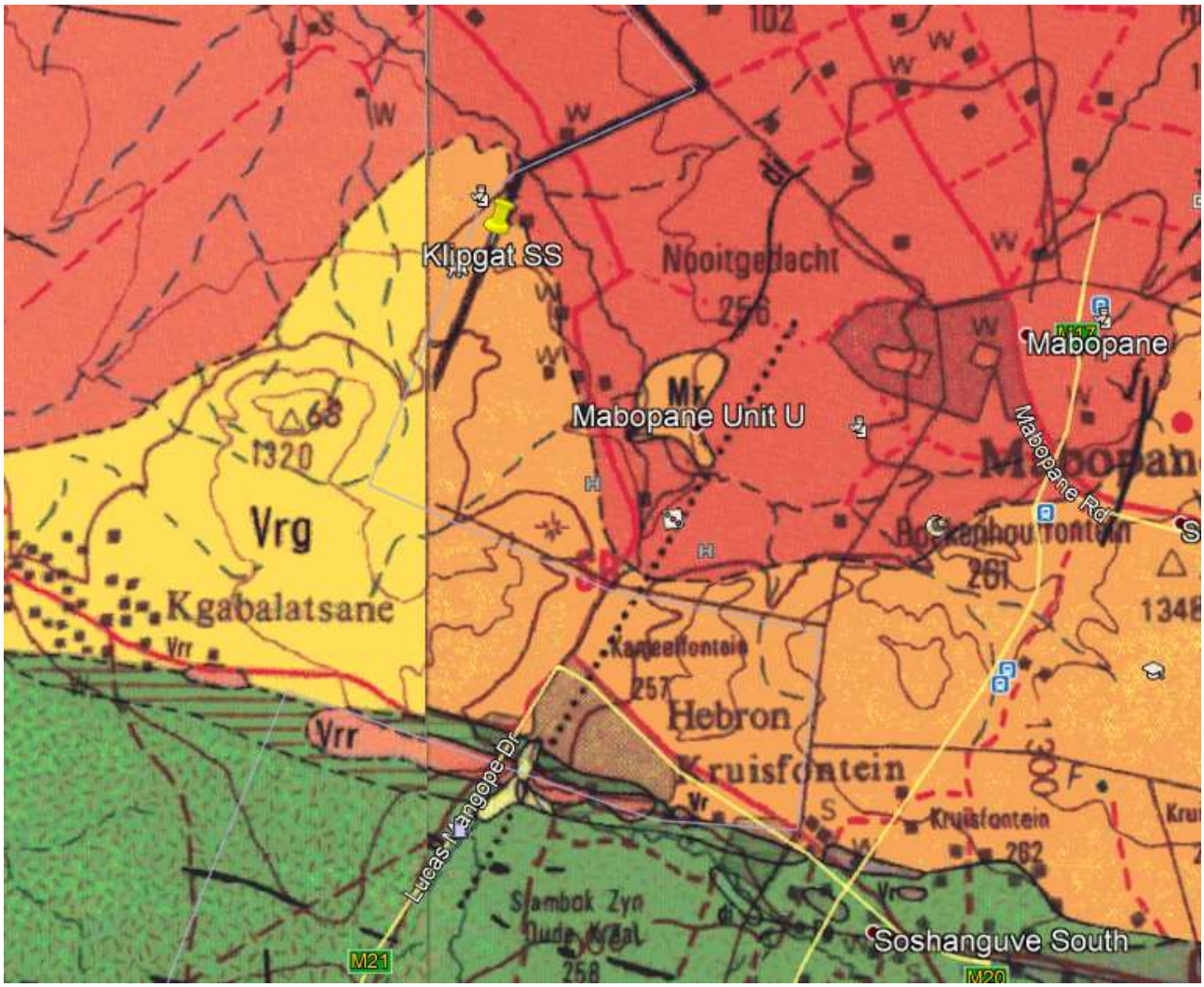


Figure 3: Geology Map

Extracted from the 1: 250 000 scale geology map titled: "2528 Pretoria" Council for Geoscience

Symbol	Stratigraphy	Lithology
Vrg	Rashoop Granophyre Suite	Granophyre, pseudogranophyre, microgranophyre, granite porphyry

6 CLIMATE

The climatic regime plays a fundamental role in the development of a soil profile. Weinert (1964) demonstrated that mechanical disintegration is the predominant mode of rock weathering in areas where his climatic "N-value" is greater than 5, while chemical decomposition predominates where the N-value is less than 5. Weinert's climatic N-value for the area is approximately 2.4. This implies that chemical disintegration is the dominant mode of weathering at the site.

7 FIELDWORK

The fieldwork was undertaken on the 21th January 2020, during the wet summer season, during and after significant rainfall has occurred. The fieldwork comprised of the following:

7.1 Test Pits & Hand Auger Hole

One test pit, designated TP1 was excavated using hand tools to a depth of 1,20 m, before a hand auger was used to advance it further until refusal was met at 2,30 m.

The pit was terminated due to refusal of the auger in dense ferricrete material.

The test pit / auger hole spoils were profiled by a professionally registered engineering geologist in accordance with "*Guidelines for Soil and Rock Logging in SA, 2nd Impression, Brink & Bruin, 2002*". The test pit and auger hole were loosely backfilled after profiling. The test pit / auger hole log and photographs can be found in Annexure A. The location of the hand excavated TP1 / AH1 is indicated in Figure 4.

7.2 Sample Recovery

One sample was recovered from the test pit and sent to the laboratory for testing. The results are discussed further on in this report.

7.3 DCP Tests

Two Dynamic Cone Penetration (DCP) tests were undertaken:

- DCP1 was undertaken from the TP1 / AH1 from a depth of 1,20 m
- DCP2 was undertaken to the south of the TP1 / AH1, from, from 0,20 m depth, just below the gravel layer (see Figure 2).

Refusal of the DCP test occurred at similar depths of between 1, 95 m (DCP2) and 1,99 m (DCP1).

The results have been used to empirically derive Estimated Allowable Safe Bearing Pressures (EASBPs) for the soils. The estimation of the EASBP's is based on Terzaghi's settlement chart for 25 mm of settlement, using SPT values estimated from the DCP test results.

The interpretation of the DCP test results must take into account the condition of the soil profile through which the probe is advanced. Based on the test pit profile, the DCP test was advanced through silty sands and gravelly sands. A non-cohesive profile was assumed when interpreting the DCP test results.

Figure 4: Location of TP1 /AH1

The DCP test results indicate the following:

- **Pedogenic soils** between **0,20 and 0,80** m depth have very low EASPBs, of **24 - 56 KPa**.
- **Pedogenic soils** between **0,80 and 2,30 m** depth have EASBPs of **171 - 237 KPa**.
- Both DCPs refused at approximately 2,00 m depth on what is suspected to be cemented ferricrete horizon or possibly bedrock.

The interpretation of the DCP test results must take into account the moisture content of the soil, as a wet soil horizon will provide lower consistencies than a similar test undertaken under drier conditions, as percolating water softens the subsoils. Moisture content should thus always be noted and made mention of in any DCP investigation. The DCP tests were undertaken on soils that were observed to have a “moist” moisture content.

Another factor to note is that the blow count may be influenced by shaft friction, with depth. Therefore, it is recommended that the DCP test results are interpreted with caution and a

conservative approach must be taken when utilizing the DCP results for design purposes. The DCP test results are given in Appendix B.

Figure 5: Locations of DCP1 & DCP2

8 LABORATORY TESTING

One disturbed sample was recovered from the test pit and submitted for grading analyses and Atterberg Limit determinations.

The test results are summarized in Table 1 and the full results are included in Annexure C:

Table 1: Grading and Atterberg Limit Determinations

Pit No	Depth (m)	Description	Particle Size (%)				Atterberg Limits (%)			Heave Potential	Soil Classification AASHTO
			Clay	Silt	Sand	Gravel	LL	PI	LS		
TP1 / AH1	0.80	Gravel Pedogenic	2	4	33	61	26	8	4.0	Low	A-2-4(0)

LL- Liquid Limit **PI - Plasticity Index** **LS - Linear Shrinkage**

The results of the soil grading test indicate that the soil consists predominately of gravel. It is therefore recommended that the soil be classified as non-cohesive for engineering evaluation purposes.

The potential for heave related movement of the soil sample was assessed according to the Van der Merwe method of predicting potential heave (Williams and Donaldson 1980). This estimates the expansiveness from the equivalent Plasticity Index of the whole sample and the clay content of the

whole sample. The laboratory test results indicate that the soils have a "low" potential for expansiveness. It is anticipated that no moisture induced heave is to be encountered at this site. The AASHTO soils classification is A-2-4(0).

From an Eskom specifications' point of view the soils are classified as follows:

- 0,00 – 1,80 m depth Type "3"
- 1,80 – 2,30 m depth Type "1".

9 ASSESSMENT OF THE SITE

The ground conditions described below are based on visual observations in the test pit / hand auger hole, DCP test results and laboratory test results. It must be noted that the investigation was undertaken during the wet summer season.

The ground conditions are summarized below and for more comprehensive details, the test pit log and photographs can be found in Annexure A.

9.1 Fill Material

A thin layer of fill material comprising crushed gravel was encountered from surface to a depth of approximately 0,20 m below ground level. This is expected to be consistent on the entire area of the proposed tower site.

9.2 Pedogenic Horizon

Pedogenic soils are soils that had their chemical composition changed by pedogenesis, in this case by leaching of iron oxides into the existing soils. Pedogenic soils were encountered from a depth 0,20 m below existing ground level and persisted to 2,30 m below existing ground level, which is the depth of refusal of the auger test. The DCP tests refused at shallower depths.

No residual soils or weathered bedrock were retrieved or observed during this investigation.

10 RECOMMENDATIONS

10.1 Foundations

It is understood that the proposed structure is a 15 m high, self-supporting, lattice-type mast/tower. The bearing pressure resulting from wind loading will be significantly higher than the bearing pressure induced by the tower itself.

Based on typical foundation design for similar communication towers, it is expected that the structure will be founded on a single concrete base (spread footing). Generally, these foundation bases are designed such that a load of approximately 150 kPa is imposed on the founding medium.

The foundation must be designed to resist the uplift forces, as well as sliding and overturning forces, imposed by wind loading. For spread footing foundations, this is typically achieved by:

- The weight of the spread footing
- The weight of the spread footing and overlying soils
- Rock/soil anchors or micro-pile systems (possibly in combination with methods above)

Based on the DCP test results, the Estimated Allowable Safe Bearing Pressure (EASPB) for the subsoils are between 71kPa and 157 kPa up to approximately 1,80 m depth. These soils are expected to undergo consolidation settlement when loaded. Founding on these soils is not recommended, unless some form of ground improvement is undertaken. A soil raft may be constructed within these soils to support the tower foundations. The fill type, dimensions and compaction specifications must be designed by a suitably qualified engineer, taking into account the foundation loadings and the strength requirements of the engineered soil raft. It should be noted that the soil raft will need to be larger than the footprint of the tower base and this may be problematic due to space constraints on the site.

Below approximately 1,80m depth, the bearing capacities of the subsoils obtained from the DCP tests increased significantly to over 400KPa. This corresponds to the refusal of all equipment in what is believed to be either cemented pedogenic soils or potential bedrock. Founding the proposed tower at approximately 1,80 m depth is recommended.

The founding conditions exposed during the construction phase must be assessed by and approved by a competent person. Should conditions at variance from those described in this geotechnical report be encountered, the services of a geotechnical professional must be sought.

10.2 Drainage

Surface ponding and runoff will be expected after intense and/or prolonged periods of rainfall. Surface drainage should be designed to remove all runoff and prevent ponding.

10.3 Cut and Fill Design

All earthworks must be carried out in accordance with SANS 1200 (current version). No significant cuttings or fills are expected, However, should cuttings occur, these should not be steeper than 1:2 and higher than 2,00 m. Exposure of cuttings to elements may result in erosion. Cuttings should be rehabilitated as soon as practically possible, by implementing revegetation.

10.4 Ease of Excavation

It is anticipated that light excavation plant (TLB) is expected to reach a depth of approximately 2,00 m. Beyond this depth, intermediate or even hard excavation should be expected.

10.5 Trench Stability

The test pit sidewalls did not collapse during the test pit excavation and stood well for the short period of time they were opened.

The contractor must, however, appoint a competent excavation supervisor in terms of Section 14 of the Construction Regulations 2014 to inspect the excavations during construction. Shoring of excavations should be implemented if deemed necessary.

11 CONCLUSIONS

- This report presents the information from the geotechnical investigation undertaken for the proposed radio mast at the Klipgat Substation site.
- According to the 1:250 000 scale Geological Series Map 2528 Pretoria, the site is underlain by granophyre, pseudogranophyre, microgranophyre, granite porphyry of the Rashoop Granophyre Suite, of the Bushveld Complex. However, no rock was encountered during this investigation.
- One test pit, advanced further by an auger hole, designated TP1/ AH1, was excavated using hand tools to practical refusal of 2,30 m below ground level.
- One disturbed sample was recovered and sent for testing.
- Two DCPs were undertaken and advanced to between 1,95 and 1,99 m depth where refusal was encountered.
- The proposed Klipgat Radio Mast may be founded at a depth of approximately 1,80 m below ground level, within the cemented pedogenic layer, where refusal was encountered by the DCP tests.
- The founding conditions exposed during the construction phase must be assessed and approved by a competent person. Should conditions at variance from those described in this geotechnical report be encountered, the services of a geotechnical professional must be sought.
- Soft excavation conditions are expected to about 2,00 m depth; beyond which intermediate and possibly hard excavation may be encountered.
- Trench sidewalls are considered stable, for short periods of time, during dry weather. However, a competent excavation supervisor, in terms of Section 14 of the Construction Regulations 2014 must be appointed to inspect the excavations during construction. Shoring of excavations should be implemented if considered necessary.

12 REFERENCES

1) Brink, A.B.A. (1979). *Engineering Geology of South Africa Volume 3*. Building Publications Pretoria.
2) Core Logging Committee of the South African Section of the Association of Engineering Geologists (1976). *A Guide to Core Logging for Rock Engineering.* Proceedings of the Symposium on Exploration for Rock Engineering, Johannesburg.
3) Jennings, J.E., Brink, A.B.A. and Williams, A.A.B. (1973). *Revised Guide to Soil Profiling for Civil Engineering Purposes in Southern Africa.* Transactions of the South African Institution of Civil Engineers, Vol. 15.
4) SANS (1990). SANS 10400:1990 The Application of the National Building Regulations. Standards South Africa, Pretoria.

Annexure A: TEST PIT LOGS AND PHOTOGRAPHS

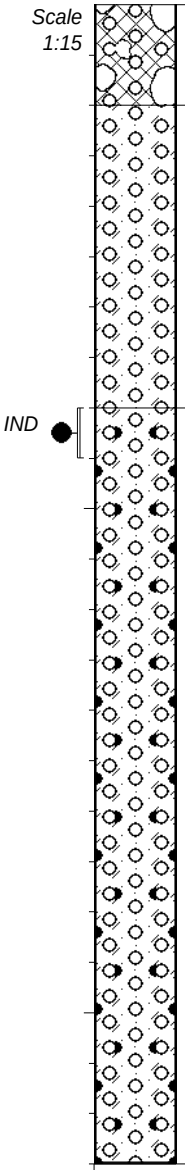
JG AFRIKA

ESKOM
KLIPGAT RADIO MAST

HOLE No: TP1/AH1
Sheet 1 of 1

JOB NUMBER: 5027

Scale 1:15



0.00 Slightly moist, grey, medium dense, GRAVEL with abundant cobbles: Fill.

0.20 Moist, reddish brown, medium dense, slightly clayey sandy GRAVEL with fericrete nodules: Pedogenic.

0.80 Moist, reddish brown, medium dense to dense, slightly clayey sandy GRAVEL with fericrete nodules.

At 2.30m depth ferricrete becomes more strongly cemented: Pedogenic.

2.30

NOTES

1) No groundwater seepage.
2) No sidewall collapse.
3) IND sample taken 0.80--0.90m.
4) Refusal at 2.30m.

CONTRACTOR :
MACHINE : HAND EXCAVATION
DRILLED BY :
PROFILED BY : CC

INCLINATION :
DIAM :
DATE :
DATE : JANUARY 2020

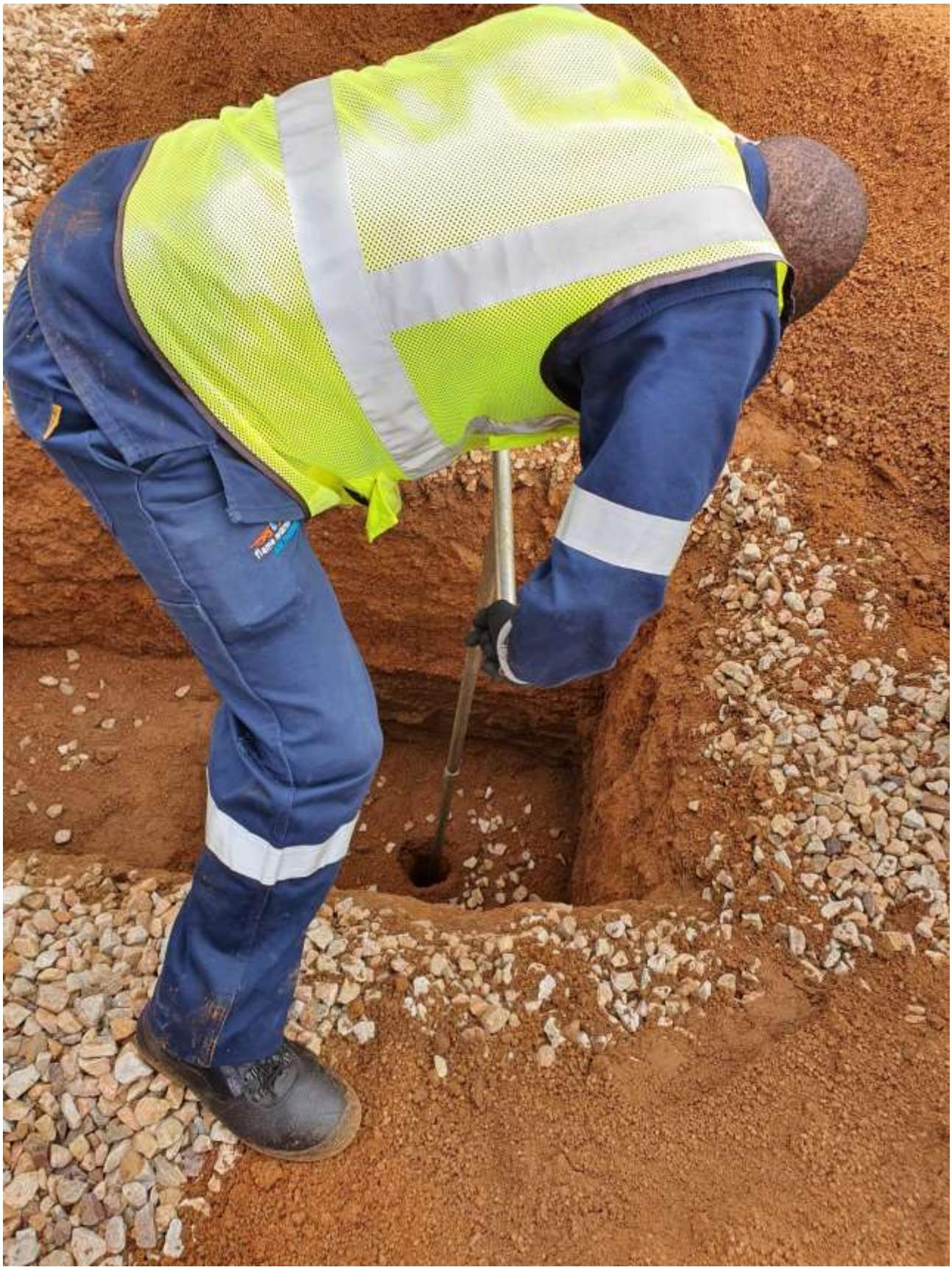
ELEVATION :
X-COORD : 25˚29'21.00"S
Y-COORD : 28˚0'30.63"E

TYPE SET BY : CC
SETUP FILE : TP-JGA-A4.SET

DATE : 19/02/2020 12:06
TEXT : ..502709ESKOMKLIPGATRS.TXT

HOLE No: TP1/AH1

TP1 /AH1_Note gravel ferricrete recovered from TP1



Undertaking of Auger hole at 1,2 m depth.

Annexure B: DCP RESULTS

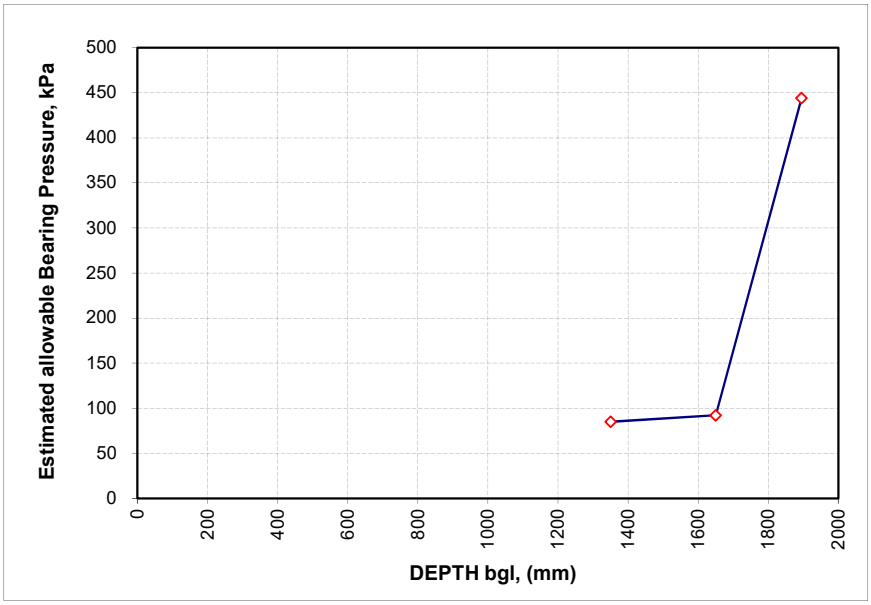
EASBP FROM DCP, sand

Job Name Eskom Klipgat Radio Mast

File No: Job No: 5027/09 Date of Test: 21/01/2020

DCP No: 1 Location: Within TP1

note: EASBP from Terzaghi & Peck p4 for 25mm settlement



Penetration Guide		
SPT mm/blow	DCP DN	Consistency
< 5	132-210	Very Dense
5 - 10	78-132	Dense
10 - 30	25-78	Med Dense
30 - 75	10 25	Loose
75 -100	<10	Very Loose

NOTE :
Stated consistencies do not apply to cohesive materials. Describe using "stiff or firm or soft".

Depth of hole in which DCP was taken : 1200 mm below NGL

Applied Factor : 1 times Terzaghi's value

Remarks : Refusal at 1.99 m

Reading No.	Layer From	Layer To	Average Layer Depth	DCP DN lows/300mı	Level Below NGL mm	DCP enetratio mm/blow	Equiv. SPT N Value	Approx In-situ CBR	Approx EASBP kPa
1	0	300	150	18	1350	17	7	12	85
2	300	600	450	20	1650	15	8	13	92
3	600	790	695	90	1895	2	34	110	444

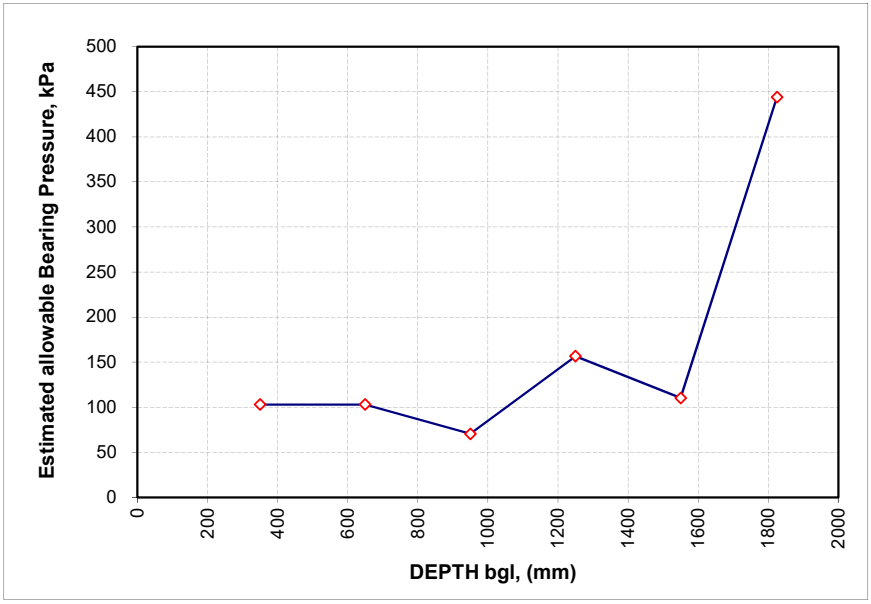
EASBP FROM DCP, sand

Job Name Eskom Klipgat Radio Mast

File No: Job No: 5027/09 Date of Test: 21/01/2020

DCP No: 2 Location: Adjacent to TP1

note: EASBP from Terzaghi & Peck p4 for 25mm settlement



Penetration Guide		
SPT mm/blow	DCP DN	Consistency
< 5	132-210	Very Dense
5 - 10	78-132	Dense
10 - 30	25-78	Med Dense
30 - 75	10 25	Loose
75 -100	<10	Very Loose

NOTE :
Stated consistencies do not apply to cohesive materials. Describe using "stiff or firm or soft".

Depth of hole in which DCP was taken : 200 mm below NGL

Applied Factor : 1 times Terzaghi's value

Remarks : Refusal at 1.95 m

Reading No.	Layer From	Layer To	Average Layer Depth	DCP DN lows/300mı	Level Below NGL mm	DCP enetratio mm/blow	Equiv. SPT N Value	Approx In-situ CBR	Approx EASBP kPa
1	0	300	150	23	350	13	9	16	103
2	300	600	450	23	650	13	9	16	103
3	600	900	750	14	950	21	5	8	71
4	900	1200	1050	29	1250	10	11	22	157
5	1200	1500	1350	25	1550	12	10	18	110
6	1500	1750	1625	90	1825	3	34	110	444

Annexure C: LABORATORY RESULTS

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Client	:	J G AFRIKA			
Address	:	P O BOX 1109	**Client Reference**	:	
	:	SUNNINGHILL	**Order No.**	:	K Naidoo
	:	2157			
Attention	:		**Date Received**	:	24/01/2020
Facsimile	:	011 807 1607	**Date Tested**	:	24/01/2020 - 13/02/2020
E-mail	:	chettyn@jgafrika.com	**Date Reported**	:	18/02/2020
Project	:	Klipgat			
Project No.	:	2020-B-78	**Report Status**	:	Final
			Page	:	1 of 2

Herewith please find the test report(s) pertaining to the above project. All tests were conducted in accordance with prescribed test method(s). Information herein consists of the following:

Test(s) conducted / Item(s) measured	Qty.	Test Method(s)	Authorized By**	Page(s)
Atterberg Limits <0.425mm	1.000	SANS 3001 GR10	S Pullen	2
Sieve Analysis 0.075mm	1.000	SANS 3001 GR1	S Pullen	2
Hydrometer Analysis	1.000	SANS 3001 GR3	S Pullen	2

Any test results contained in this report and marked with * in the table above are "not SANAS accredited" and are not included in the schedule of accreditation for this laboratory.

Any information contained in this test report pertain only to the areas and/or samples tested. Documents may only be reproduced or published in their full context.

While every care is taken to ensure that all tests are carried out in accordance with recognised standards, neither Civilab (Proprietary) Limited nor its employess shall be liable in any way whatsoever for any error made in the execution or reporting of tests or any erroneous conclusions drawn therefrom or for any consequences thereof.

All interpretations, Interpolations, Opinions and/or Classifications contained in this report falls outside our scope of accreditation.

The following parameters, where applicable, were excluded from the classification procedure: Chemical modifications, Additional fines, Fractured Faces, Soluble Salts, pH, Conductivity, Coarse Sand Ratio, Durability (COLTO: G4-G9).

The following parameters, where applicable, were assumed: Rock types were assumed to be of an Arenaceous nature with Siliceous cementing material.

Unless otherwise requested or stated, all samples will be discarded after a period of 3 months.

This report is completely confidential between the parties (Civilab and Civilab`s client) and shall not be disclosed to anybody else, unless agreed upon in writing or made publicly available by the client or required to make available by law.

Deviations in Test Methods:

Technical Signatory:	
Signature:	

**All results are authorized electronically by approved managers and/or technical signatories.

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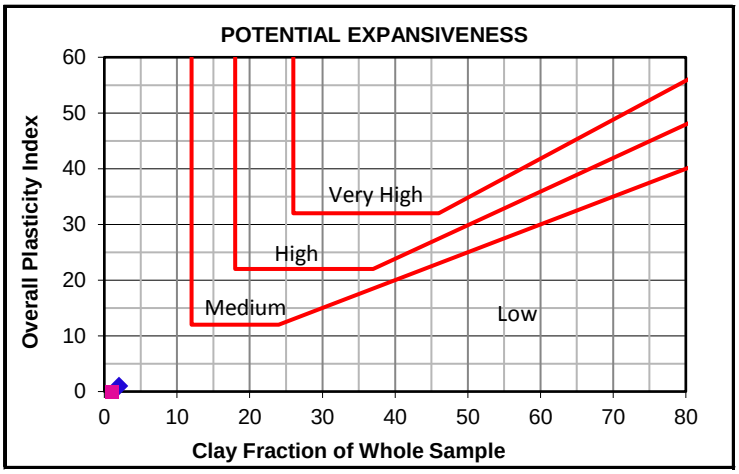
Client	:	J G AFRIKA	Date Received:	24/01/2020
Project	:	Klipgat	Date Reported:	18/02/2020
Project No	:	2020-B-78	Page No. :	2 of 2

FOUNDATION INDICATOR

Laboratory Number		1 ◆	■
Field Number		TP1	
Client Reference			
Depth (m)		0.80-0.90	
Position			
Coordinates	X		
	Y		
Description		Pedogenic	
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

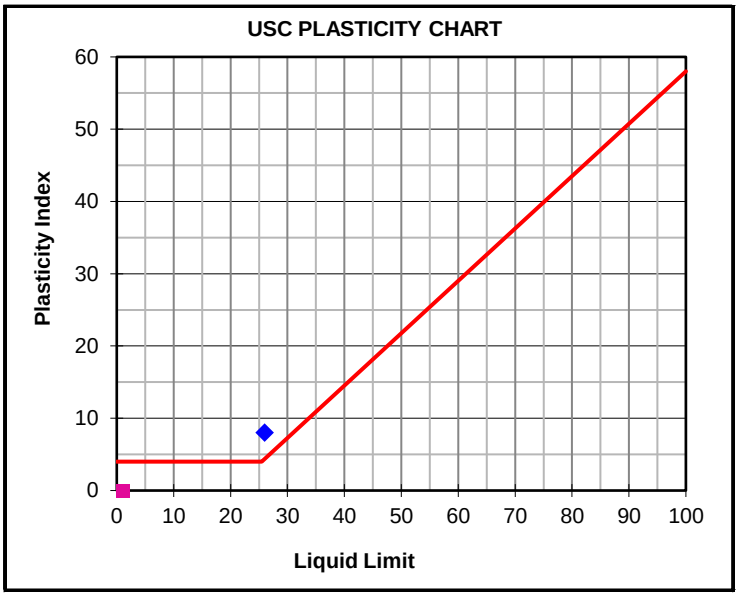


Moisture Content & Relative Density

Moisture Content (%)	
Relative Density (S.G.)	

Sieve Analysis (Wet Prep) — **SANS 3001 GR1**

Percentage Passing	100 mm	100	
	75 mm	100	
	63 mm	100	
	50 mm	100	
	37.5 mm	100	
	28 mm	100	
	20 mm	100	
	14 mm	100	
	5 mm	77	
	2 mm	39	
	1 mm	22	
	0.425 mm	12	
	0.250 mm	11	
	0.150 mm	10	
	0.075 mm	8	
Grading Modulus		2.41	



Hydrometer Analysis — **SANS 3001 GR3**

Percentage Passing	0.060 mm	6	
	0.040 mm	4	
	0.020 mm	4	
	0.006 mm	3	
	0.002 mm	2	
Gravel	%	61	
Sand	%	33	
Silt	%	4	
Clay	%	2	

Note: An assumed S.G. may be used in Hydrometer Analysis calculations

Laboratory Number		1 ◆	■
Atterberg Limits -425µ		**SANS 3001 GR10**	
Liquid Limit	%	26	
Plasticity Index	%	8	
Linear Shrinkage	%	4.0	
Overall PI	%	1	

Classifications

HRB (AASHTO)	A-2-4(0)	
Unified (ASTM D2487)	SP-SC	
Weston Swell @ 1 kPa