- *Site Investigations*
- *Slope Stability*
- *Rock Mechanics*
- *Soil Mechanics*
- *Foundations*
- *Borrow Pits and Materials*
- *Roads*
- *Groundwater*
- *NHBRC*
- *Geotechnical Instrumentation*

Results of a Shallow Geotechnical Investigation for the Proposed Filling Station on Portion 36 Olifantsvlei 327-IQ, Gauteng

Client: Great Site Investments (Pty) Ltd

Reference: 16-0730R03

Dated: 27 February 2017

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Results of a Shallow Geotechnical Investigation for the Proposed Filling Station on Portion 36 Olifantsvlei 327-IQ, Gauteng

Reference: 16-0730R03 **Date: 27 February 2017**

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Results of a Shallow Geotechnical Investigation for the Proposed Filling Station on Portion 36 Olifantsvlei 327-IQ, Gauteng

Reference: 16-0730R03 **Date: 27 February 2017**

EXECUTIVE SUMMARY

This report presents the results of a shallow geotechnical investigation for a proposed new filling station on Portion 36 of the farm Olifantsvlei 327-IQ, Gauteng, and presents the conclusions and recommendations for the proposed excavations, foundations and earthworks.

The most critical aspect of these two sites in relation to the proposed development is the presence of a steep boulder talus slope at the western site and a deeply incised drainage channel at the eastern site. The uppermost topsoil horizon should prove excavatable using soft excavation (SABS 1200 D) to depths of around 0.2 m. The potentially collapsible hillwash and residuum should also prove excavatable using soft excavation to around 2 m, and possibly intermediate to hard excavation below this depth, if required.

Soft and Boulder Class A excavation in terms of SABS 1200 D is generally anticipated to an average of 2 m below natural ground level over the site, and possibly intermediate to hard excavation below this depth, if required for the fuel tanks. The talus boulder materials excavated as part of the earthworks at the western site can be stockpiled on site for use in pioneer or dumprock layer backfilling, especially in the deep drainage trench on the eastern site.

Semi-conventional reinforced strip/pad footings can be designed for a maximum safe allowable bearing capacity of around 150 kPa, provided these are placed on at least stiff residual lava at depths of 1.5 m or more.

It is recommended that once excavations have been opened, blinding of the exposed geology takes place as soon as possible, so as to prevent water ingress as this may result in material deterioration, if not controlled.

*Finally, the ground conditions described in this report refer specifically to those encountered at the test positions advanced on site. It is therefore possible that conditions at variance with those discussed above may be encountered elsewhere on the site. In this regard it is critical that materials management be maintained continuously on site and that **GCS Geotechnical** carry out periodic inspections of the site during construction to ensure that any variation in the anticipated ground conditions can be assessed and revised recommendations subsequently provided in order to avoid unnecessary delays and expense. Furthermore it is important that the construction phase of the project be treated as an augmentation of the geotechnical investigation.*

Results of a Shallow Geotechnical Investigation for the Proposed Filling Station on Portion 36 Olifantsvlei 327-IQ, Gauteng

Reference: 16-0730R03 **Date: 27 February 2017**

Definitions and Abbreviations

Commercial:

GCS Geotechnical	GCS Geotechnical (Pty.) Ltd.

Technical:

CH	Chainage (metres)
mbgl	metres below ground level
masl	metres above sea level
NGL	Natural Ground Level
FL	Foundation Level
BH	Borehole
SPT	Standard Penetration Test
N	SPT N value (blows per 300 mm)
TLB	Tractor-mounted Loader Backhoe
TP	Test Pit
DCP	Dynamic Cone Penetrometer
EABC	Estimated Allowable Bearing Capacity
G1-G10	Standard classification of natural road building materials (TRH 14)
CBR	California Bearing Ratio
MDD	Maximum Dry Density (kg/m3)
MADD	Modified AASHTO Dry Density
OMC	Optimum moisture Content (%)
PI	Plasticity Index
LL	Liquid Limit
LS	Linear Shrinkage
RMR	Rock Mass Rating
GSI	Geological Strength Index
mi	Hoek-Brown Constant (origin & texture dependent)
RQD	Rock Quality Designation (%)
FF	Fracture frequency
UCS	Unconfined Compressive Strength (MPa)
C (c')	Cohesion (kPa) – total stress and (effective stress)
Φ (Φ')	Friction Angle (degrees) – total stress and (effective stress)
Kv	Modulus of Subgrade Reaction (MN/mm or kPa/mm)
CFA	Continuous Flight Auger (pile type)
DCI	Driven Cast In situ (pile type)
Cv	Coefficient of Consolidation (m2/yr)
Mv	Modulus of Compressibility (m2/MN)
MC1	Moisture Content Before Test (%)
MC2	Moisture Content After Test (%)
ρ	Dry Density (kg/m3)
VSR	Very soft rock
SR	Soft rock
MHR	Medium hard rock
HR	Hard rock
VHR	Very hard rock

Results of a Shallow Geotechnical Investigation for the Proposed Filling Station on Portion 36 Olifantsvlei 327-IQ, Gauteng

Reference: 16-0730R03 **Date: 27 February 2017**

1. INTRODUCTION & TERMS OF REFERENCE

At the request of Mr. Farhat Shaik and on behalf of Great Site Investments (Pty) Ltd (hereafter referred to as GSI), ***GCS Geotechnical*** (hereafter referred to as GCS) was asked to provide a proposal and cost estimate quotation for the undertaking of a shallow geotechnical investigation for the proposed filling station on Portion 36 of Olifantsvlei 327-IQ. The appointment accepted and finalized and the fieldwork was completed on 31 January 2017.

2. AVAILABLE INFORMATION

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

- The 1:250 000 Geological Map titled *"2626 – West Rand*" as compiled by the South African Geological Survey, 1986.
- The 1:50 000 Geotechnical Map 2627BD Lenasia, CGS, 2003
- Google Earth
- SABS 1200 D – Earthworks

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

Table 2-1: Summary of Available Desk Study Information

Parameter	Value	Reference
Development	Filling station	Box Ways
Site coordinates	26°17'32"S / 27°59'40"E	Box Ways
Weinerts N-value	2-5	Weinert (1974)
Climatic Region	Moderate	TRH 2 (1978)
Rainfall	550-600 mm	www.saexplorer.co.za
Temperature	17.5-26 ˚C	after DWAF (1986)
Evaporation	1625 mm	After DWAF (1986)
Water Balance	Deficit	Schulze (1985)
Weathering Type	Slight disintegration, moderate decomposition, very slight weathering	Fookes et al (1971)
Geology	Predominantly Adesite lava of the Hekpoort Group	2626 West Rand (1986) 1:250 000 scale
Soil Cover	Sand	Brink (1985)
Origin	Transported & residual	Brink (1985)
Topography	1 : 50	Garmap SA Topo & Rec 2012.1
Drainage	None	Garmap SA Topo & Rec 2012.1
Drainage Region	Quaternary Catchment: C22	DWAF (1999)
Hydrogeology	Intergranular and fractured; 0.5-1 l/s	2526 Johannesburg (1999) 1:500 000 scale
Groundwater depth	Unknown	DWAF-WRC (1995)
Erodibility Index	16-20 (Low)	WRC (1992)
Seismic Intensity	VI (MMS)	Fernandez et al (1972)
Liquefaction	Unlikely (<50 cm/s2)	Welland (2002)

3. SITE DESCRIPTION

The site is located on portion 36 of Olifantsvlei 327-IQ which is bisected by the Johannesburg-Vereeniging highway (route K57 – Road P1/1).

The total site area comprises two individual sites (west and east) on either side of the above-mentioned highway.

No known sub-surface or overhead services were observed on site except for a Rand Water servitude on the east site.

Topographically, both sites fall steeply towards the highway and a deeply incised drainage path that affects the site to the east.

4. GEOLOGY

Based on the 1:250 000 Geological Map titled *"2627 – West Rand*", the site is underlain by Andesite lava of the Hekpoort Group, Ventersdorp Supergroup.

5. FIELDWORK

TLB-excavated trial pits (hereafter referred to as TP's) were conducted on site, in order to better understand the general engineering properties of the subsurface materials in relation to the proposed filling station development. In addition, hand-held DCP penetrometers were completed along the centreline of the access roads and apron courtyard of the two sites.

5.1 TLB-Excavated Trial Pits

Five TP's were excavated on the western site and one TP on the eastern site, in order to better understand the properties of the subsurface soils.

The results of the TP's indicated refusal by the TLB at depths ranging between 1.3 and 2.3 m at an average of 1.7 m below existing ground level, refusing, in all instances, on saprolite or boulders.

The detailed profiles are provided in Appendix A and a summary is provided below.

Table 5-1a: Summary of Soil Profile (West Site - Structures)

Depth		Description	Excavatibility (SABS 1200D)	EABC (kPa)	Kv (kPa/mm)	E (MPa)
From (m)	To (m)					
Talus						
0	1.0	Hard BOULDERS of lava in a silty matrix.	Boulder A	N/A	N/A	N/A
Residual Lava						
1.0	1.6	Slightly moist, red-pink, STIFF, SILT with scattered cobbles and boulders.	Soft	150-200	50-100	15-25
Weathered Lava						
1.6	1.6+	As above but becoming VERY DENSE BOULDERS, to weathered SOFT ROCK LAVA.	Soft	200-250	100-200	25-35

EABC = estimated allowable bearing capacity (ignoring collapse potential)
Kv = modulus of subgrade reaction
E = elastic modulus
NB. Tabulated depths are an average across the site. For more detailed Pit specific depths, refer to the TP Logs

Table 5-1b: Summary of Soil Profile (West Site – Access Roads/Apron)

Depth		Description	Excavatibility (SABS 1200D)	EABC (kPa)	Kv (kPa/mm)	E (MPa)
From (m)	To (m)					
Fill						
0	0.4	Slightly moist, grey to yellow brown, LOOSE/SOFT, clayey SILT with scattered gravel.	Soft	N/A	N/A	N/A
Hillwash						
0.4	1.0	Slightly moist, dark grey brown, STIFF/DENSE, pin-holed, clayey sandy SILT.	Soft	150-200	50-100	15-25
Saprolite						
1.0	1.1	Slightly moist, pink-red, STIFF, SILT.	Soft	200-250	100-200	25-35

EABC = estimated allowable bearing capacity (ignoring collapse potential)
Kv = modulus of subgrade reaction
E = elastic modulus
NB. Tabulated depths are an average across the site. For more detailed Pit specific depths, refer to the TP Logs

Table 5-1c: Summary of Soil Profile (East Site – Structure)

Depth		Description	Excavatibility (SABS 1200D)	EABC (kPa)	Kv (kPa/mm)	E (MPa)
From (m)	To (m)					
Topsoil						
0	0.2	Slightly moist, grey to yellow brown, LOOSE/SOFT, clayey SILT with scattered gravel.	Soft	N/A	N/A	N/A
Hillwash						
0.2	1.0	Slightly moist, dark grey brown, STIFF/DENSE, pin-holed, clayey sandy SILT.	Soft	150-200	50-100	15-25
Saprolite						
1.0	2.0	Slightly moist, pink-red, STIFF, clayey SILT with scattered boulders of hard lava.	Soft	200-250	100-200	25-35

EABC = estimated allowable bearing capacity (ignoring collapse potential)
Kv = modulus of subgrade reaction
E = elastic modulus
NB. Tabulated depths are an average across the site. For more detailed Pit specific depths, refer to the TP Logs

5.2 DCP Penetrometer

5.2.1 West Site

Table 5.2.1: Summary of DCP Results (West Site)

Depth (m-m)	Consistency	CBR (%)
0-0.2	Loose	3 to 5
0.2-0.6	Med dense	7 to 15
0.6-1.0	Dense	>15

5.2.2 East Site

Table 5.2.2: Summary of DCP Results (East Site)

Depth (m-m)	Consistency	CBR (%)
0-0.35	V loose to loose	2 to 5
0.35-1.0	Med dense	7 to 17

6. GROUNDWATER

Groundwater seepage was not encountered in any of the test pits. A portion of the eastern site may be affected by the 1:100 year floodline.

The site is situated in the C22 Tertiary Catchment area.

7. LABORATORY TESTING

Laboratory tests were scheduled on soil samples recovered from the site.

The following tests were carried out:

- 3 No. Foundation indicator tests (PSD, hydrometer and Atterberg Limits),
- 2 No. Collapse Potential

Detailed laboratory test results are provided in Appendix B and a summary of the results are provided in tabular format below:

Table 7-1: Summary of Foundation Indicators

TP	Depth (m-m)	LL	PI	GM	CBR* (%)	Classifications		
						TRH14	PRA	USCS
Hillwash								
E1	0.5	36	15	0.37	8	A.6	G10	CL-OL
W5	0.5	30	14	0.26	9	A.6	G10	CL-OL
Residual lava								
W1	1.0-1.7	51	16	0.70	10	A.7.5	G10	OH-MH

***CBR estimated from PI-GM relationship.**

The hillwash is borderline medium expansive.

Table 7-2: Collapse Potential Results

TP	Depth (m-m)	MCa* (%)	MCb** (%)	Dry density (kg/m3)	e0	CP200*** (%)	Settlement (mm)
Hillwash							
E1	0.5	16.84	23.87	1062	1.51	7.1	50-60
W5	0.5	8.09	12.83	1574	0.67	0.5	<5
Residual lava							
W1	1.0-1.7	25.25	30.94	1256	1.11	0.4	<5

Table 7-3: Materials Classification and Recommended Usage

Material Description	Classification	Recommended Usage
Talus	Not tested	Cut to spoil or as dump rock
Hillwash	PI = 14-15 GM = 0.26-0.37 Classification: A.6, G10, CL-OL, CP = 0.5 to 7.1%, medium expansive	Cut to spoil
Residual	PI = 16 GM = 0.70 Classification: A.7.5, G10, OH-MH,	Cut to spoil

8. DEVELOPMENT RECOMMENDATIONS

8.1 Materials Usage

The soils encountered on site range from silty clayey sand to silt, and finally to a boulder talus. Topsoil may be stockpiled for re-use at a later stage in landscaping, while the hillwash, residuum and talus cannot be used for any construction application except for the boulder talus which may be considered for a pioneer layer or dump rock fill. This may be required to backfill the deep drainage path on the eastern site.

8.2 Foundations

8.2.1 West Site

The west site is situated against a steep, talus slope and will require extensive excavation within this material. The boulders could be placed and compacted as a dump rock fill at the base of the proposed fill area or transported to the eastern site to backfill the deep drainage trench. Alternatively, the main structure and forecourt area could be levelled in cut as one platform.

Semi-conventional reinforced strip/pad foundations could be considered on the stiff residuum or saprolite with an allowable bearing pressure of 150 kPa.

8.2.2 East Site

The eastern side of the site is compromised by an incisive drainage path that cuts the access roads from the main structure. Test pit E1 shows competent foundation conditions within stiff residual silt which occurs below the potentially collapsible hillwash horizon at about 1 m depth. Semi-conventional reinforced strip/pad foundations could be placed at this level.

8.3 Excavatability & Earthworks

Soft excavation (SABS 1200 D) and Boulder Class A is anticipated to a depth of around 2.5 m below ground level at both sites, below which intermediate to hard excavation should be encountered.

8.4 Drainage

For the promotion of a stable site, it is important that adequate drainage, both surface and subsurface, be constructed so that no water ingress into the subsurface soils in and around the foundation base is possible. Drainage should be such that any rainfall is diverted to the nearest stormwater drainage system. Areas of potential pooling or damming of rainfall on site should be carefully designed and sloped so as the remove this water from the site. Once excavations have been opened, they are to be blinded with mass concrete as soon as possible, so as to prevent any rainfall occurring having an impact on the founding subsurface.

A particular constraint has been identified on the eastern site where an incisive drainage path will require a culvert crossing for both the entrance and exit ramps. The backfill of this trench could be achieved by using the boulder talus from the bulk earthworks excavation on the western site. This would provide a pervious yet stable backfill horizon around the culvert.

9. CONCLUSIONS & RECOMMENDATIONS

General

- This report presents the results of a shallow geotechnical investigation for the proposed new filling station on Portion 36 of Olifantsvlei 357-IQ, Gauteng, and presents the conclusions and recommendations for the proposed excavations, foundations and earthworks.

- The most critical aspect of these sites in relation to the proposed development is the presence of a steep talus slope at the west site and a deep incised drainage channel at the east site. Construction materials are scarce but the adjacent Readymix quarry can supply materials.

Geology & Ground Conditions

- The sites are underlain by Andesite lava of the Hekpoort Formation. Potentially collapsible sand was encountered at both sites and was also discovered to be borderline medium expansive. Boulder talus affects the wet site and a deep drainage path affects the east site.

Excavatability

- Soft and Boulder Class A excavation in terms of SABS 1200 D is generally anticipated to an average of 2.5 m below natural ground level over the site, and possibly intermediate to hard excavation below this depth. The boulder talus excavated as part of the earthworks on the western site could be re-used as a dump rock or pioneer layer or backfill of the drainage channel to facilitate access to the eastern site.

Foundations

- Semi-conventional reinforced strip and pad footings can be designed for a maximum safe allowable bearing capacity of around 150 kPa at nominal depth on the stiff residual to saprolitic lava and light reinforcement is introduced into the footings and masonry. It is recommended that once excavations have been opened, blinding of the exposed geology takes place as soon as possible, so as to prevent water ingress as this may result in material deterioration, if not controlled.

Further Investigations

- Finally, the ground conditions described in this report refer specifically to those encountered at the test positions advanced on site. It is therefore possible that conditions at variance with those discussed above may be encountered elsewhere on the site. In this regard it is critical that materials management be maintained continuously on site and that ***GCS Geotechnical*** carry out periodic inspections of the site during construction to ensure that any variation in the anticipated ground conditions can be assessed and revised recommendations subsequently provided in order to avoid unnecessary delays and expense. Furthermore it is important that the construction phase of the project be treated as an augmentation of the geotechnical investigation.

21 February 2017

For GCS Geotechnical

ninow@gcs-sa.biz
www.gcs-sa.biz

APPENDIX A
TLB-Excavated Trial Pit Profiles

Job Description:	portion 36 Olifantsvlei					
Job No.:	16-0730					
Client:	Boxways					
Machine:	Cat 422E					
Location:	Olifantsvlei					
Logged by:	AMW					
Date:	31-Jan-17	**Sheet:**	1	of	1	

-

Test Pit Profile

Test Pit No.

TP W1

63 Wessels St, Rivonia **Tel: +27 (0)82 567 1561** **e-mail: ninow@gcs-sa.biz**

Co-ordinates:	**Job Description:**	portion 36 Olifantsvlei	
x	**Job No.:**	16-0730	
y	**Client:**	Boxways	
Elevation:	**Machine:**	Cat 422DE	
Co-ord System:	**Logged by:**	AMW	
	Date:	31-Jan-17	**Sheet:** 1 of 1

From:	To:	Thickness (m)	Description
0.00	0.45	0.45	Slightly moist, yellow grey brown, LOOSE to V LOOSE, silty **SAND with roots**. FILL.
0.45	0.50	0.10	Tar layer. Old road surface.
0.50	1.00	0.50	Slightly moist, red brown, DENSE-STIFF, silty clayey GRAVEL & cobble grave; of hard weathered lava with minor roots. Subbase FILL.
1.00	1.70	0.70	Slightly moist to moist, red brown, V STIFF, micro-shattered, CLAY/SILT. RESIDUAL LAVA.
1.70	1.80	0.10	Slightly moist, pale yellow grey brown, STIFF, reworked, SILT. SAPROLITE.

Notes:

1) No groundwater seepage encountered
2) Partial refusal of TLB at 1.8 m
3) No visible sidewall collapse
4) U/D sample at 1.0-1.7m

Test Pit Profile

Test Pit No.

TP W4

Tel: +27 (0)82 567 1561 e-mail: ninow@gcs-sa.biz

Co-ordinates:	**Job Description:**	portion 36 Olifantsvlei	
x	**Job No.:**	16-0730	
y	**Client:**	Boxways	
Elevation:	**Machine:**	Cat 422DE	
Co-ord System:	**Logged by:**	AMW	
	Date:	31-Jan-17	**Sheet:** 1 of 1

From:	To:	Thickness (m)	Description
0.00	0.20	0.20	
0.20	1.00	0.80	Slightly moist, grey brown, FIRM (pp=35mm), pin-holed, clayey SILT with roots. HILLWASH.
1.00	2.00	1.00	Slightly moist, red orange brown, STIFF (pp=10mm), intact, clayey SILT with mnor roots and occassional scattered boulders of hard lava (<250mm). RESIDUAL LAVA.
2.00	2.20	0.20	Refusal on BOULDERS or weathered lava bedrock.

Notes:

1) No groundwater seepage encountered
2) Refusal of TLB at 2.2 m
3) No visible sidewall collapse
4) Small U/D samples at 0.5 m
5) Approach lane

Test Pit Profile

Test Pit No.

TP W2

Tel: +27 (0)82 567 1561 e-mail: ninow@gcs-sa.biz

Co-ordinates:	**Job Description:**	portion 36 Olifantsvlei	
x	**Job No.:**	16-0730	
y	**Client:**	Boxways	
Elevation:	**Machine:**	Cat 422DE	
Co-ord System:	**Logged by:**	AMW	
	Date:	31-Jan-17	**Sheet:** 1 of 1

From:	To:	Thickness (m)	Description
0.00	0.20	0.20	Moist, dark grey brown, SOFT, organic, clayey SILT with abundant roots. TOPSOIL.
0.20	0.60	0.40	Slightly moist to moist, grey brown, SOFT to FIRM (pp=25mm), clayey SILT. ALLUVIUM?
0.60	1.00	0.40	Slightly moist to moist, red grey brown, SOFT (pp=30mm), intact, clayey SILT. RESIDUAL LAVA.
1.00	2.30	1.30	Slightly moist, red brown speckled black, STIFF to FIRM, partially ferruginised, intact, clayey SILT with scattered ferricrete nodules and core-stones. SAPROLITE.

Notes:

1) No groundwater seepage encountered
2) No refusal of TLB at 2.3 m
3) No visible sidewall collapse
4) Access road

Test Pit Profile

Test Pit No.

TP W3

Tel: +27 (0)82 567 1561 e-mail: ninow@gcs-sa.biz

Co-ordinates:	**Job Description:**	portion 36 Olifantsvlei	
x	**Job No.:**	16-0730	
y	**Client:**	Boxways	
Elevation:	**Machine:**	Cat 422DE	
Co-ord System:	**Logged by:**	AMW	
	Date:	31-Jan-16	**Sheet:** 1 of 1

From:	To:	Thickness (m)	Description
0.00	1.00	1.00	Slightly moist, BOULDERS of hard lava in a matrix of red-pink, STIFF, SILT. TALUS.
1.00	1.60	0.60	Slightly moist, red-pink, STIFF, SILT with scattered rounded boulders (250mm max) of hand lava. TALUS.
1.60	1.65	0.05	Refusal on DENSE BOULDERS. TALUS.

Notes:

1) No groundwater seepage encountered
2) Refusal of TLB at 1.65 m
3) No visible sidewall collapse
4) Main filling station

Test Pit Profile

Test Pit No.

TP W4

Tel: +27 (0)82 567 1561 e-mail: ninow@gcs-sa.biz

Co-ordinates:	**Job Description:**	portion 36 Olifantsvlei	
x	**Job No.:**	16-0730	
y	**Client:**	Boxways	
Elevation:	**Machine:**	Cat 422DE	
Co-ord System:	**Logged by:**	AMW	
	Date:	31-Jan-17	**Sheet:** 1 of 1

From:	To:	Thickness (m)	Description
0.00	0.40	0.40	Slightly moist, grey brown, LOOSE, fine GRAVEL of platy shale. FILL.
0.40	1.10	0.70	Slightly moist, dark grey brown, STIFF-DENSE, pin-holed, clayey sandy SILT. RESIDUL LAVA.
1.10	1.20	0.10	Refusal on BOULDERS or weathered lava bedrock.

Notes:

1) No groundwater seepage encountered
2) Refusal of TLB at 1.2 m
3) No visible sidewall collapse
5) Approach lane

Test Pit Profile

Test Pit No.

TP W5

Tel: +27 (0)82 567 1561 e-mail: ninow@gcs-sa.biz

Co-ordinates:	**Job Description:**	portion 36 Olifantsvlei	
x	**Job No.:**	16-0730	
y	**Client:**	Boxways	
Elevation:	**Machine:**	Cat 422DE	
Co-ord System:	**Logged by:**	AMW	
	Date:	31-Jan-17	**Sheet:** 1 of 1

From:	To:	Thickness (m)	Description
0.00	0.40	0.40	Slightly moist, grey to yellow brown, LOOSE to SOFT, clayey SILT with fine shattered gravel. FILL.
0.40	1.00	0.60	Slightly moist, dark grey brown, STIFF-DENSE, pin-holed, clayey sandy SILT. HILLWASH.
1.10	1.20	0.10	Becoming STIFF SILT. SAPROLITE.

Notes:

1) No groundwater seepage encountered
2) No refusal of TLB at 1.2 m
3) No visible sidewall collapse
4) Small U/D sample at 0.5 m
5) Exit lane

APPENDIX B
Laboratory Test Results

Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

FOUNDATION INDICATOR

Client	GCS GEOTECHNICAL ENGINEERING		
Location	OLIFANTSVLEI FS W 5 @ 0,5m		
Date	06 FEBRUARY 2017	Test No	136
Job No	17025	Checked By	EB

SIEVE ANALYSIS

Values are expressed as a percentage of total sample

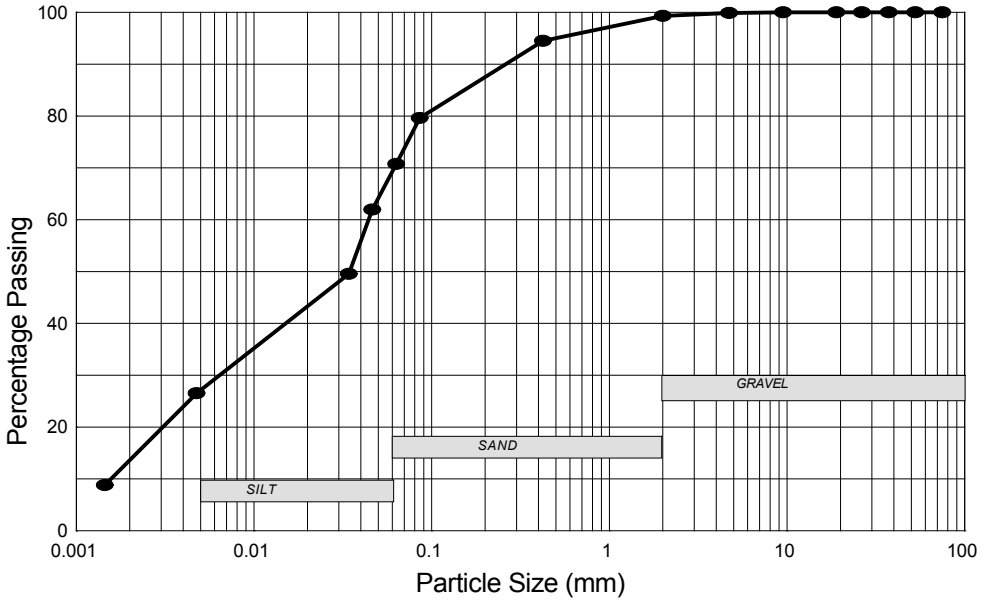
Sieve Size (mm)	Total Passing (%)
75.00	100.00
53.00	100.00
37.50	100.00
26.50	100.00
19.00	100.00
9.50	100.00
4.75	99.92
2.00	99.32
0.425	94.54

HYDROMETER ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
0.0861	79.67
0.0633	70.82
0.0464	61.97
0.0343	49.58
0.0048	26.56
0.0015	8.85

GRADING ANALYSIS



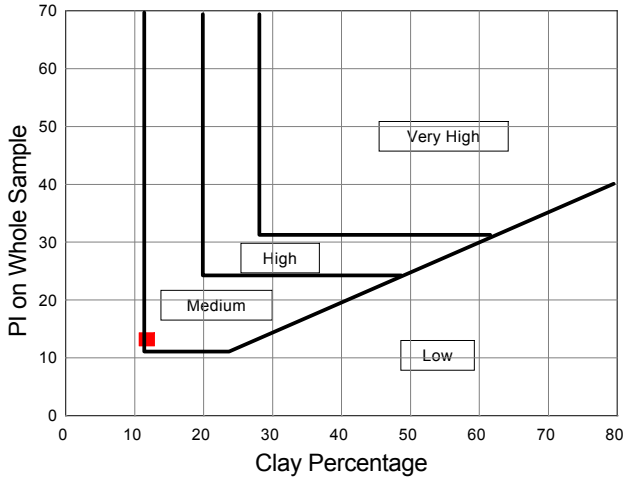
ATTERBERG LIMITS & OTHER VALUES

Liquid Limit	30
Plastic Limit	16
Plastic Index	14
Linear Shrinkage	7
Grading Modulus	0.26
Moisture Content	14.50
PI on Whole Sample	13
PRA Classification	A.6
Unified Classification	See Plasticity Chart

ESTIMATED COMPOSITION (As BS 1377)

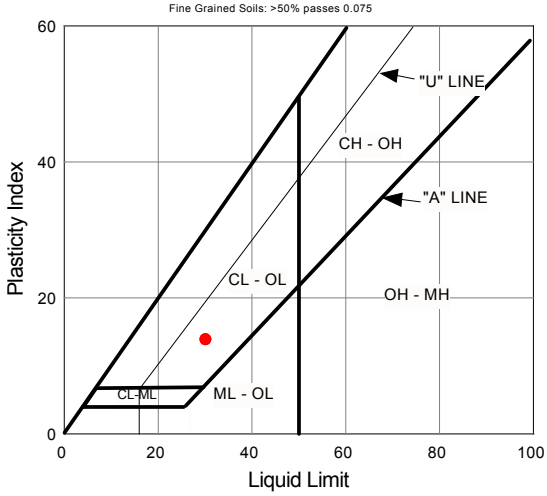
Clay (<0.002)	11.78
0.002 < Silt < 0.06	57.34
0.06 < Sand < 2.0	30.21
Gravel > 2.0	0.68
% less than 0.075	75.38

ACTIVITY CHART



PLASTICITY CHART

Fine Grained Soils: >50% passes 0.075



Geopractica
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TEL: (011) 674 1325
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FOUNDATION INDICATOR

Client	GCS GEOTECHNICAL ENGINEERING		
Location	OLIFANTSVLEI FS E 1 @ 0,5m		
Date	06 FEBRUARY 2017	Test No	138
Job No	17025	Checked By	EB

SIEVE ANALYSIS

Values are expressed as a percentage of total sample

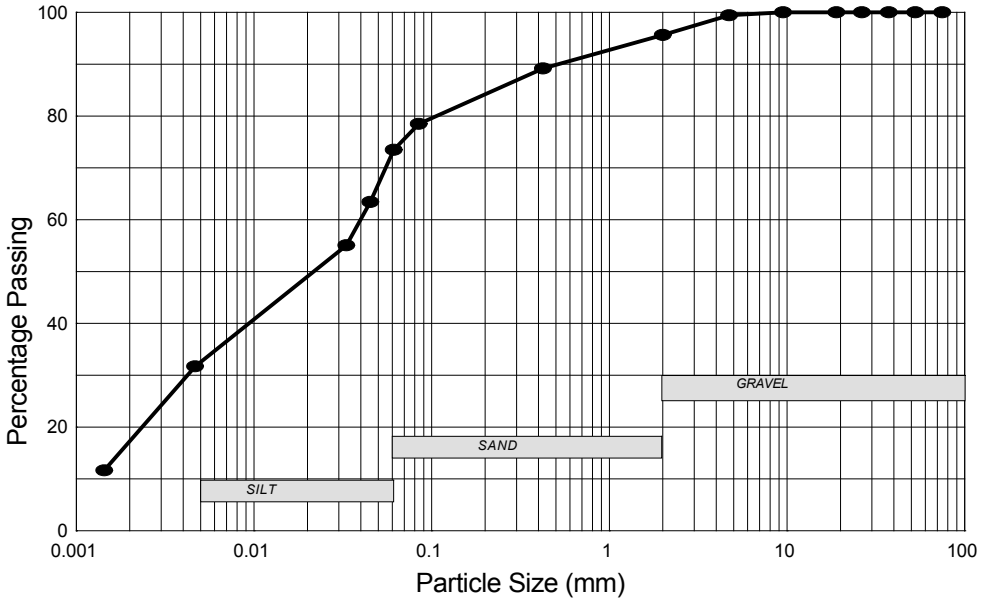
Sieve Size (mm)	Total Passing (%)
75.00	100.00
53.00	100.00
37.50	100.00
26.50	100.00
19.00	100.00
9.50	100.00
4.75	99.43
2.00	95.67
0.425	89.18

HYDROMETER ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
0.0847	78.49
0.0613	73.48
0.0454	63.46
0.0332	55.11
0.0047	31.73
0.0014	11.69

GRADING ANALYSIS



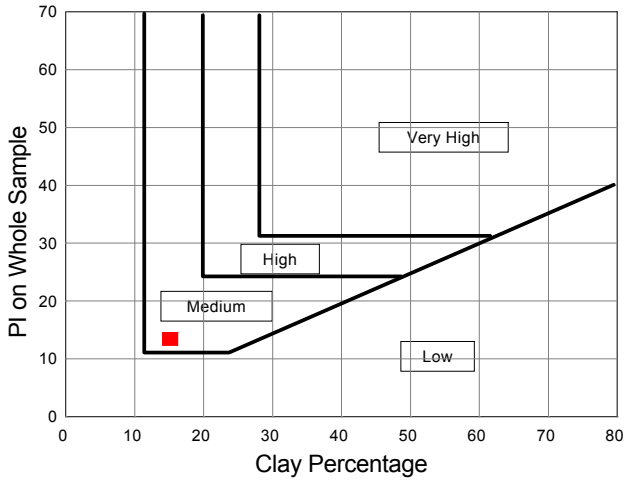
ATTERBERG LIMITS & OTHER VALUES

Liquid Limit	36
Plastic Limit	21
Plastic Index	15
Linear Shrinkage	8
Grading Modulus	0.37
Moisture Content	20.47
PI on Whole Sample	13
PRA Classification	A.6
Unified Classification	See Plasticity Chart

ESTIMATED COMPOSITION (As BS 1377)

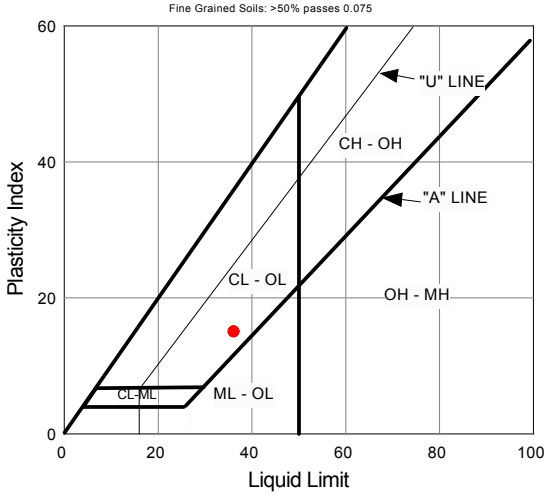
Clay (<0.002)	15.15
0.002 < Silt < 0.06	57.49
0.06 < Sand < 2.0	23.02
Gravel > 2.0	4.33
% less than 0.075	76.42

ACTIVITY CHART



PLASTICITY CHART

Fine Grained Soils: >50% passes 0.075



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FOUNDATION INDICATOR

Client	GCS GEOTECHNICAL ENGINEERING		
Location	OLIFANTSVLEI FS W 1 @ 1.0 - 1,7m		
Date	06 FEBRUARY 2017	Test No	140
Job No	17025	Checked By	EB

SIEVE ANALYSIS

Values are expressed as a percentage of total sample

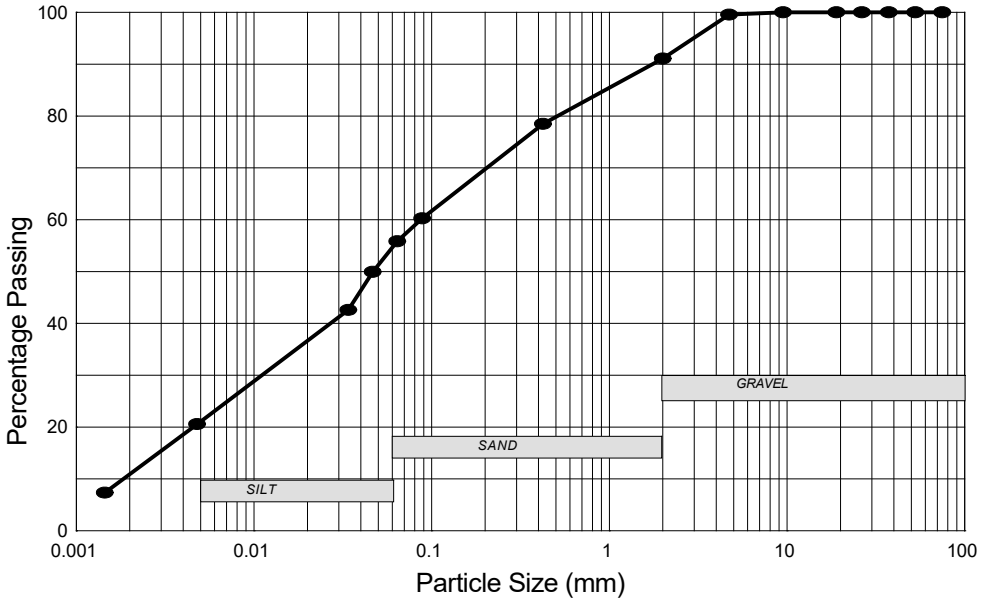
Sieve Size (mm)	Total Passing (%)
75.00	100.00
53.00	100.00
37.50	100.00
26.50	100.00
19.00	100.00
9.50	100.00
4.75	99.56
2.00	91.12
0.425	78.50

HYDROMETER ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
0.0888	60.27
0.0642	55.86
0.0467	49.98
0.0341	42.63
0.0048	20.58
0.0015	7.35

GRADING ANALYSIS



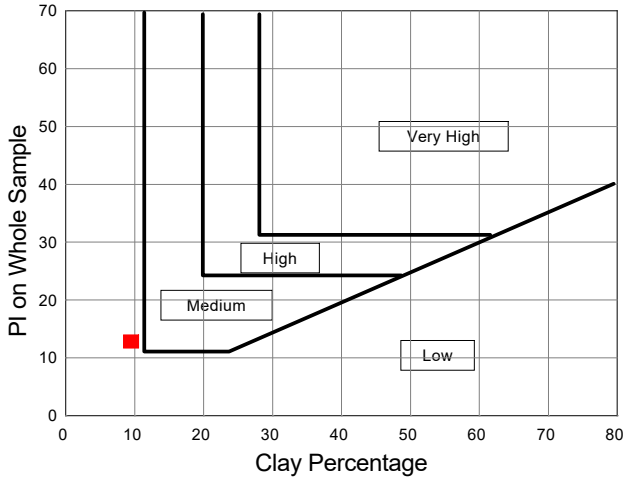
ATTERBERG LIMITS & OTHER VALUES

Liquid Limit	51
Plastic Limit	35
Plastic Index	16
Linear Shrinkage	11
Grading Modulus	0.70
Moisture Content	12.76
PI on Whole Sample	13
PRA Classification	A.7.5
Unified Classification	See Plasticity Chart

ESTIMATED COMPOSITION (As BS 1377)

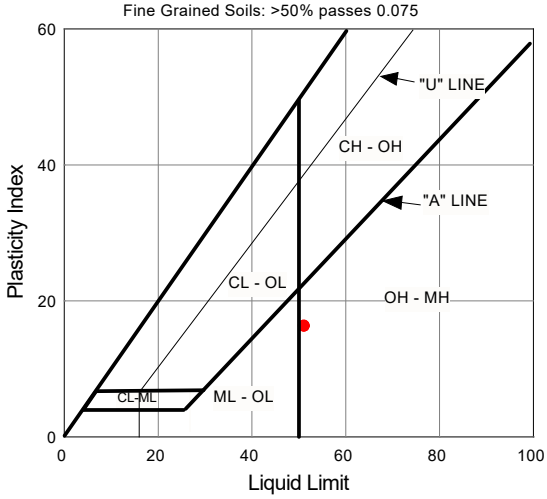
Clay (<0.002)	9.52
0.002 < Silt < 0.06	44.94
0.06 < Sand < 2.0	36.67
Gravel > 2.0	8.88
% less than 0.075	57.80

ACTIVITY CHART



PLASTICITY CHART

Fine Grained Soils: >50% passes 0.075



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COLLAPSE POTENTIAL at 200 kPa

Client	GCS GEOTECHNICAL ENGINEERING		
Location	OLIFANTSVLEI FS W5 @ 0,5m		
Date	06 FEBRUARY 2017	Test No	135
Job No	17025	Checked By	EB

Sample Height (mm)	20	Sample Diameter (mm)	64	Sample Specific Gravity	2.624

Sample Preparation	NMC

Effective Stress (kPa)	Time (mins)	Consolidation Reading	Voids Ratio	Strain (%)
10	60	1295	0.667	0.00
10	90	1296	0.666	0.05
33	130	1312	0.652	0.85
65	190	1328	0.639	1.65
127	310	1340	0.629	2.25
200	1750	1357	0.615	3.10
200	3190	1367	0.607	3.60
498	3430	1398	0.581	5.15
993	3670	1434	0.551	6.95
1868	5110	1488	0.506	9.65
743	5230	1484	0.509	9.45
118	5350	1470	0.521	8.75
10	5470	1444	0.542	7.45

Moisture Content Calculations

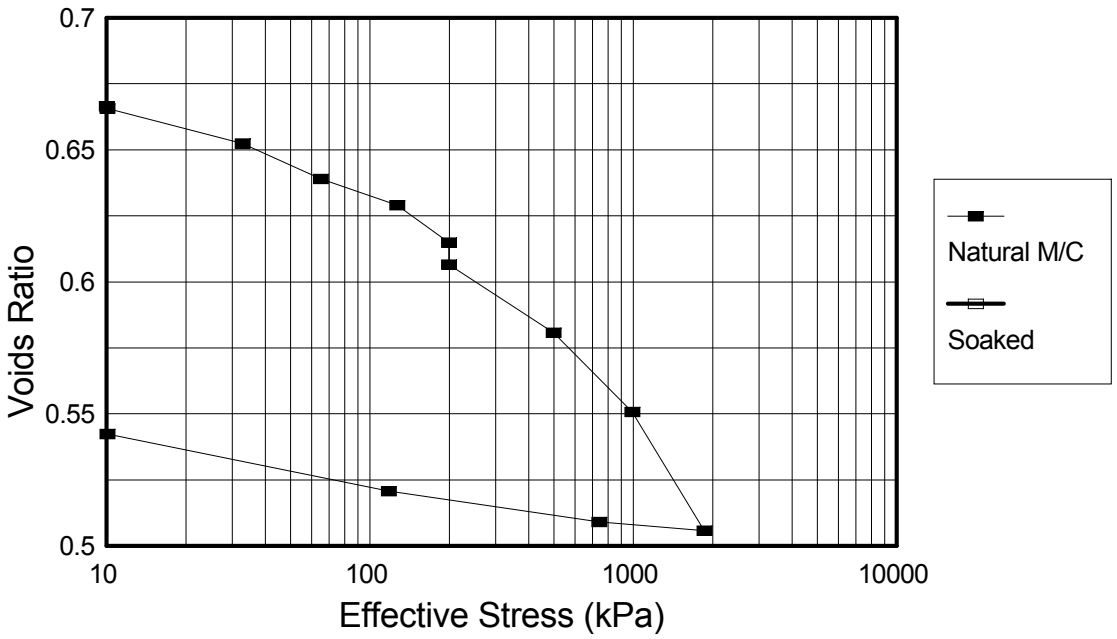
Mass wet sample plus ring before test (gms)	323.90
Mass wet sample plus ring after test (gms)	328.70
Mass dry sample plus ring (gms)	315.70
Mass ring (gms)	214.40
Moisture content before test (%)	**8.09**
Moisture content after test (%)	**12.83**

Other Data

Initial Dry Density (kg/m3)	**1574**
Initial Void Ratio	**0.67**

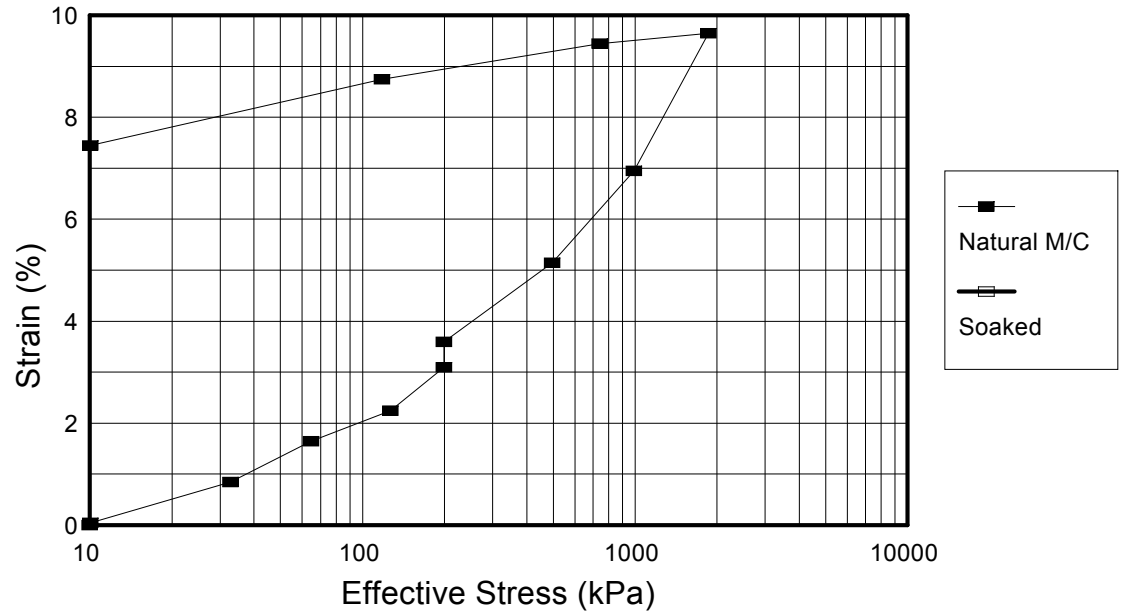
VOIDS RATIO v EFFECTIVE STRESS

Test No: 135



STRAIN v EFFECTIVE STRESS

Test No: 135



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COLLAPSE POTENTIAL at 200 kPa

Client	GCS GEOTECHNICAL ENGINEERING		
Location	OLIFANTSVLEI FS E1 @ 0,5m		
Date	06 FEBRUARY 2017	Test No	137
Job No	17025	Checked By	EB

Sample Height (mm)	20	Sample Diameter (mm)	64	Sample Specific Gravity	2.663

Sample Preparation	NMC

Effective Stress (kPa)	Time (mins)	Consolidation Reading	Voids Ratio	Strain (%)
10	60	654	1.509	0.00
10	90	654	1.509	0.00
33	130	671	1.487	0.85
65	190	690	1.463	1.80
127	310	708	1.441	2.70
200	1750	720	1.426	3.30
200	3190	862	1.248	10.40
498	3430	954	1.132	15.00
993	3670	1015	1.056	18.05
1868	5110	1073	0.983	20.95
743	5230	1058	1.002	20.20
118	5350	1045	1.018	19.55
10	5470	1021	1.048	18.35

Moisture Content Calculations

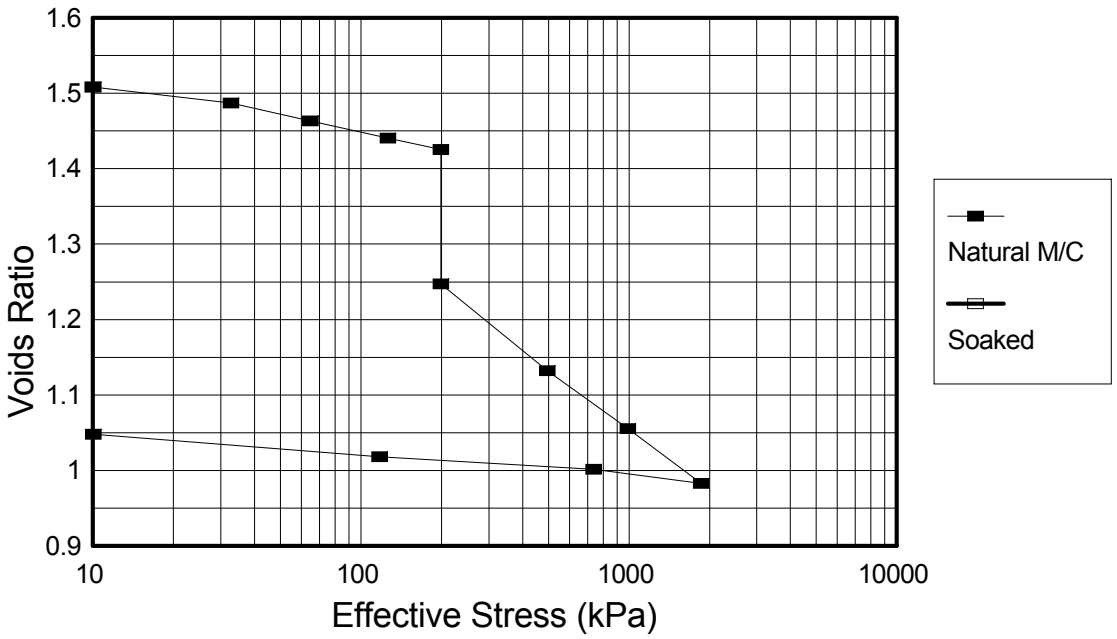
Mass wet sample plus ring before test (gms)	292.20
Mass wet sample plus ring after test (gms)	297.00
Mass dry sample plus ring (gms)	280.70
Mass ring (gms)	212.40
Moisture content before test (%)	**16.84**
Moisture content after test (%)	**23.87**

Other Data

Initial Dry Density (kg/m3)	**1062**
Initial Void Ratio	**1.51**

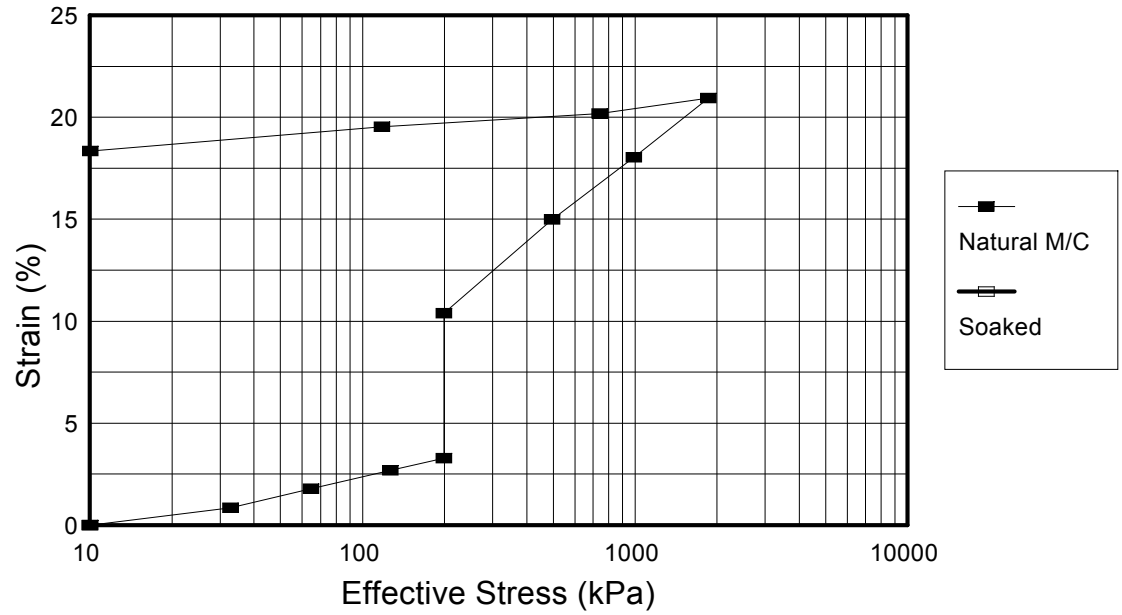
VOIDS RATIO v EFFECTIVE STRESS

Test No: 137



STRAIN v EFFECTIVE STRESS

Test No: 137



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COLLAPSE POTENTIAL at 200 kPa

Client	GCS GEOTECHNICAL ENGINEERING		
Location	OLIFANTSVLEI FS W1 @ 1,0 - 1,7m		
Date	06 FEBRUARY 2017	Test No	139
Job No	17025	Checked By	EB

Sample Height (mm)	20	Sample Diameter (mm)	64	Sample Specific Gravity	2.648

Sample Preparation	NMC

Effective Stress (kPa)	Time (mins)	Consolidation Reading	Voids Ratio	Strain (%)
10	60	458	1.109	0.00
10	90	460	1.106	0.10
33	130	464	1.102	0.30
65	190	470	1.096	0.60
127	310	480	1.085	1.10
200	1750	490	1.075	1.60
200	3190	497	1.067	1.95
498	3430	547	1.015	4.45
993	3670	597	0.962	6.95
1868	5110	647	0.909	9.45
743	5230	633	0.924	8.75
118	5350	612	0.946	7.70
10	5470	582	0.978	6.20

Moisture Content Calculations

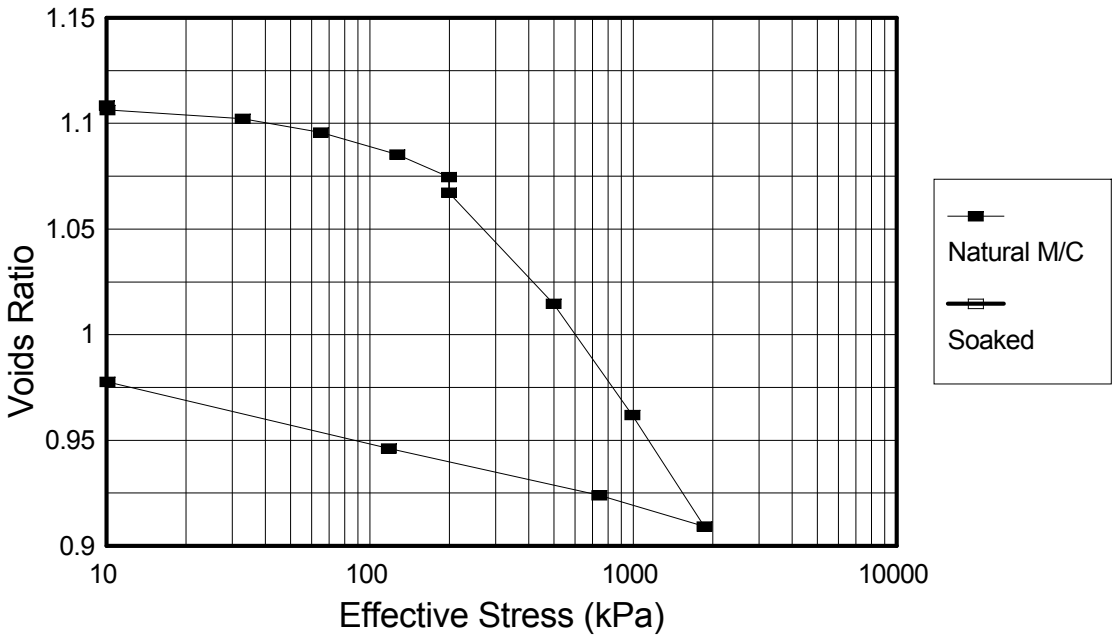
Mass wet sample plus ring before test (gms)	315.10
Mass wet sample plus ring after test (gms)	319.70
Mass dry sample plus ring (gms)	294.70
Mass ring (gms)	213.90
Moisture content before test (%)	**25.25**
Moisture content after test (%)	**30.94**

Other Data

Initial Dry Density (kg/m3)	**1256**
Initial Void Ratio	**1.11**

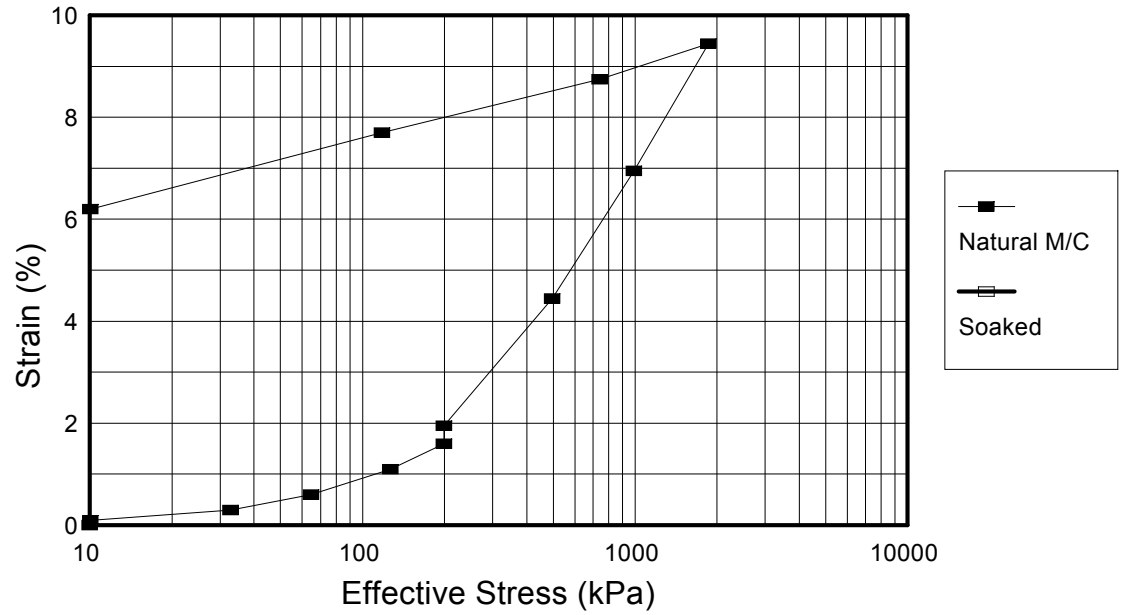
VOIDS RATIO v EFFECTIVE STRESS

Test No: 139



STRAIN v EFFECTIVE STRESS

Test No: 139



APPENDIX C
DCP Profiles

GCS Geotechnical Engineering

- Geology
- Geotechnics
- Groundwater
- Wetland Delineations
- Mining Rights
- Environmental
- Geophysics

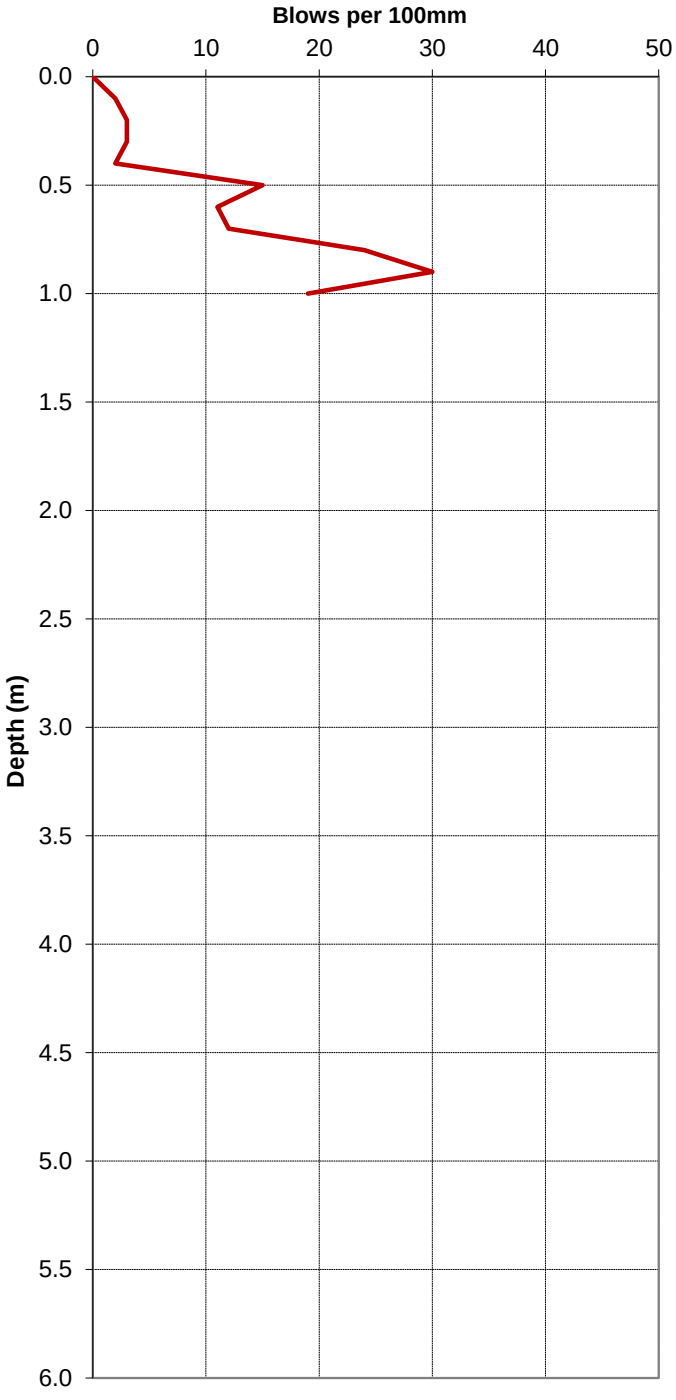
Tel: (082) 567 1561 Fax: (086) 672 4258 Email: ninow@gcg-sa.biz www.gcs-sa.biz

Client:	Boxways	**Ref. No.:**	16-0730
Project:	Olifantsvlei Filling Station	**Date:**	06-Feb-1
Section:	Foundations	**Operator:**	Warren

CBR DYNAMIC CONE PENETROMETER PROBE — ***TEST No*** ***DCP 1***

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0.0	0			
0.1	2	Loose	<30 deg	3
0.2	3	Loose	<30 deg	5
0.3	3	Loose	<30 deg	5
0.4	2	Loose	<30 deg	3
0.5	15	Dense	37 deg	27
0.6	11	Dense	36 deg	19
0.7	12	Dense	36 deg	21
0.8	24	Dense	38 deg	47
0.9	30	V.Dense	>38 deg	>55
1.0	19	Dense	37 deg	35
1.1				
1.2				
1.3				
1.4				
1.5				
1.6				
1.7				
1.8				
1.9				
2.0				



GCS Geotechnical Engineering

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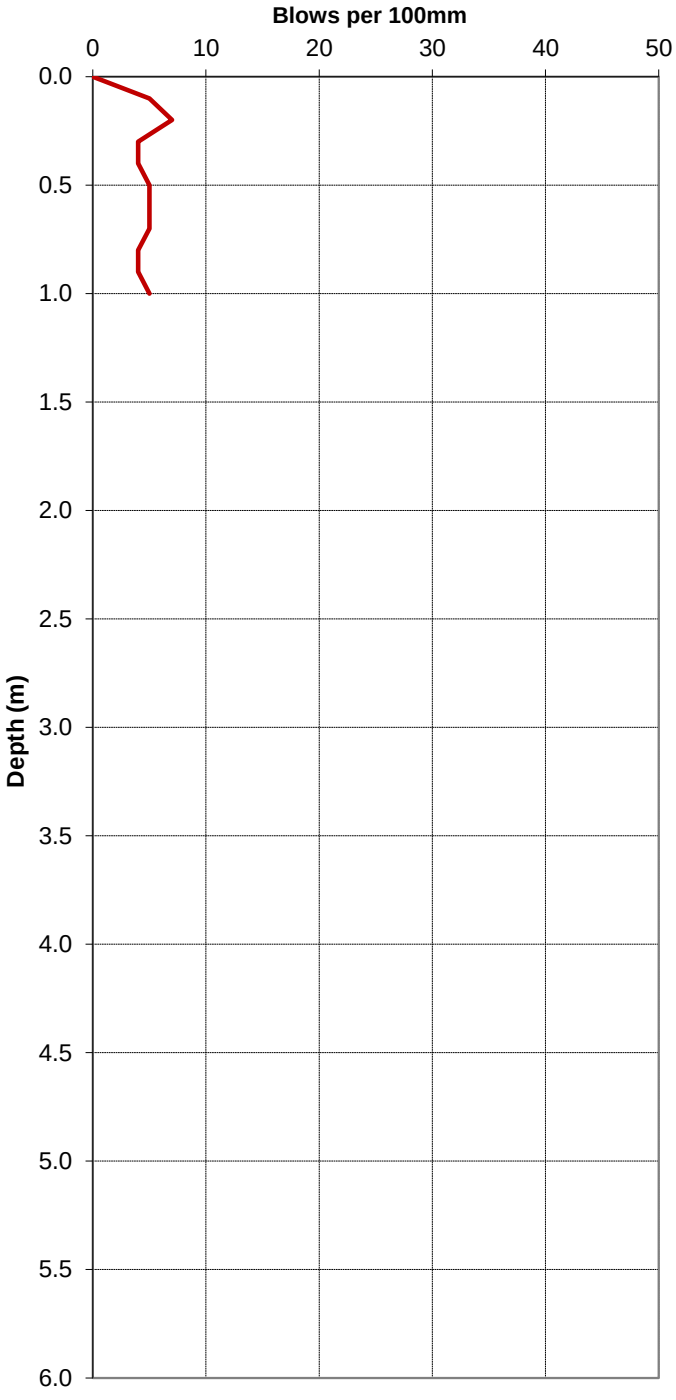
Client:	Boxways	**Ref. No.:**	16-0730
Project:	Olifantsvlei Filling Station	**Date:**	06-Feb-1
Section:	Foundations	**Operator:**	Warren

CBR DYNAMIC CONE PENETROMETER PROBE — ***TEST No*** ***DCP 2***

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0.0	0			
0.1	5	Med.Dense	32 deg	8
0.2	7	Med.Dense	34 deg	12
0.3	4	Med.Dense	30 deg	7
0.4	4	Med.Dense	30 deg	7
0.5	5	Med.Dense	32 deg	8
0.6	5	Med.Dense	32 deg	8
0.7	5	Med.Dense	32 deg	8
0.8	4	Med.Dense	30 deg	7
0.9	4	Med.Dense	30 deg	7
1.0	5	Med.Dense	32 deg	8
1.1				
1.2				
1.3				
1.4				
1.5				
1.6				
1.7				
1.8				
1.9				
2.0				



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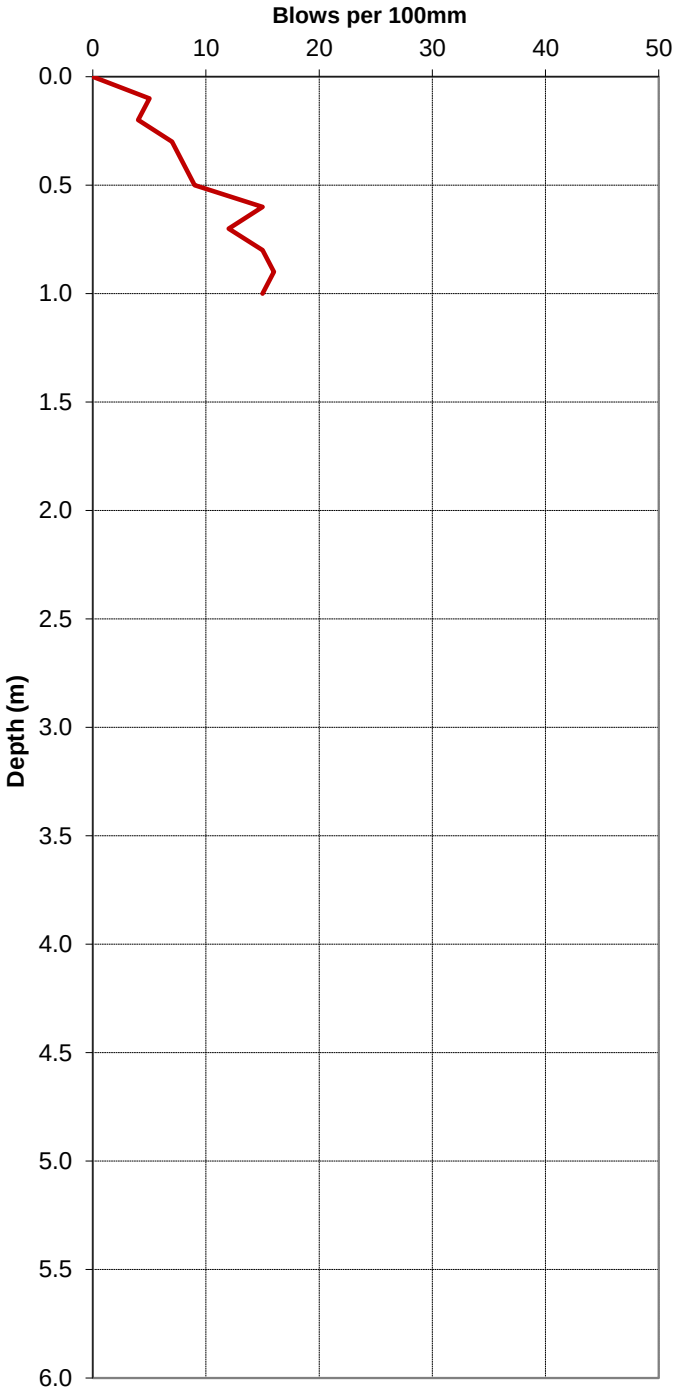
Client:	Boxways	**Ref. No.:**	16-0730
Project:	Olifantsvlei Filling Station	**Date:**	06-Feb-1
Section:	Foundations	**Operator:**	Warren

CBR DYNAMIC CONE PENETROMETER PROBE — ***TEST No*** ***DCP 3***

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0.0	0			
0.1	5	Med.Dense	32 deg	8
0.2	4	Med.Dense	30 deg	7
0.3	7	Med.Dense	34 deg	12
0.4	8	Med.Dense	35 deg	14
0.5	9	Med.Dense	35 deg	15
0.6	15	Dense	37 deg	27
0.7	12	Dense	36 deg	21
0.8	15	Dense	37 deg	27
0.9	16	Dense	37 deg	29
1.0	15	Dense	37 deg	27
1.1				
1.2				
1.3				
1.4				
1.5				
1.6				
1.7				
1.8				
1.9				
2.0				



GCS Geotechnical Engineering

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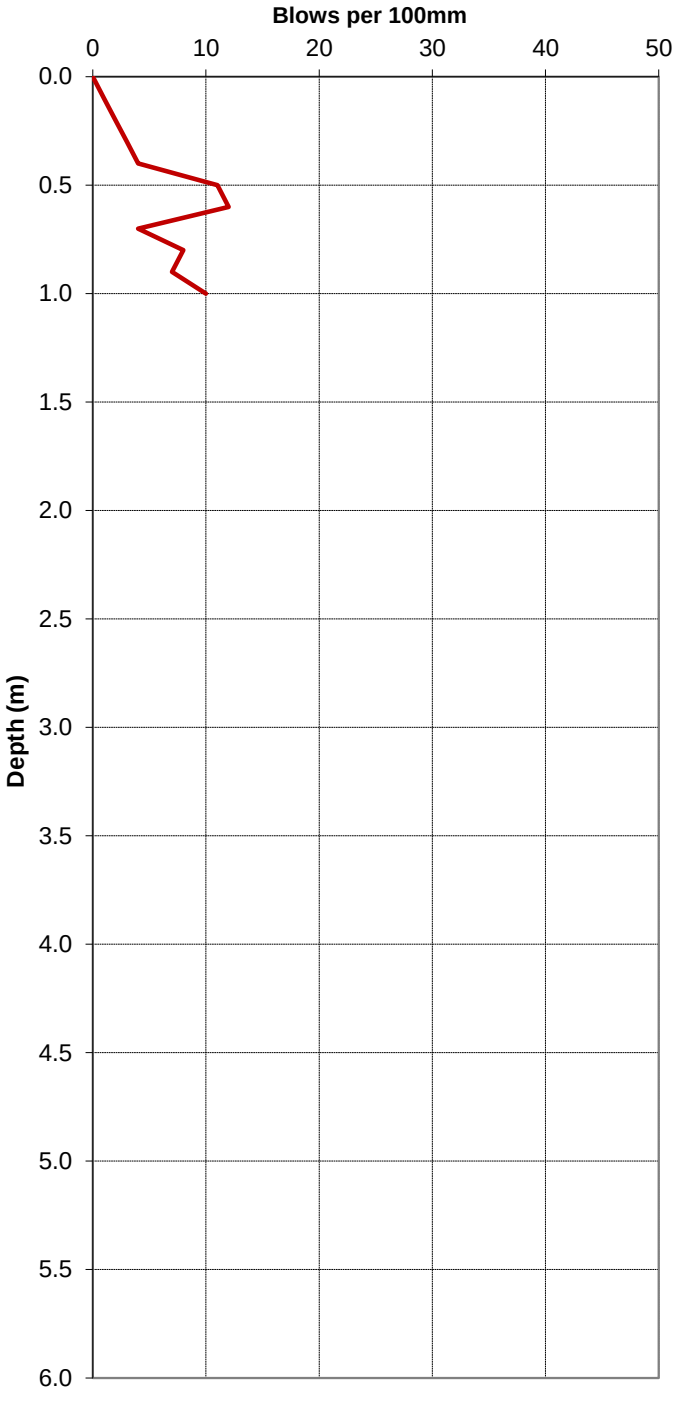
Client:	Boxways	**Ref. No.:**	16-0730
Project:	Olifantsvlei Filling Station	**Date:**	06-Feb-1
Section:	Foundations	**Operator:**	Warren

CBR DYNAMIC CONE PENETROMETER PROBE — ***TEST No*** ***DCP 4***

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0.0	0			
0.1	1	V.Loose	<29 deg	2
0.2	2	Loose	<30 deg	3
0.3	3	Loose	<30 deg	5
0.4	4	Med.Dense	30 deg	7
0.5	11	Dense	36 deg	19
0.6	12	Dense	36 deg	21
0.7	4	Med.Dense	30 deg	7
0.8	8	Med.Dense	35 deg	14
0.9	7	Med.Dense	34 deg	12
1.0	10	Med.Dense	36 deg	17
1.1				
1.2				
1.3				
1.4				
1.5				
1.6				
1.7				
1.8				
1.9				
2.0				



GCS Geotechnical Engineering

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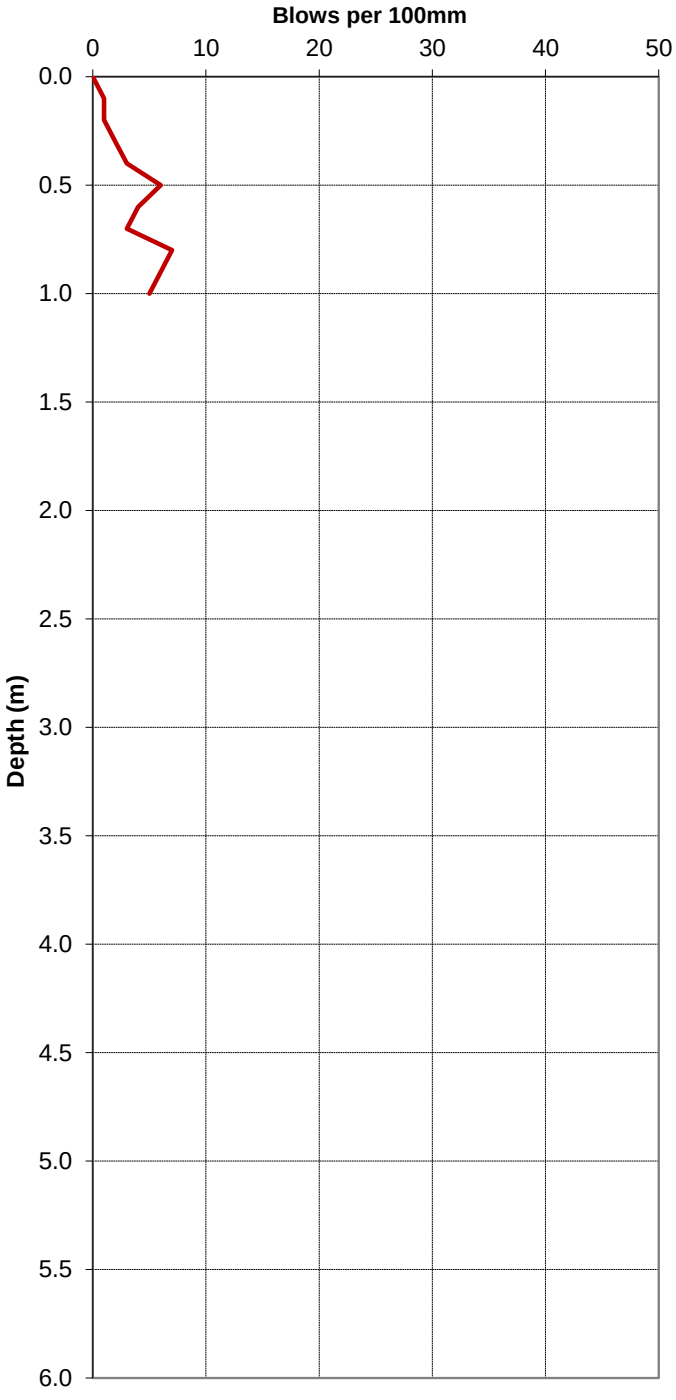
Tel: (082) 567 1561 Fax: (086) 672 4258 Email: ninow@gcg-sa.biz www.gcs-sa.biz

Client:	Arrow Property Investments	**Ref. No.:**	16-0730
Project:	Olifantsvlei Filling Station	**Date:**	06-Feb-1
Section:	Foundations	**Operator:**	Warren

CBR DYNAMIC CONE PENETROMETER PROBE — ***TEST No*** ***DCP 5***

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0.0	0			
0.1	1	V.Loose	<29 deg	2
0.2	1	V.Loose	<29 deg	2
0.3	2	Loose	<30 deg	3
0.4	3	Loose	<30 deg	5
0.5	6	Med.Dense	33 deg	10
0.6	4	Med.Dense	30 deg	7
0.7	3	Loose	<30 deg	5
0.8	7	Med.Dense	34 deg	12
0.9	6	Med.Dense	33 deg	10
1.0	5	Med.Dense	32 deg	8
1.1				
1.2				
1.3				
1.4				
1.5				
1.6				
1.7				
1.8				
1.9				
2.0				



GCS Geotechnical Engineering

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- Groundwater
- Wetland Delineations
- Mining Rights
- Environmental
- Geophysics

Tel: (082) 567 1561 Fax: (086) 672 4258 Email: ninow@gcg-sa.biz www.gcs-sa.biz

Client:	Boxways	**Ref. No.:**	16-0730
Project:	Olifantsvlei Filling Station	**Date:**	06-Feb-1
Section:	Foundations	**Operator:**	Warren

CBR DYNAMIC CONE PENETROMETER PROBE — ***TEST No*** ***DCP 6***

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0.0	0			
0.1	1	V.Loose	<29 deg	2
0.2	1	V.Loose	<29 deg	2
0.3	3	Loose	<30 deg	5
0.4	3	Loose	<30 deg	5
0.5	10	Med.Dense	36 deg	17
0.6	6	Med.Dense	33 deg	10
0.7	3	Loose	<30 deg	5
0.8	3	Loose	<30 deg	5
0.9	5	Med.Dense	32 deg	8
1.0	5	Med.Dense	32 deg	8
1.1				
1.2				
1.3				
1.4				
1.5				
1.6				
1.7				
1.8				
1.9				
2.0				

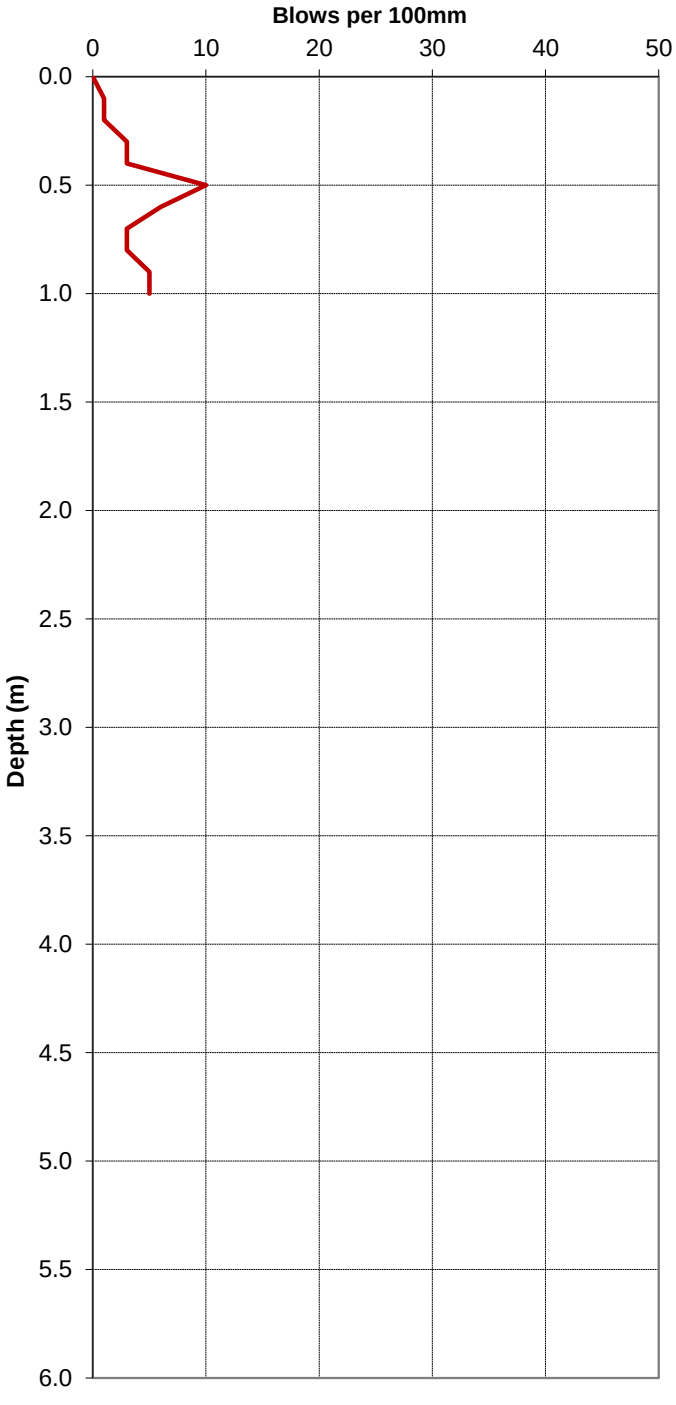

Figure 1
Site Plan

OLIFANTSVLEI FILLING STATION - SITE PLAN

LEGEND

- Test Pit Location
- DCP Location
- Light Pole
- Concrete Channel
- Servitude
- Guard Rail
- Road Edge
- Parent Farm
- Farm Portion

Data Sources:
Google Earth™ mapping service: 2017
Imagery Date: 20/05/2016

0 12.5 25 50 Meters

SCALE: 1:1 200

FIGURE NO.:	-	MAP NUMBER:	16-0730-02
DRAWN BY:	JF VERMEULEN GIS TECHNICIAN	REVIEWED BY:	W KRETZINGER ENGINEERING GEOLOGIST
DATUM: PROJECTION:	WGS84 TRANSVERSE MERCATOR (29)	DATE:	22 FEBRUARY 2017
PROJECT:	OLIFANTSVLEI FILLING STATION		
CLIENT:	ARROW PROPERTY INVESTMENTS		

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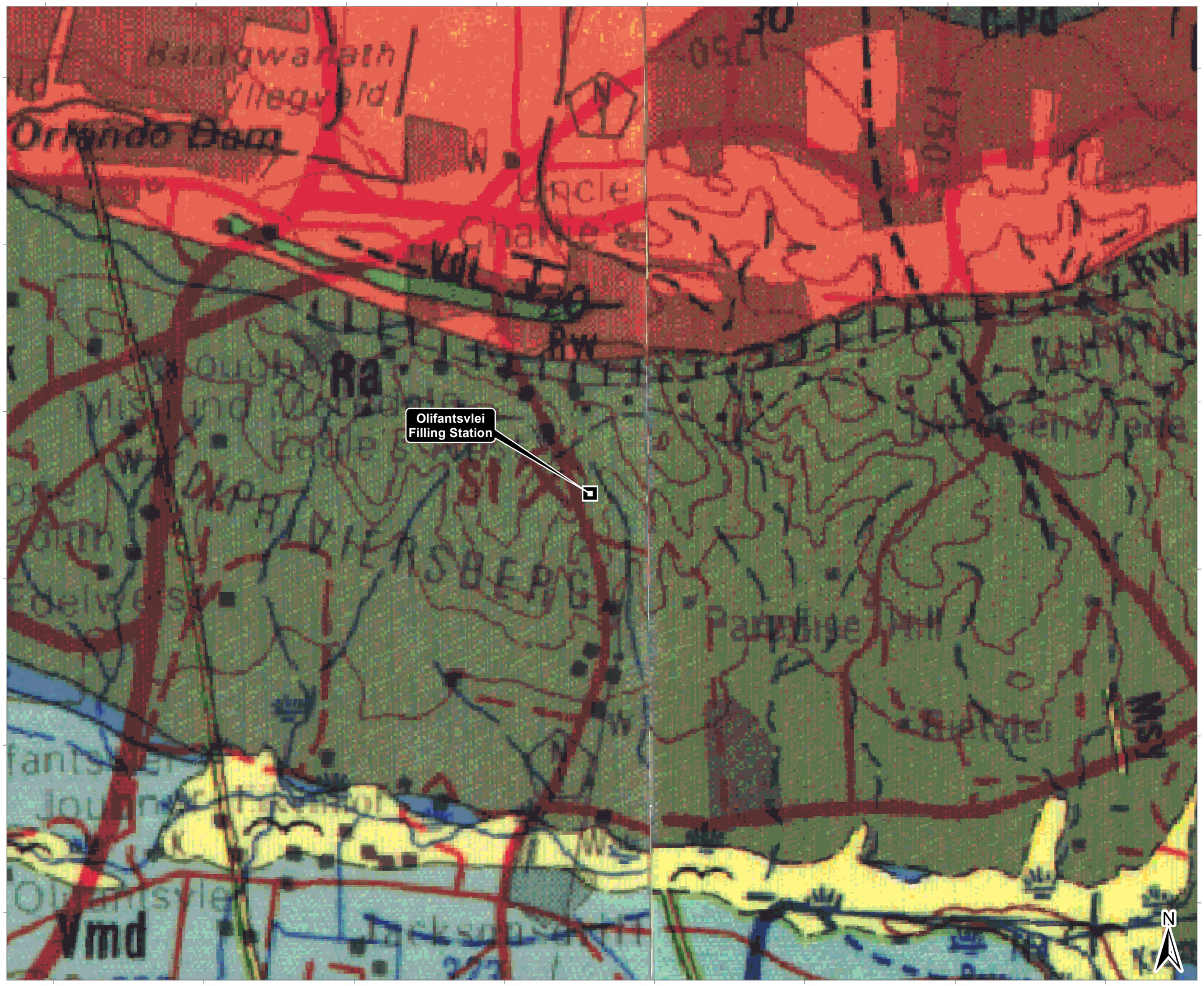
Figure 2
Geological Plan

OLIFANTSVLEI FILLING STATION - GEOLOGY

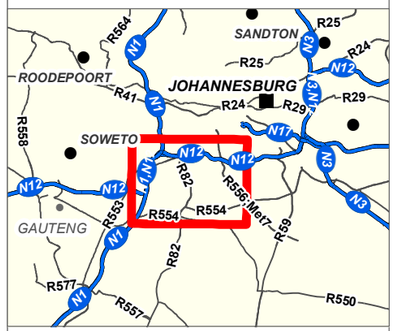


LEGEND

Site Location

LITHOLOGY:

~	Alluvium
Ra	Feldspar porphyry
Rk	Basaltic Lava, agglomerate, tuff
Rt	Quartzite, conglomerate, shale
Rw	Tuff, lava
Vbr	Quartzite, conglomerate, shale
Vdi	Diabase
Vmd	Dolomite, chert and remnants of chert breccia of the Rooihoogte Formation



Data Sources:
Council for Geoscience
1:250 000 Geological Series: 2626, 2628

0 0.5 1 2 Kilometers

SCALE: 1:40 000

FIGURE NO.:	-	MAP NUMBER:	16-0730-03
DRAWN BY:	JF VERMEULEN GIS TECHNICIAN	REVIEWED BY:	W KRETZINGER ENGINEERING GEOLOGIST
DATUM: PROJECTION:	WGS84 TRANSVERSE MERCATOR (29)	DATE:	22 FEBRUARY 2017
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