



## **NONYANE RADIO MAST GEOTECHNICAL REPORT**

**FEBRUARY 2020**

Prepared for:



Prepared by:

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**NONYANE 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 Nonyane Substation, in Soshanguve, Gauteng Province.

**KEY WORDS:**

Radio Mast, Geotechnical Investigation, Nonyane, Gauteng Province

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**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	Engineering Geologist <i>Pr.Sci.Nat (400275/16)</i>	K. Naidoo		2020/02/13
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Authorised by:	Technical Director <i>Pr.Sci.Nat (400011/00)</i>			

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# NONYANE RADIO MAST GEOTECHNICAL REPORT

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# NONYANE RADIO MAST GEOTECHNICAL REPORT

## 1 INTRODUCTION

This report presents the results of a geotechnical site investigation undertaken for the proposed construction of a radio mast. The site is located at the Nonyane Substation, 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 16<sup>th</sup> of January 2020 and entailed the following:

- The excavation of one hand dug test pit.
- The 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 pit 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 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. 4300345561.

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

## 3 PROJECT DESCRIPTION

It is understood that a 40 m high, self-supporting, lattice-type mast/tower will be constructed at the site to support telecommunications antennae.

#### 4 SITE LOCATION

The site is located approximately 16 km north west of Soshanguve, in the Gauteng Province, at the coordinates: 25°24'46"S, 27°59'43"E.

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

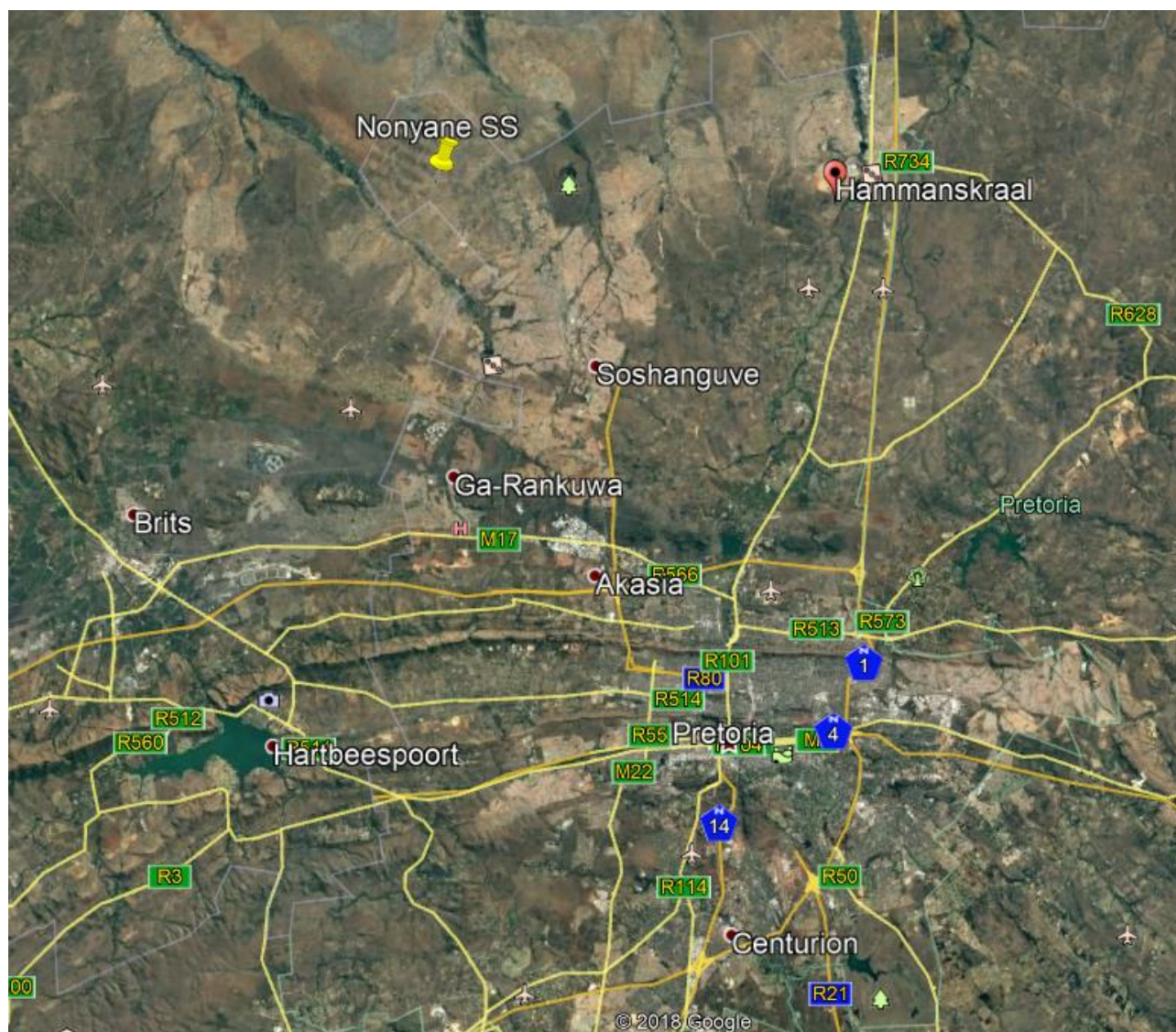
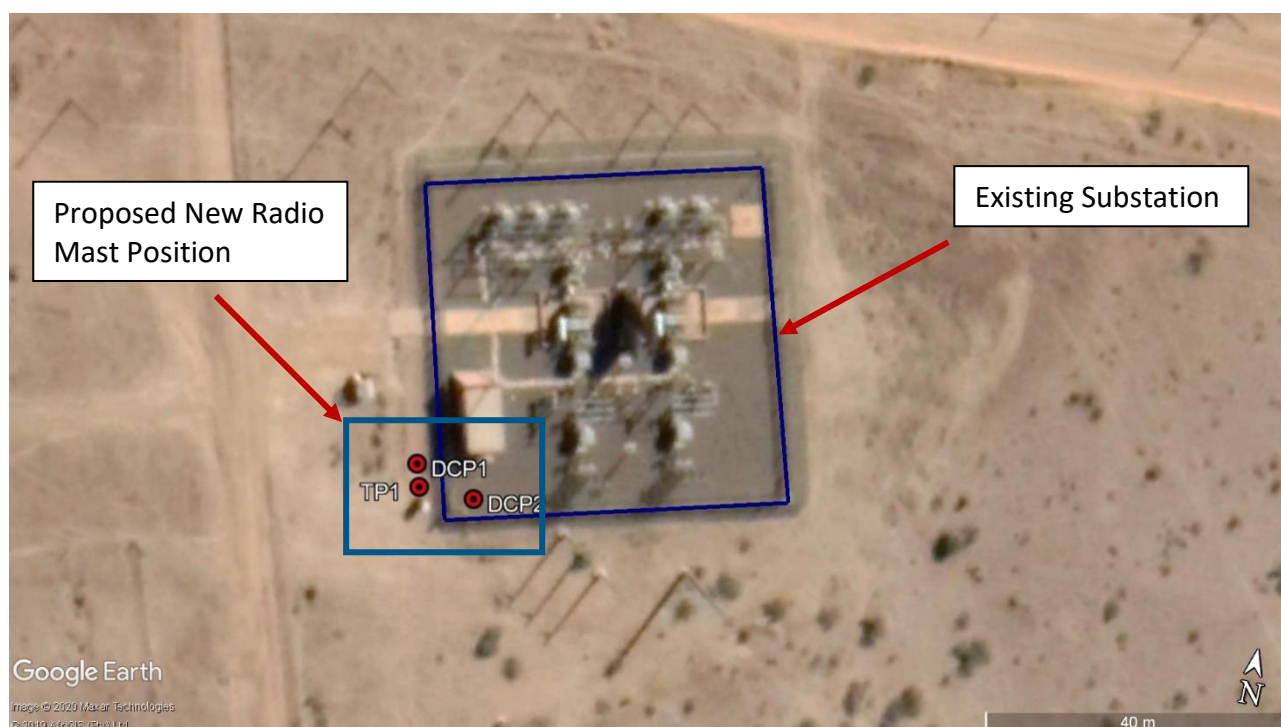


Figure 1: Locality Map





*Figure 2: Test Pit Layout Plan*

#### 4.1 Topography and Drainage

The topography of the site is generally flat and the surrounding area undulates gently.

#### 4.2 Groundwater

Minor groundwater seepage was observed in the test pit from a depth of 1.00 m, below existing ground level. It should be noted that the investigation was undertaken during the wetter summer season, after significant rainfall had occurred. Areas underlain by granitic bedrock are prone to the formation of temporary perched water tables, after intense or prolonged periods of rainfall.

#### 4.3 Vegetation, Land Use and Existing Infrastructure

The vegetation on site was typically grassy with scattered isolated shrubs and small trees. The surrounding area is currently used for agricultural purposes and the grazing of cattle. Residential housing was located approximately 100 m south west of the substation site.

The site is currently occupied by an existing substation and associated infrastructure. A brick structure housing the substation electrical controls is located directly adjacent to the proposed tower position.

#### 4.4 Access

The site is accessible via a gravel access road, off the Main Road M39. The majority of the site can be traversed by a LDV. Movement of large plant may be hindered, due to the close proximity of the existing substation infrastructure.

## 5 GEOLOGY

According to the 1:250 000 scale Geological Series Map 2528 Pretoria, the site is underlain by Nebo Granites, of the Lebowa Granite Suite, of the Bushveld Complex. The Nebo granites are represented by grey to pink, coarse grained granite, and by red medium grained granite near the top.

The geology of the site is depicted in Figure 3.

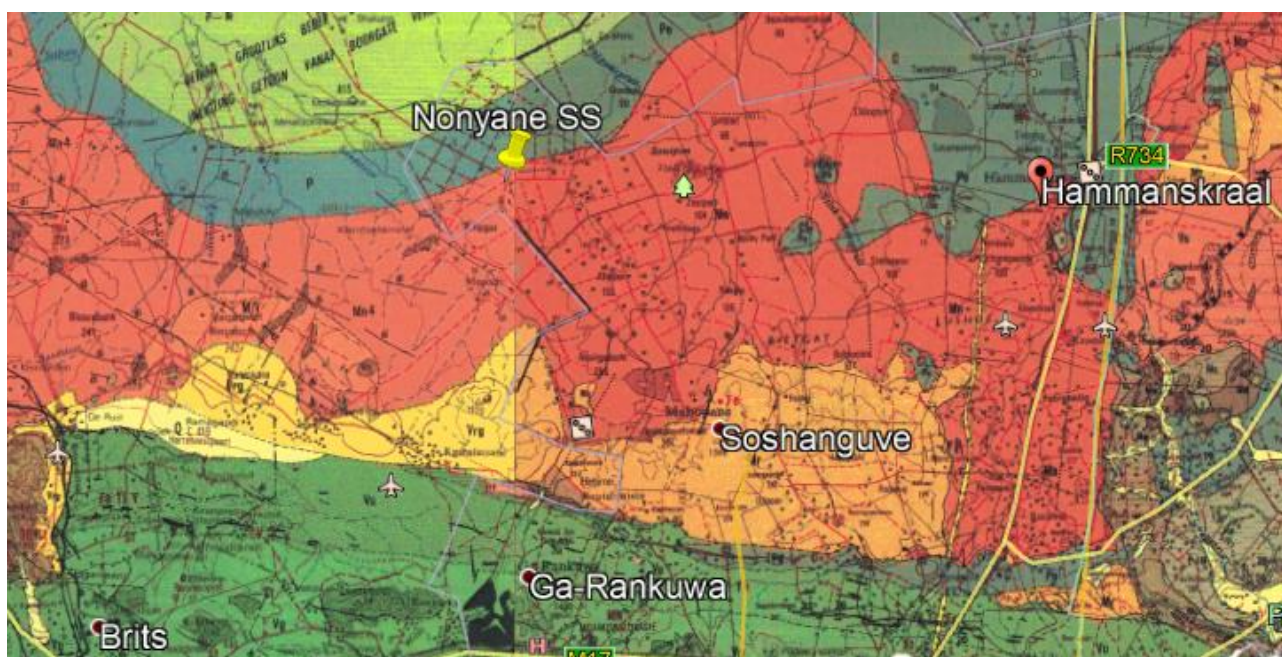
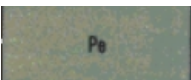



Figure 3: Geology Map

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

Symbol	Stratigraphy	Lithology
	Eccra Group, Karroo Sequence	Shale, shaly sandstone, grit, sandstone, conglomerate, coal in places near base and top
	Nebo Granite, Lebowa Granite Suite, Bushveld Complex	Grey to pink, coarse grained granite, red medium grained granite near top

## 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 3. This implies that chemical disintegration is the dominant mode of weathering at the site.



## 7 FIELDWORK

The fieldwork was undertaken on the 16<sup>th</sup> of January 2019, in the middle of the wetter summer season, after significant rainfall had occurred. The fieldwork comprised of the following:

### 7.1 Test Pit & Auger Hand Hole

One test pit, designated TP1, was excavated using hand tools to a depth of 1.50 m below ground level. The test pit was then advanced by hand auger to a depth of 2.80 m, below existing ground level before refusal occurred. The test pit and auger hole spoils were profiled and photographed by a professionally registered engineering geologist in accordance with “*Guidelines for Soil and Rock Logging in SA, 2<sup>nd</sup> Impression, Brink & Bruin, 2002*”. The test pit was loosely backfilled after profiling. The test pit log and photographs can be found in Annexure A. The location of the hand excavated TP1 is indicated in Figure 4.



Figure 4: Location of TP1 & TP2

### 7.2 DCP Tests

A total of two Dynamic Cone Penetration (DCP) tests were undertaken across the site as follows:

Designation	Location	Refusal (below egl)
DCP1	Adjacent to TP1	1.78 m
DCP2	Within the substation yard	2.00 m

In general, DCP test results can be influenced by the moisture content of the soil. A DCP test undertaken through a soil profile in dry conditions will yield higher blow counts than a test undertaken in the same profile with a higher moisture content. The sub-soils observed within the test pits were generally described as “wet” becoming “moist” with depth and are not expected to lose strength with increasing moisture content. Also, with depth, the blow counts may be influenced by shaft friction and hence soils may appear to have higher than actual consistencies.

The DCP test results indicate the following:

- Fill soils between 0.00 and 0.60 m depth have EASBPs of **110 - 175 KPa**.

- **Hillwash** between **0.60 and 1.00** m depth have very low EASPBs, of **110 - 194 KPa**.
- **Residual soils** between **1.00 and 2.80** m depth have EASPBs of **56 - 585 KPa**

The high EASBP values obtained for the residual layers are considered overstated, mainly due to the gravelly nature of the soil profiles and of the apparatus striking gravel or boulders. **Therefore, the DCP results shall be interpreted with caution.**

## 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 (%)			Soil Classification AASHTO
			Gravel	Sand	Silt	Clay	LL	PI	LS	
TP1	1.00 – 2.10	Sandy GRAVEL Residual	58	33	4	5	35	15	7.5	A-2-6 (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 laboratory test results indicate that the soils have a liquid limit of 35, a PI of 15 and a linear shrinkage of 7,5. The AASHTO soils classification is A-2-4(0). The soil sample was also assessed to have a “low” potential for expansiveness, as per the van der Merwe Method.

## 9 ASSESSMENT OF THE SITE

### 9.1 Ground Conditions

The ground conditions described below are based on visual observations in the test pits, hand auger hole and on DCP test results. It must be noted that the investigation was undertaken in the middle of the wetter summer season, after significant rainfall had occurred.

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

#### 9.1.1 Fill Horizon

A fill horizon was encountered at TP1 from surface to a depth of 0.60 m, below existing ground level (egl). The fill horizon was described as dense and comprised of silty gravelly sand with scattered cobbles and small boulders.

### 9.1.2 Hillwash Horizon

A hillwash soil horizon was encountered within the test pit. Hillwash is a term used to describe soils that were transported and deposited by gravity. The hillwash layer was fairly consistent on site and was encountered from a depth of 0.60 m to 1.00 m below egl. The hillwash was described as medium dense, intact and comprised of silty gravelly sand.

### 9.1.3 Residual Horizon

Residual soils are soils that are formed from the complete weathering of the parent rock. Residual soils were encountered at TP1 from a depth 1.00 m below egl and persisted to a depth of 2.80 m below egl, where refusal of the hand auger occurred.

The residual soils were described as dense with a relict rock structure and comprised of sandy gravel.

## 10 RECOMMENDATIONS

### 10.1 Foundations

It is understood that the proposed structure is a 40 m high, self-supporting, lattice-type mast/tower.

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 from DCP1 and DCP2, the Estimated Allowable Safe Bearing Pressure (EASPB) for the residual soils between 1.00 to 2.80 m depth range between 56 kPa to 585 kPa. The values of 56 kPa and 114 kPa, obtained from DCP2 between depths 0.90 m and 1.50 m, are considered an untrue representation of the residual soil horizon and may be attributed to a weaker horizon overlying more competent residual soil horizons.

It is recommended that the new tower be founded at a minimum depth of 1.80 m below ground level within the dense residual horizons identified at DCP1 and DCP2. Due to the variability in the ground conditions and depth to bedrock, it is possible that weaker horizons residual soils may extent to greater than 1.80 m beneath the foundation footprint. Should these zones of residual soils be encountered at founding level during construction, these must be over-excavated and backfilled to founding level with G5 quality construction materials placed in layers, compacted to 90 % Mod AASHTO density. This must be undertaken to at least 0.50 m beyond the foundation footprint in all directions. The footing should be designed to impose a maximum pressure of 150 kPa.

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.

## 10.2 Drainage

Minor groundwater seepage was noted from 1.00 m, below egl, during the excavation of TP1. Areas underlain by granitic bedrock are often susceptible to the formation of a temporary perched water table after prolonged or intense periods of rainfall. Temporary subsoil drains should be installed to prevent water ingress during construction, especially if construction is undertaken during the wetter summer season.

Due to the gentle topographical nature of the site 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).

The sandy and gravelly soils removed during excavations could be potentially used as construction material (for access roads etc.).

## 10.4 Ease of Excavation

According to the criteria published in SANS 1200D Earthworks, as specified for restricted excavation (shown in Table 2), soft excavation conditions are expected throughout the site to depths of 1.80 m, below egl.

Areas underlain by granitic bedrock are commonly associated with the presence of corestones. No corestones were encountered during the excavation of TP1, however, the occurrence of which should not be discounted. Boulder excavation or hard excavation measures will be required should corestones be present.

*Table 2: SANS 1200D excavation class descriptions – restricted excavation*

Excavation Class	Description
Soft	<i>Excavation in material that can be efficiently removed by a back-acting excavator of flywheel power approximately 0.10 kW per millimetre of tined-bucket width, without the use of pneumatic tools such as paving breakers</i>
Intermediate	<i>Excavation in material that requires a back-acting excavator of flywheel power exceeding 0.10 kW per millimetre of tined-bucket width or the use of pneumatic tools before removal by equipment equivalent to that specified for soft excavation.</i>
Hard	<i>Hard rock excavation shall be excavation in material (excluding boulder excavation) that cannot be efficiently removed without blasting or wedging and splitting.</i>



Excavation Class	Description
<i>Boulder (excavation class B)</i>	<i>Excavation in material containing less than 40% by volume of boulders of size in the range of 0.03 - 20m<sup>3</sup>, in a matrix of soft or smaller boulders.</i>

## 10.5 Trench Stability

The fill and hillwash layers were medium dense to dense in consistency and numerous cobbles and small boulders were identified within the fill horizon. Gravel, cobbles and boulders can be expected to fall off the sidewalls of the excavation. All loose material should be removed prior to any work within trenches / excavations.

The contractor must 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 where necessary.

## 11 CONCLUSIONS

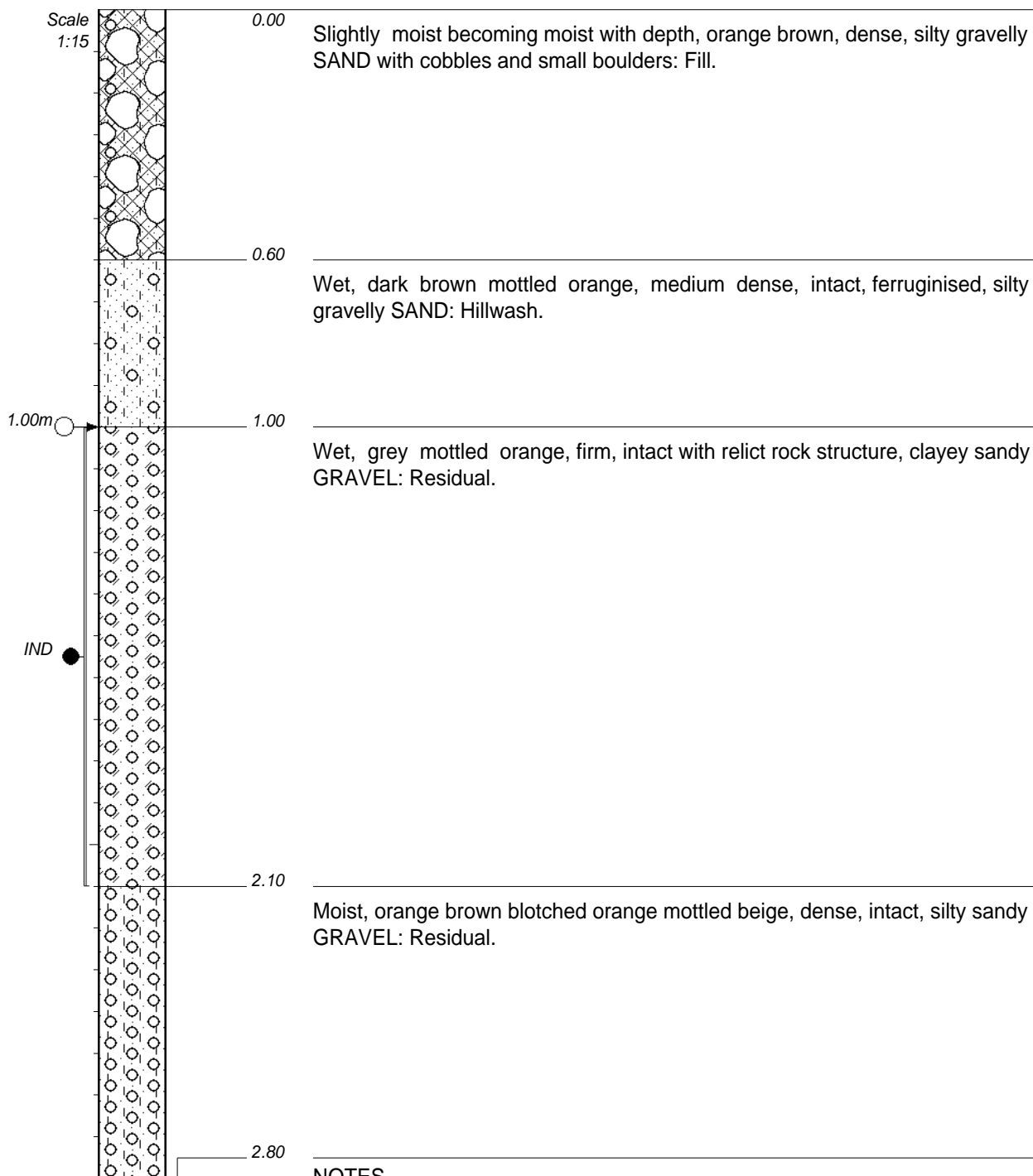
- This report presents the information from the geotechnical investigation undertaken for the proposed radio mast at the Nonyane Substation Site.
- According to the 1:250 000 scale Geological Series Map 2528 Pretoria, the site is underlain by Nebo Granites, of the Bushveld Complex.
- One test pit, designated TP1, was excavated using hand tools to a depth of 1.50 m below egl and was advanced by hand auger to a depth of 2.80 m below egl before refusal of the hand auger occurred.
- No bedrock was encountered in the test pit.
- Horizons described as residual were encountered to the refusal of the hand auger hole at a depth of 2.80 m, below egl.
- Two DCP test were undertaken and refusal occurred at depths of between 1.78 m and 2.00 within residual granitic soil horizons.
- The information gathered from the geotechnical investigation indicates that the residual soil horizon encountered at 1.80 m below egl will be a suitable founding medium for the new proposed radio mast.
- Should weaker zones of residual soils be encountered at founding level below during construction, these must be over-excavated and backfilled with a G5 material placed in layers and compacted to 90% modified AASHTO density to founding level.
- The footing should be designed to impose a maximum pressure of 150 kPa.
- 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.
- Soft excavation conditions are expected throughout the site to depths of 1.80 m, below egl.
- Due to the gentle topographical nature of the site and the shallow bedrock, surface ponding and runoff will be expected after intense and/or prolonged periods of rainfall. Surface runoff shall be diverted away from the site to avoid water ingress into the foundation area.



## 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***


**NOTES**

- 1) Slow groundwater seepage from 1.00m.
- 2) No sidewall collapse.
- 3) Hand auger refusal at 2.80m.
- 4) IND sample taken 1.00--2.10m.

CONTRACTOR :  
MACHINE : HAND EXCAVATION  
DRILLED BY :  
PROFILED BY : KN  
TYPE SET BY : KN  
SETUP FILE : TP-JGA-A4.SET

INCLINATION :  
DIAM :  
DATE :  
DATE : JANUARY 2020  
DATE : 13/02/2020 10:12  
TEXT : ..502710ESKOMNONYANESS.TXT

ELEVATION :  
X-COORD : 25°24'46.40"S  
Y-COORD : 27°59'42.79"E

**HOLE No: TP1**



TP1 Profile



TP1 Spoil

## ***Annexure B: DCP RESULTS***



# EASBP FROM DCP, sand

Job Name Eskom Nonyane Radio Mast

File No:

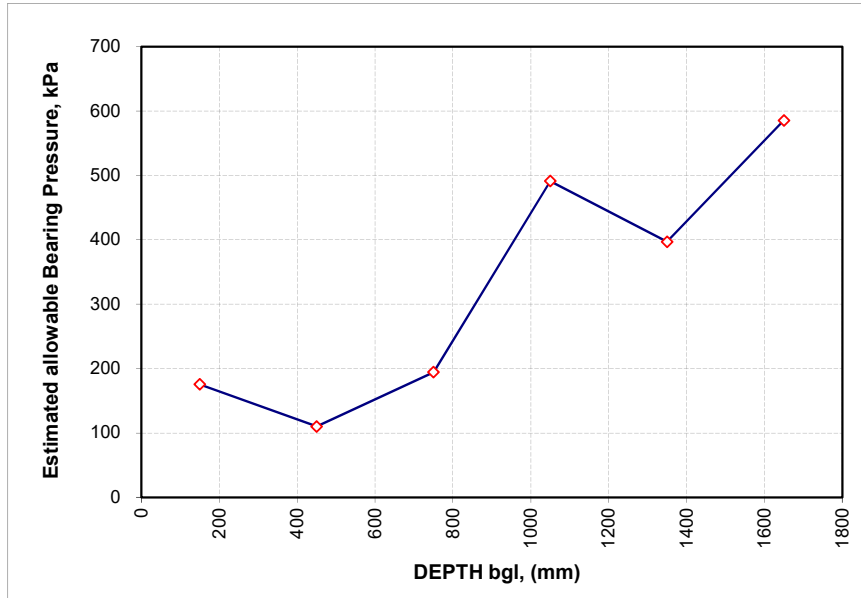
Job No: 5027/10

Date of Test:

16/01/2020

DCP No: 1 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 : 0 mm below NGL

Applied Factor : 1 times Terzaghi's value

Remarks : No Refusal

Reading No.	Layer From	Layer To	Average Layer Depth	DCP DN blows/300mm	Level Below NGL mm	DCP Enetratic mm/blow	Equiv. SPT N Value	Approx In-situ CBR	Approx EASBP kPa
1	0	300	150	33	150	9	13	26	175
2	300	600	450	25	450	12	10	18	110
3	600	900	750	37	750	8	14	30	194
4	900	1200	1050	100	1050	3	38	110	491
5	1200	1500	1350	80	1350	4	30	82	397
6	1500	1800	1650	120	1650	3	46	110	585

# EASBP FROM DCP, sand

Job Name Eskom Nonyane Radio Mast

File No:

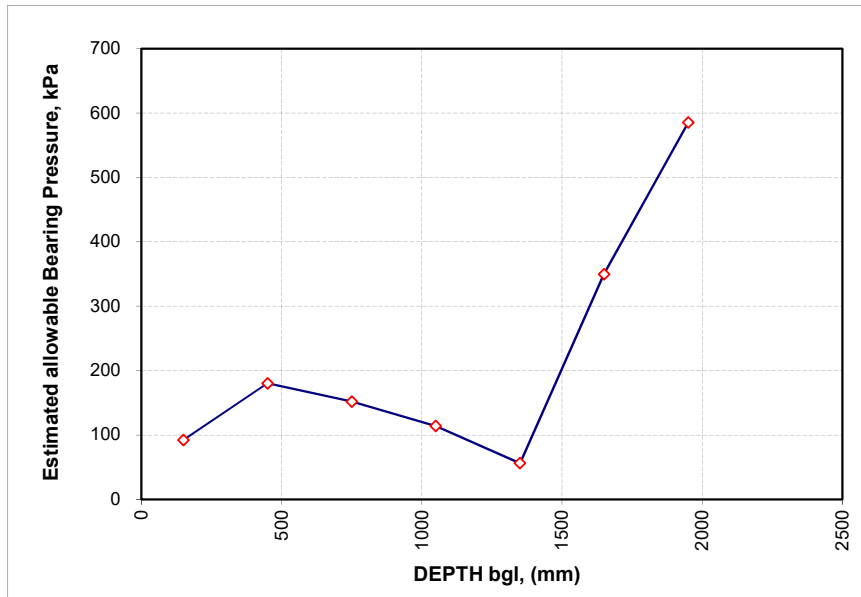
Job No: 5027/10

Date of Test:

16/01/2020

DCP No: 1 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 : 0 mm below NGL

Applied Factor : 1 times Terzaghi's value

Remarks : No Refusal

Reading No.	Layer From	Layer To	Average Layer Depth	DCP DN lows/300mi	Level Below NGL mm	DCP Penetratic mm/blow	Equiv. SPT N Value	Approx In-situ CBR	Approx EASBP kPa
1	0	300	150	20	150	15	8	13	92
2	300	600	450	34	450	9	13	27	180
3	600	900	750	28	750	11	11	21	152
4	900	1200	1050	26	1050	12	10	19	114
5	1200	1500	1350	10	1350	30	4	5	56
6	1500	1800	1650	70	1650	4	27	69	350
7	1800	2100	1950	120	1950	3	46	110	585

## ***Annexure C: LABORATORY RESULTS***

**Client** : J G AFRIKA  
**Address** : P O BOX 1109  
 : SUNNINGHILL  
 : 2157

**Client Reference** :  
**Order No.** : 5027-10

**Attention** :  
**Facsimile** : 011 807 1607  
**E-mail** : chettyn@jgafrika.com

**Date Received** : 20/01/2020  
**Date Tested** : 20/01/2020 - 04/02/2020  
**Date Reported** : 10/02/2020

**Project** : Nnyane RS  
**Project No.** : 2020-B-50

**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	B Mvubu	2
Hydrometer Analysis	1.000	SANS 3001 GR3	B Mvubu	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.

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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:	

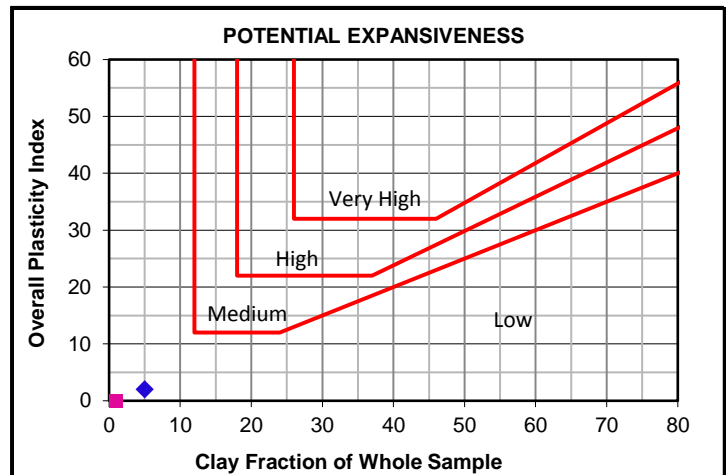
\*\*All results are authorized electronically by approved managers and/or technical signatories.

Client : J G AFRIKA  
 Project : Nnyane RS  
 Project No : 2020-B-50

Date Received: 20/01/2020  
 Date Reported: 04/02/2020  
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## FOUNDATION INDICATOR

Laboratory Number	1	
Field Number	TP1/AH1	
Client Reference		
Depth (m)	1.00 - 2.10	
Position		
Coordinates	X	
	Y	
Description		
Additional Information		
Calcrete / Crushed		
Stabilizing Agent		

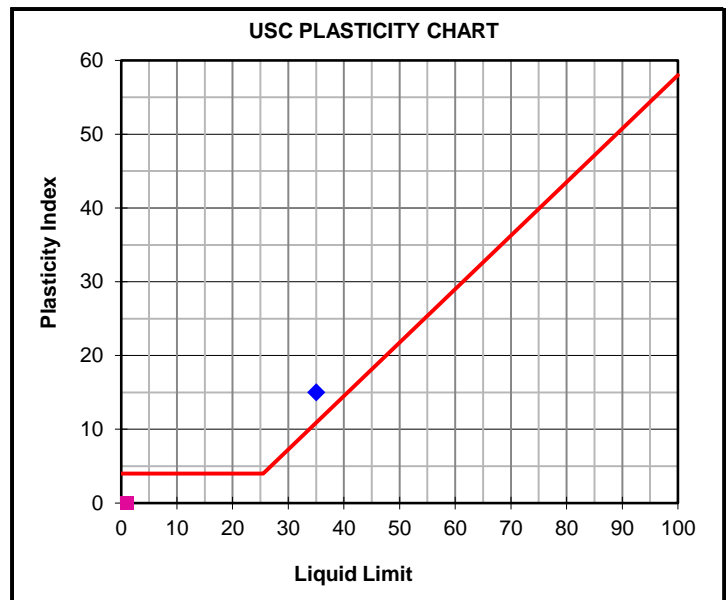


### Moisture Content & Relative Density

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	87	
	2 mm	42	
	1 mm	24	
	0.425 mm	12	
	0.250 mm	11	
	0.150 mm	11	
0.075 mm	10		
Grading Modulus		2.36	



### Hydrometer Analysis SANS 3001 GR3

Percentage Passing	0.060 mm	9	
	0.040 mm	9	
	0.020 mm	8	
	0.006 mm	6	
	0.002 mm	5	
Gravel	%	58	
Sand	%	33	
Silt	%	4	
Clay	%	5	

Laboratory Number	1	
Atterberg Limits -425µ		
Liquid Limit	%	35
Plasticity Index	%	15
Linear Shrinkage	%	7.5
Overall PI	%	2

### Classifications

HRB (AASHTO)	A-2-6(0)	
Unified (ASTM D2487)	SP-SC	
Weston Swell @ 1 kPa		

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

