Geotechnical Investigation
Eloff Erf 174 & 175, Delmas

REPORT TO

Shangoni Management Services (Pty) Ltd

BY ***Vela VKE*** Consulting Engineers

REPORT NO.: PJ096/KNP/2011/10/2349 **OCTOBER 2011**

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Report Title	**Eloff Erf 174 & 175, Delmas**
Client	Shangoni Management Services
Type of Work	Foundation Investigation TPs
Other	Ecca overlying Dolomite
Keywords	Possible dolomite

Co-ordinates	Latitude	S -26.14928
	Longitude	E 28.62336
Geographic Reference		
Location	Delmas	
Report Number	PJ096/KNP / 2011 / 10/ 2349	

Report Verification (this version)

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Revision Schedule (externally issued versions only)

Date	**Version and Details**

EXECUTIVE SUMMARY

A geotechnical investigation has been undertaken for the proposed construction of a truck depot at Eloff Erf 174 & 175, Delmas.

The site co-ordinates are S26.149277° and E28.623361°.

The investigation is aimed at identifying geotechnical factors that would have an impact on the development, to enable economic design and construction of the proposed development and to serve as a mitigating measure against unknown and/or variable ground conditions.

The geotechnical investigation, comprising a site walkover, test pitting and laboratory testing, revealed the site to be underlain by clayey sand, overlying very weakly to weakly cemented ferricrete at depths of between 0.8m and 1.2m. In a single test pit hardpan ferricrete was encountered at 1.2m. No groundwater was encountered within the test pits

It is understood that the proposed development will comprise a number of light single storey buildings and concrete storage bays. These may be founded on the loose sand at a nominal depth of 0.5m. A bearing capacity of 50kPa may be taken for the sand at this depth. If higher loadings are envisaged, a bearing capacity of 100kPa may be taken for the ferricrete at about 1.0m depth.

The ferricrete is not suitable for layerworks in pavement construction or for use in unpaved road construction. Therefore, materials for use in layerworks or surfacing will have to be imported onto the site.

Precautions associated with dolomitic site classification D2/D3 must be adopted, as described in section 4.5.

CONTENTS

1. INTRODUCTION AND TERMS OF REFERENCE

1.1. Scope

This report presents the findings of a geotechnical investigation undertaken for the purpose of investigating founding conditions for the construction of a truck depot at Eloff Erf 174 & 175, Delmas. The proposed development will comprise a number of light single storey buildings and concrete storage bays.

1.2. Terms of Appointment

The work was carried out on behalf of Shangoni Management Services (Pty) Ltd in accordance with our quote no. 363, dated 29 July 2011 and the instruction to proceed from Isabel Hough, dated 31 August 2011.

1.3. Aims and Methodology

The objectives of the study are:

- To analyse the geotechnical conditions present, assess the general suitability of the site for, and to make recommendations for site works for, the proposed development
- Provide foundation recommendations for the proposed development
- To identify relevant ground-related features and determine the variability of ground conditions and the effect of such variability on the proposed development

The following methodology was adopted to realise the aims of the study:

- Review of available geological records and site plans.
- Undertaking of a geotechnical site investigation including machine excavated trial pits to profile soils, investigate soil strengths/capacities and identify potential problem soils on site.
- Undertaking of laboratory testing to establish geotechnical and design parameters of the soils.
- Identification of relevant ground-related features and their influence on the proposed development.

1.4. Codes of Practice and Standards

The services performed by ***Vela VKE*** were conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the geotechnical profession practising under similar conditions in the locality of the project.

The investigation was carried out according to standard practice codes and guidelines.

1.5. Limitations of Assessment

The nature of geotechnical engineering is such that variations in what is reported here may become evident during construction and it is thus imperative that a Competent Person inspects all excavations to ensure that conditions at variance with those predicted do not occur and to undertake an interpretation of the facts supplied in this report.

Limitations of the report are discussed in Appendix A. These limitations further explain the realities of geotechnical engineering and the limitations that exist in evaluating geotechnical issues.

This report has been prepared for the exclusive use of the client, with specific application to the proposed project.

2. INFORMATION ON THE SITE

2.1. Information Sources

The following sources were consulted and/or made available;

- Geological Map, Sheet 2628 East Rand at a scale of 1:250 000 published 1986
- Site plans showing the local topography
- Published technical references (listed in Section 7 of this report)
- Council for Geoscience borehole records

2.2. Site Location and Description

The site is located on Eloff Erf 174 & 175, Delmas and the approximate site centre has co-ordinates of S26.149277° and E28.623361° (WGS84). The site is roughly rectangular and extends to dimensions of 140m x 140m, and is bound by adjacent undeveloped plots to the east, and by roads to the north, south and west. The site is grassed and generally flat. At the time of the investigation the southern half of the site

had been gravelled and was in use as a parking area for trucks. A container and ablution block were also present.

A site locality plan is given below as Diagram 1 and investigation layout as Diagram 2.

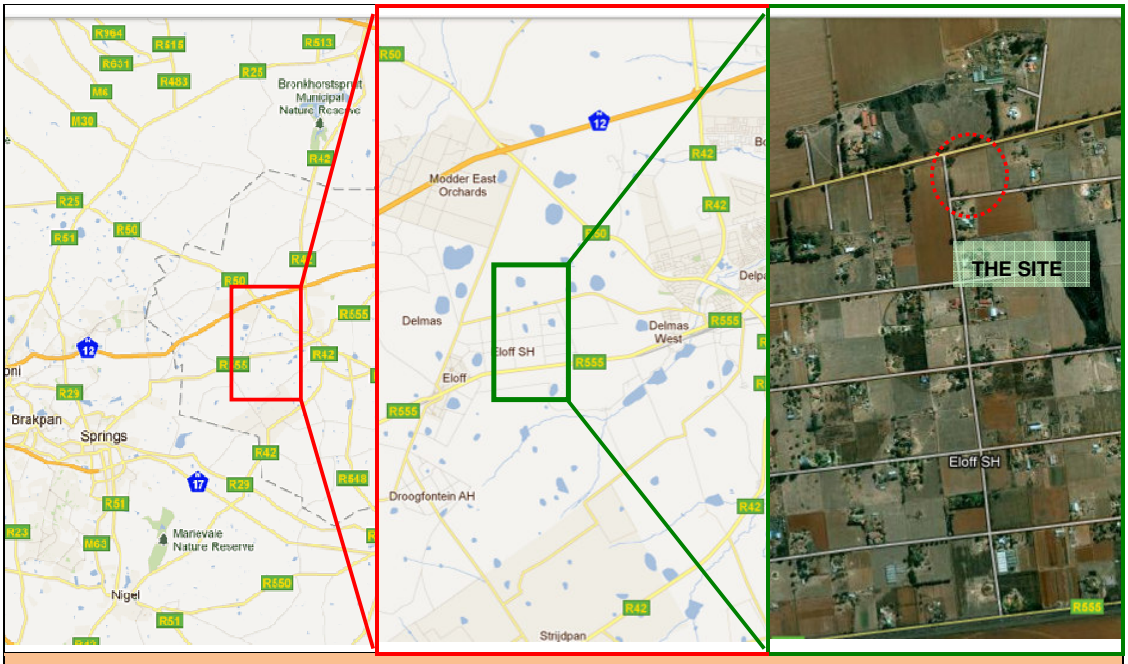


Diagram 1. Site locality plan

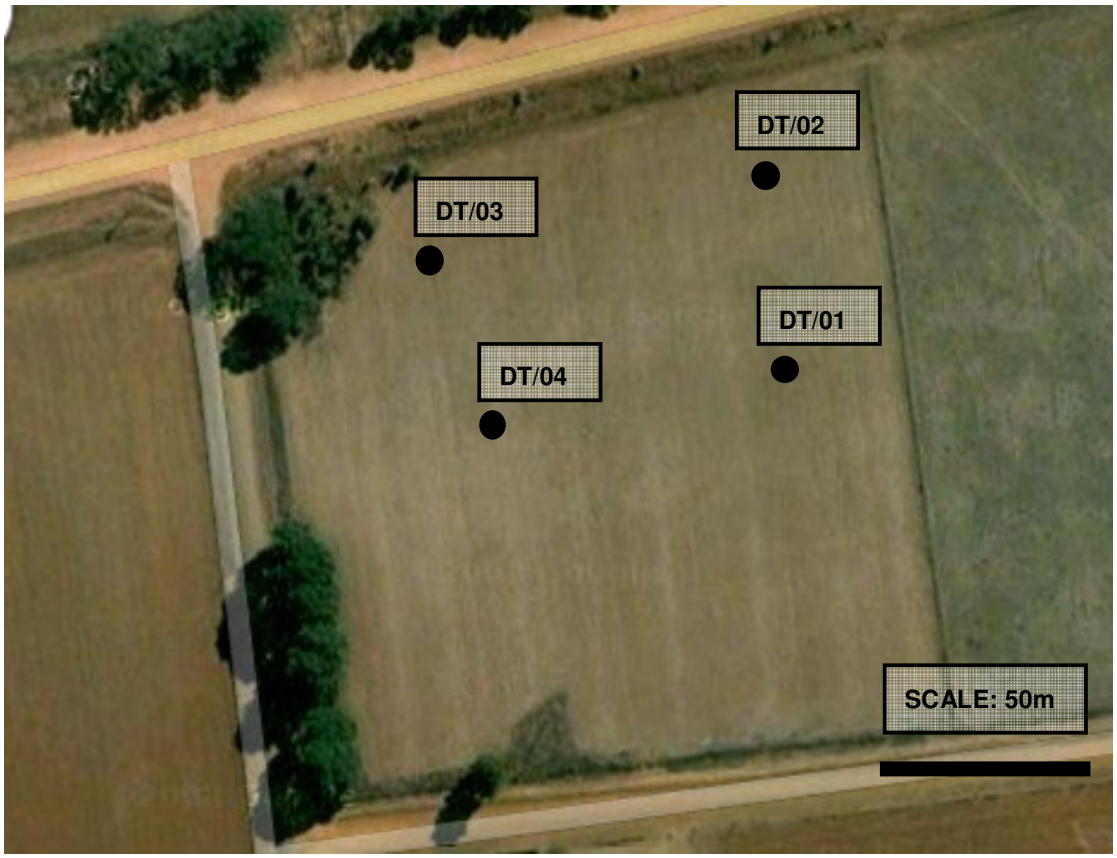


Diagram 2. Investigation Layout Plan

	
Southern part of site used for truck parking, workshop and ablution block (right)	Undeveloped northern part of site

2.3. Drainage and Topography

The site is generally flat. Drainage of the site is in the form of sheetwash.

2.4. Climate

The site lies within the Highveld climatic zone. The climate is mild and characterised by warm, moist summers and cool dry winters with a mean annual temperature of about 16.0°C. Most rainfall occurs from October to March, with a mean annual precipitation of about 600mm.

Climate determines the mode and rate of weathering. The effect of climate on the weathering process (i.e. soil formation) is determined by the climatic N-value defined by Weinert. The N-value for the area is approximately 2.5, which implies a moderate climate, and is an indication that both chemical decomposition and mechanical disintegration can occur as the rock weathering mode, though chemical decomposition predominates.

3. GEOTECHNICAL INVESTIGATION AND GROUND CONDITIONS

3.1. Overview

The geotechnical investigation comprised a site walkover, fieldwork and laboratory testing. Fieldwork on the site was undertaken on 16 September 2011, which comprised the excavation of 4 trial pits.

The trial pits were excavated by a CAT 428B TLB, to depths of between 1.2m and 2.4m, and were profiled according to standard practice: using the 2001, "*Guidelines for Soil and Rock Logging in South Africa"* (which is based on Jennings 1973) and is published by the AEG, SAICE and SAIEG (Refer to Section 7 and Appendix D). The profiles are provided in Appendix B of this report.

Soil samples were recovered from representative materials on site and submitted for laboratory testing; these are discussed in further detail below.

3.2. Geology and Soil

The geological map of East Rand (sheet 2628) shows the entire site to be underlain by sandstone, shale and coal beds of the Vryheid Formation, within the Ecca Group. However, the documented geology indicates the Ecca overlies dolomite. Therefore, the Council for Geoscience was consulted regarding the depth to the dolomite in the area.

Records held by the Council for Geoscience indicate several boreholes in the area, the closest approximately 260m from the site, which was drilled to 33m depth without encountering dolomite.

The profiles observed within the pits excavated comprised 0.3m of topsoil overlying loose to medium dense generally clayey sand, occasionally tending to clayey sandy silt, which was observed extending to between 0.8m and 1.2m. Below this layer very weakly to weakly cemented ferricrete was encountered in a grey/orange clayey sand matrix in DT/02-04. In DT/02 the TLB refused on strongly cemented ferricrete at 1.5m, and in DT/01 the TLB refused on hardpan ferricrete at 1.2m, directly below the clayey sandy silt.

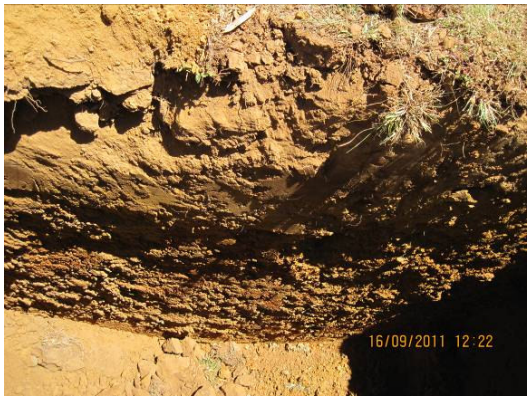
No groundwater was encountered within the test pits.

Laboratory testing of the clayey material encountered in the pits has proven it to be of low expansiveness.

A summary of the profiles is given in Table 3.2.1 below:

Test pit	*Topsoil (m)*	*Clayey sand / silt (m)*	*Ferricrete (m)*	*Seepage (m)*
DT/01	0-0.3	0.3-1.2	1.2 Refusal	N/A
DT/02	0-0.3	0.3-0.8	0.8-1.5 Refusal	N/A
DT/03	0-0.3	0.3-0.7	0.7-2.0	N/A
DT/04	0-0.3	0.3-0.8	0.8-2.4	N/A

DT/01



DT/03

3.3. Laboratory testing

Laboratory tests were scheduled to confirm the on-site investigation and establish engineering parameters for the soils. Testing was undertaken by our associated SANAS accredited laboratory, Soillab (Pty) Ltd.

The various tests and pertinent information from these tests are highlighted below; with the detailed test results included as Appendix D of this report. The tests undertaken included:

- 4 Foundation Indicator tests (including grading and Atterberg Limits)
- 1 chemical suite (pH and conductivity) tests
- 1 CBR test

Indicator Tests; The tests showed the clayey sands have a moderately high clay content (approx. 20%), but have a "low" potential expansiveness according to the van der Merwe Method. The test results are summarised in the table below:

Trial pit No.	Depth of sample (m)	Description	Clay %	Silt %	Sand %	Gravel %	PI (whole sample)	Expansiveness classification*
DT/01	0.3-1.2	Clayey SILT	18	33	46	4	9	Low
DT/02	0.8-1.5	FERRICRETE	21	29	36	14	13	Low
DT/04	0.3-0.8	Clayey SAND	18	30	39	13	13	Low
DT/04	0.8-2.4	FERRICRETE	23	34	43	0	12	Low

* According to van der Merwe (ref.7)

From the Indicator Test Results, no significant heave related problems are expected on the site.

Chemical Analysis suite of tests was undertaken. The results showed the soil to be slightly basic, with a pH of between 4.97 and 5.13 and with conductivity tests indicating that the soil are slightly aggressive to buried steel. Damage to new buried steel can be avoided by the use of either an epoxy double coating system or similar (primer plus polyurethane topcoat).

CBR Test; The results of the CBR test indicate that the ferricrete qualifies as >G9 (according to the TRH14 and Colto Classifications).

4. GEOTECHNICAL EVALUATION AND CONCLUSIONS

An evaluation of the impact of the geotechnical characteristics on the development are discussed below.

4.1. Ground Conditions

The trial pitting and laboratory testing undertaken has revealed conditions on the site to be favourable for the development. Suitable foundation solutions are discussed hereunder.

4.2. Foundations

It is understood that the proposed development will comprise a number of light single storey buildings and concrete storage bays. These may be founded on the loose sand at a nominal depth of 0.5m. A bearing capacity of 50kPa may be taken for the sand at this depth. If higher loadings are envisaged, a bearing capacity of 100kPa may be taken for the ferricrete at about 1.0m depth.

4.3. Ground Water & Flooding

Groundwater was not encountered within any of the test pits, and is not considered as a significant factor for the proposed construction.

The site is not located near a river. Therefore, it is not anticipated that flooding will be an issue for this site.

However, shallow perched water tables are likely to occur after periods of heavy, continuous rainfall, as evidenced by the ferricrete in the profile.

4.4. Services and Excavatability

Materials encountered to about 1m would classify as “soft” according to the SABS 1200 D Earthworks classification, or as “Soft class 2” (materials which can be readily excavated with the aid of a pick) according to the Department of Works, (Watermeyer, 1997). No blasting would thus be required.

Notwithstanding that the pit sides remained vertical and stable during the investigation, instability in excavations may be caused by periods of sustained rain, which will weaken the soil structure. As such, particular care must be taken with the excavation of trenches, with appropriate protection of workers but shoring and/or battering of deep excavations (greater than 1.2m), is envisaged.

4.5. Dolomite

Whilst the documented geology indicates the site not to lie directly on the dolomite, it is known that the Ecca Formation overlies the dolomite in this area. Records of borehole

drilling in the area, provided by the Council for Geoscience, indicate several boreholes, the closest approximately 260m from the site which extends to 33m deep and does not encounter dolomite.

However, in the absence of specific data, it is assumed that this site classifies as D2/D3, and as such, the precautions listed in SANS 1936 are required. These include, but are not limited to:

- Service pipes specified as HDPE, with watertight joints
- Manholes / valves must be in watertight chambers
- Stormwater runoff to be in impermeable channels and water from truck wash areas to be fed into this
- Water must not be allowed to pool on the surface of the site
- Fuel reticulations shall be above ground

However, if the site were to be developed for residential use, a full dolomitic survey will be required.

5. RECOMMENDATIONS

Ground conditions on the site are suited to normal spread foundations at a nominal depth of 0.5m. A bearing capacity of 50kPa may be taken for foundations at this depth.

Shoring and/or battering of trench excavations deeper than 1.2m will be required.

The ferricrete classifies as >G9, and therefore, is not suitable for layerworks in pavement construction. Furthermore, the ferricrete does not meet the criteria for use as unpaved road construction, in accordance with Clause 3.3 in TRH20 (1990), due to the amount of fine material within the soil. Therefore, materials for use in layerworks or surfacing gravel will have to be imported onto the site.

Precautions associated with dolomitic site classification D2/D3 must be adopted, as described above.

6. CLOSING

We trust that this report will assist you in the design and construction of the proposed project. **Vela VKE** appreciate the opportunity of providing our services on this project and look forward to working with you on future projects.

Should you have any questions, please do not hesitate to contact us.

Respectfully submitted,

Vela VKE *Consulting Engineers (Pty) Ltd*

7. REFERENCES

1. 1:250 000 Geological Sheet, 2628 East Rand, Council for Geoscience. Pretoria 1986.
2. SABS 1200; "*Code of practice for use with standardised specifications for civil engineering construction and contract documents*". Second revision, SABS Pretoria, 1986.
3. AEG, SAICE AND SAIEG. "*Guidelines for Soil and Rock Logging in South Africa".* 2nd Impression 2001, eds. A.B.A. Brink and R.M.H. Bruin, Proceedings, Geoterminology Workshop. Johannesburg 2001.
4. SANS 10161-1980; "*Code of Practice for the Design of Foundations for Buildings*". SABS Pretoria, 1980. Including 3 amendments to the code to 13 March 1986.
5. TRH20 (1990); The Structural Design, Construction and Maintenance of Unpaved Roads.
6. VAN DER MERWE D.H. "*The prediction of heave from the plasticity index and percentage clay fraction of soils*". SAICE 1964
7. SANS 1936; "Development of Dolomite Land". SABS Pretoria, 2009.

Appendix

Limitations

1. It should be noted that all test pits excavated have only been lightly backfilled. Where necessary, tests pits should be re-excavated and suitably backfilled with compaction provided which is appropriate for the support/loads required.

2. Trees with large roots may have to be removed from the site in order to facilitate development. Care should be taken to ensure that the underlying soils in such areas, disturbed during the removal of the roots, are not left untreated to the extent that this negatively impacts on the development. All disturbed soil should be removed and replaced with suitably compacted, engineered fill, capable of supporting envisaged loads.

3. This investigation has been performed primarily for provision of preliminary design parameters. A general outline of ground conditions is thus provided. However, for further site-specific foundation inspections the site will have to be opened up. This is recommended as it allows for the verification of final, for-construction details which may vary and influence individual structure footprints and particular structural requirements.

   It is, therefore, recommended that this Practice be appointed to inspect the earthworks, service trenches and foundation excavations during construction. Periodic inspection of the site will allow confirmation of the recommendations given in this report and any change from the anticipated conditions can then be taken into account timeously.

4. Vela VKE should be allowed the opportunity to review the geotechnical aspects of plans and specifications prior to construction, to allow confirmation of the correct interpretation of the recommendations provided in this report.

5. Foundation, earthworks, underground construction and pavement construction should be undertaken only with full time monitoring by qualified personnel.

6. The conclusions and recommendations submitted in this report is based on data obtained from a limited number of widely spaced subsurface explorations. The nature and extent of variations between these may not become evident until construction or further investigation. If variations or other latent conditions do become evident, it will be necessary to re-evaluate the recommendations of this report.

7. The recommendations contained herein are not intended to dictate construction methods or sequences. They are furnished to help designers identify potential construction problems related to foundation and earth plans and specifications.

   Recommendations may also be useful to personnel who observe construction activity. Potential contractors for the project must evaluate potential construction problems on the basis of their review of the contract documents, their own knowledge of and experience in the local area, and on the basis of similar projects in other localities, taking into account their own proposed methods and procedures.

8. The Scope of Services did not include any environmental assessment for the presence of or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater, or air, on or below or around this site. Any comments made in this regard are for the information of the client.

Appendix

B

Trial Pit Profiles

TRIAL PIT LOG

CLIENT: Shangoni Management Services
PROJECT: Eloff Erf 174 & 175, Delmas
PROJECT NO: PJ096/KNP

HOLE NO: DT/01
X COORD: 2,893,427
Y COORD: Lo29 37,649
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
		Loose to medium dense, silty SAND Slightly moist, brown, topsoil.	
	0.30		
0.5		**Loose, clayey, sandy SILT** Moist, yellow/brown, transported.	
1.0	1.20		
		Refusal on hardpan ferricrete	
		End of Log	
1.5			
2.0			
2.5			
3.0			

NOTES 1: No seepage
2: Sample DT/01/1 at 0.3 - 1.2m
3: DCP at 0.7m
4:

MACHINE: CAT 428B
DIAM: Trench
FILE REF: PJ096/reports/KNP

DATE PROFILED: 16 September 2011
PROFILED BY: rr

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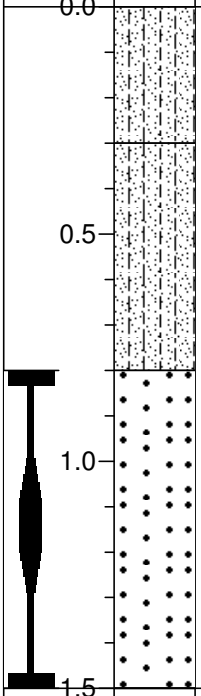
TRIAL PIT LOG

CLIENT: Shangoni Management Services
PROJECT: Eloff Erf 174 & 175, Delmas
PROJECT NO: PJ096/KNP

HOLE NO: DT/02
X COORD: 2,893,380
Y COORD: Lo29 37,660
ELEVATION:



	Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.00	Ground Surface	
0.00 – 0.30	**Loose to medium dense, silty SAND** Slightly moist, brown, topsoil.	
0.30 – 0.80	**Loose, slightly clayey, silty SAND** Moist, yellow/brown, transported.	
0.80 – 1.50	**Very weakly to weakly cemented FERRICRETE** Moist, grey/orange, mottled, clayey sand matrix.	
1.50	**Refusal on strongly cemented ferricrete**	
	End of Log	

NOTES 1: No seepage
2: Sample DT/02/1 at 0.8 - 1.5m
3:
4:

MACHINE: CAT 428B
DIAM: Trench
FILE REF: PJ096/reports/KNP

DATE PROFILED: 16 September 2011
PROFILED BY: rr

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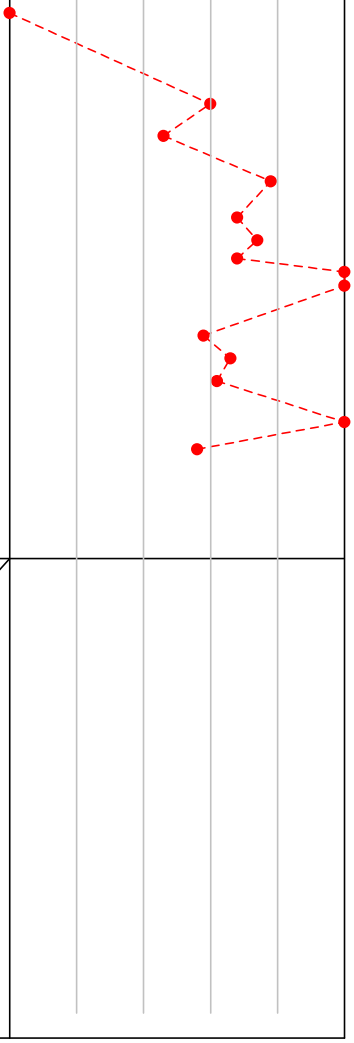
TRIAL PIT LOG

CLIENT: Shangoni Management Services
PROJECT: Eloff Erf 174 & 175, Delmas
PROJECT NO: PJ096/KNP

HOLE NO: DT/03
X COORD: 2,893,388
Y COORD: Lo29 37,696
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
		Loose to medium dense, silty SAND Slightly moist, brown, topsoil.	
	0.30		
0.5		**Loose to medium dense, silty SAND** Moist, yellow/brown, transported.	
	0.70		
1.0		**Weakly to cemented FERRICRETE** Moist, orange/grey, mottled, clayey sand matrix.	
1.5			
2.0	2.00	**Test pit stopped at required depth**	
		End of Log	
2.5			
3.0			



NOTES 1: No seepage
2: No samples
3: DCP at 0.8m
4:

MACHINE: CAT 428B
DIAM: Trench
FILE REF: PJ096/reports/KNP

DATE PROFILED: 16 September 2011
PROFILED BY: rr

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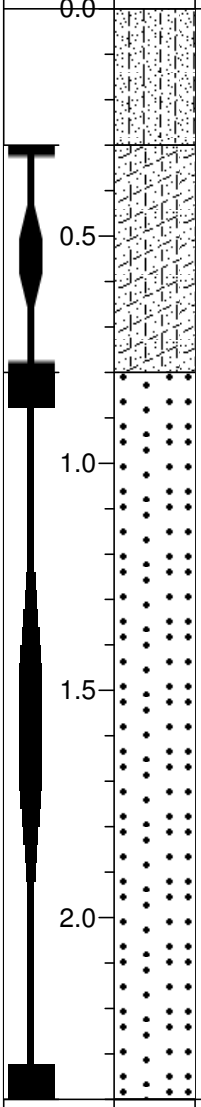
TRIAL PIT LOG

CLIENT: Shangoni Management Services
PROJECT: Eloff Erf 174 & 175, Delmas
PROJECT NO: PJ096/KNP

HOLE NO: DT/04
X COORD: 2,893,429
Y COORD: Lo29 37,689
ELEVATION:



	Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.00	Ground Surface	
0.00 – 0.30	**Loose to medium dense, silty SAND** Slightly moist, brown, topsoil.	
0.30 – 0.80	**Loose to medium dense, clayey, silty SAND** Moist, yellow/brown, transported.	
0.80 – 2.40	**Weakly to cemented FERRICRETE** Moist, orange/grey, mottled, clayey sand matrix.	
2.40	**Test pit stopped at required depth** End of Log	

NOTES 1: No seepage
2: Samples DT/04/1 at 0.3 - 0.8m; DT/04/2 at 0.8 - 2.4m
3:
4:

MACHINE: CAT 428B
DIAM: Trench
FILE REF: PJ096/reports/KNP

DATE PROFILED: 16 September 2011
PROFILED BY: rr

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Appendix

Profiling and Logging Parameters

1. SOIL DESCRIPTIVE TERMS

DESCRIPTIVE ORDER: 1. CONSISTENCY 2. SOIL TYPE 3. MOISTURE CONDITION 4. COLOUR 5. SOIL STRUCTURE 6. ORIGIN

1.(a) CONSISTENCY: GRANULAR SOILS

S P T "N" (sat.)	GRAVELS & SANDS Generally free draining soils. Cohesionless materials		TYPICAL DRY DENSITY (kg/m^3)
< 4	VERY LOOSE	Crumbles very easily when scraped with geological pick	< 1450
4-10	LOOSE	Small resistance to penetration by sharp pick point	1450-1600
10-30	MEDIUM DENSE	Considerable resistance to penetration by sharp pick point	1600-1750
30-50	DENSE	V. high resistance to penetration by sharp pick point. Requires many blows of pick for excavation	1750-1925
> 50	VERY DENSE	High resistance to repeated blows of geological pick. Requires power tools for excavation	> 1925

1(b) CONSISTENCY: COHESIVE SOILS

S P T "N" (saturated)		SILTS & CLAYS and combinations with sand. Generally slow draining soils		UCS (kPa)
Sens.	Insens.			
< 2	<5	VERY SOFT	Pick point easily pushed in 100mm. Easily moulded by fingers	< 50
2-4	5 – 10	SOFT	Pick point pushed in 30-40mm. Moulded with some pressure. Easily penetrated by thumb.	50-125
5-8	11 - 25	FIRM	Pick point penetrates 0 - 10mm. Very difficult to mould. Just indented by thumb. Spade just penetrates.	125-500
9-15	26 - 50	STIFF	Slight indentation pushing in pick point. Cannot be moulded. Thumbnail penetrates. Excavate with pick.	250-500
16-30	51 - 80	VERY STIFF	Slight indentation by blow of pick point. Requires power tools for excavation.	500-1000

2. SOIL TYPE

SOIL TYPE	PARTICLE SIZE (mm)
CLAY	< 0,002
SILT	0,002 – 0,06
SAND - fine	0,06 – 0,2
SAND - medium	0.2 – 0.6
SAND - coarse	0.6 – 2
GRAVEL - fine	2 – 6*
GRAVEL - medium	6 – 20*
GRAVEL - coarse	20 – 60*
COBBLES	60 – 200*
BOULDERS	> 200*

* Specify ave/max sizes, hardness, shape and proportion

3. MOISTURE CONDITION

DRY	No water detectable
SLIGHTLY MOIST	Water just discernable
MOIST	Water easily discernable
VERY MOIST	Water can be squeezed out
WET	Generally below the water table

4. COLOUR

Described at natural moisture content, as seen in profile.

SPECKLED	Very small patches of colour < 2 mm
MOTTLED	Irregular patches of colour 2 – 6 mm
BLOTCHED	Large irregular patches 6 – 20 mm
BANDED	Approximately parallel bands of varying colour
STREAKED	Randomly orientated streaks of colour
STAINED	Local colour variations: associated with discontinuity surfaces
Described using bedding thickness criteria. (e.g. thickly banded, thinly streaked, etc. – see Rock Logging Terms)	

5. SOIL STRUCTURE

INTACT	No structure present
FISSURED	Presence of discontinuities, open or closed, stained or unstained
SLICKENSIDED	Very smooth or glossy, often striated discontinuity planes
SHATTERED	Presence of open fissures. Soil breaks into gravel size blocks
MICRO-SHATTERED	Small scale shattering, very closely spaced open fissures. Soil breaks into sand size crumbs
RESIDUAL STRUCTURES	Relict bedding, lamination, foliation, etc.
PINHOLED	Voids or pores (<2mm), hand lens required?
HONEYCOMBED	Similar to pinholed but >2mm (specify size)
SUPPORTED	Matrix – clasts supported by matrix Clast – Clasts touching (with/without matrix)

6. ORIGIN

TRANSPORTED	Alluvium, hillwash, talus, etc.
RESIDUAL	Weathered from parent rock e.g. residual granite
PEDOCRETES	Ferricrete, laterite, silcrete, calcrete, etc.

DEGREE OF CEMENTATION OF PEDOCRETES		UCS (MPa)
VERY WEAKLY CEMENTED	Some material can be crumbled between finger and thumb. Disintegrates under knife blade to a friable state.	0,1 – 0,5
WEAKLY CEMENTED	Cannot be crumbled between strong fingers. Some material can be crumbled by strong pressure between thumb and hard surface. Under light hammer blows disintegrates to friable state.	0,5 – 2
CEMENTED	Material crumbles under firm blows of sharp pick point. Grains can be dislodged with some difficulty by a knife blade.	2 – 5
STRONGLY CEMENTED	Firm blows of sharp pick point on hand-held specimen show 1-3mm indentations. Grains cannot be dislodged by knife blade.	5 – 10
VERY STRONGLY CEMENTED	Hand-held specimen can be broken by single firm blow of hammerhead. Similar appearance to concrete.	10 - 25

REFERENCE: AEG, SAICE and SAIEG. "*Guidelines for Soil and Rock Logging in South Africa".* editors A.B.A. Brink and R.M.H. Bruin; Proceedings, Geoterminology Workshop. Johannesburg 2001.

VELA VKE

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2. ROCK DESCRIPTIVE TERMS

DESCRIPTIVE ORDER: 1. HARDNESS 2. ROCK TYPE 3. WEATHERING 4. COLOUR 5. FRACTURE SPACING 6. DISCONTINUITY SURFACE DESCRIPTION 7. GRAIN SIZE 8. STRATIGRAPHIC UNIT

1. ROCK HARDNESS

HARDNESS	DESCRIPTION	UCS (MPa)
VERY SOFT	Material crumbles under firm blows of pick point. Can be peeled with a knife. SPT refusal. Too hard to cut triaxial sample by hand	1 – 3
SOFT ROCK	Firm blows with pick point: 2-4mm indents. Can just be scraped with a knife	3 - 10
MEDIUM HARD ROCK	Firm blows of pick head will break hand-held specimen. Cannot be scraped or peeled with a knife.	10 - 25

HARDNESS	DESCRIPTION	UCS (MPa)
HARD ROCK	Breaks with difficulty, rings when struck Point load or laboratory test results necessary to distinguish between categories.	25 – 70
VERY HARD ROCK+	***+ In the absence of any of the above tests, it must be accepted that any rock described as "hard" or "very hard" rock can and may include rock of greater hardness.***	70 – 200
EXTREMELY HARD ROCK+		> 200

2. ROCK TYPE

Quartzite, sandstone, granite, limestone, etc.

4. COLOUR

Described in dry state unless otherwise indicated

3. WEATHERING

DEGREE OF WEATHERING	EXTENT OF DISCOLOURATION	FRACTURE CONDITION	SURFACE CHARACTERISTICS	ORIG. FABRIC	GRAIN BOUNDARY CONDITION
UNWEATHERED	None	Closed or stained	Unchanged	Preserved	Tight
SLIGHTLY WEATHERED	< 20% of fracture spacing on both sides of fracture	Discoloured, may contain thin filling	Partial discolouration. Often unweathered rock colour	Preserved	Tight
MODERATELY WEATHERED	>20% of fracture spacing on both side of fracture	Discoloured, may contain filling	Partial/complete discolour-ation. Not friable, except poorly cemented rocks	Preserved	Partial opening
HIGHLY WEATHERED	Throughout	-	Friable, possibly pitted	Mainly preserved	Partial separation. Not easily indented with knife. Does not slake in water.
COMPLETELY WEATHERED	Throughout	-	Resembles a soil	Partially preserved	Complete separation. Easily indented with knife. Slakes in water.

5. DISCONTINUITY SPACING

SEPARATION (mm)	SPACING (foliation, cleavage, bedding, etc.)	SPACING (fractures, joints, etc.)
< 6	very intensely	very highly
6 – 20	intensely	
20 – 60	very thinly	highly
60 – 200	thinly	
200 – 600	medium	moderately
600 – 2000	thickly	slightly
> 2000	very thickly	very slightly

6.1 JOINT FILLING

JOINT FILL TYPE	DEFINITION (wall separation specified in mm)
CLEAN	No fracture filling
STAINED	Colouration of rock only. No recognisable filling material
FILLED	Fracture filled with finite thickness filling material

6.2 DISCONTINUITY ORIENTATION

Discontinuity inclinations (i.e. of joints, bedding, faults) relative to down-axis of core (ie. 90° = vertical 0° = horizontal).
For oriented core, true azimuths given.

6.3 ROUGHNESS OF DISCONTINUITY PLANES

CLASSIFICATION	DESCRIPTION
SMOOTH	Appears smooth and is essentially smooth to the touch. May be slickensided *
SLIGHTLY ROUGH	Asperities on the fracture surface are visible and can be distinctly felt
MEDIUM ROUGH	Asperities are clearly visible and fracture surface feels abrasive
ROUGH	Large angular asperities can be seen. Some ridge and high side angle steps evident
VERY ROUGH	Near vertical steps and ridges occur on the fracture surface

* Where slickensides occur, their direction should be recorded

7. GRAIN SIZE

CLASSIFICATION	SIZE (mm)	RECOGNITION
VERY FINE GRAINED	< 0.2	Individual grains cannot be seen with a hand lens
FINE GRAINED	0.2 – 0.6	Just visible as individual grains under hand lens
MEDIUM GRAINED	0.6 – 2	Grains clearly visible under hand lens, just visible to the naked eye
COARSE GRAINED	2 – 6	Grains clearly visible to the naked eye
VERY COARSE GRAINED	> 6	Grains measurable

8. STRATIGRPHIC UNIT

Hekpoort Andesite Formation, Halfway House Granite, etc

REFERENCE: AEG, SAICE and SAIEG. "*Guidelines for Soil and Rock Logging in South Africa".* editors A.B.A. Brink and R.M.H. Bruin; Proceedings, Geoterminology Workshop. Johannesburg 2001.

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Appendix

D

Laboratory Test Results

SOIL ANALYSIS BY ..... : SOILLAB (Pty) Ltd
Lab reference No. ..... : S11-0985

Date Printed : 2011-10-14

Customer ..... : VELA VKE GEOTECHNICAL
Job Description ..... : ELOFF ERF 174+175, DELMAS
Road Number ..... :

Job Number ..... : S11-0985
Contract Number .... :
Date ..... : 2011-09-20

SAMPLE DESCRIPTION	
Sample Number	48739
Sample Position	DT/02
Sample Depth (mm)	800-1500
Material Description	DARK RED ORANGE FERRICRETE SANDY CLAY
Max size of boulder (mm)	-
SCREEN ANALYSIS (% PASS)	
75,00 mm	100
63,00 mm	100
53,00 mm	100
37,50 mm	100
26,50 mm	100
19,00 mm	100
13,20 mm	99
4,750 mm	89
2,000 mm	86
0,425 mm	79
0,075 mm	57
SOIL MORTAR	
Coarse Sand 2,000-0,425	8
Coarse Fine Sd 0,425-0,250	11
Medium Fine Sd 0,250-0,150	12
Fine Fine Sand 0,150-0,075	4
Material <0,075	65
CONSTANTS	
Grading Modulus	0.78
Liquid Limit	27
Plasticity Index	13
Linear Shrinkage (%)	6.0
Sand Equivalent	
Classification - TRB	A-6 (6)
Classification - COLTO	>G9
CBR / UCS VALUES	CBR
MOD. AASHTO	
Max Dry Density (kg/m³)	1932
Optimum Moisture Cont (%) ...	11.8
Moulding Moisture Cont (%) ...	12.3
Dry Density (kg/m³)	1916
% of Max Dry Density	99.2
100% Mod CBR/UCS	51
% Swell	0.1
NRB	
Dry Density (kg/m³)	1812
% of Max Dry Density	93.8
100% NRB CBR/UCS	24
% Swell	0.2
PROCTOR	
Dry Density (kg/m³)	1710
% of Max Dry Density	88.5
100% Proc CBR/UCS	9
% Swell	0.1
CBR / UCS VALUES	
100% Mod AASHTO	57
98% Mod AASHTO	43
97% Mod AASHTO	38
95% Mod AASHTO	28
93% Mod AASHTO	21
90% Mod AASHTO	12
Soillab No.	S11-0985-02

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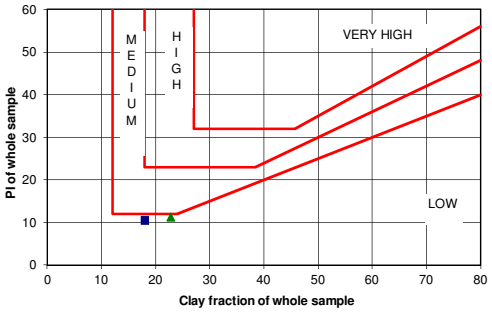
Reg No 1971/000112/07
230 Albertus Street
La Montagne
Tel (012) 481-3801
P O Box 72928
Lynnwood Ridge 0040
Fax (012) 481-3812

PARTICLE SIZE ANALYSIS

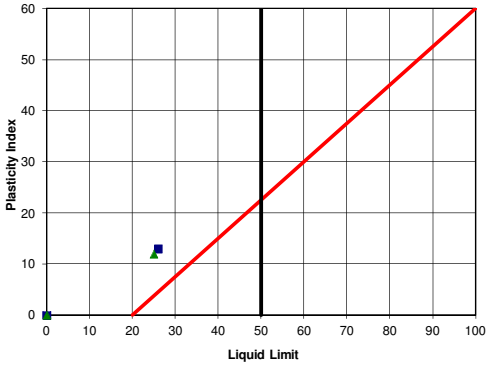
Sample No.		
Soillab sample no.	S11-0985-3	S11-0985-4
Depth (m)	0.3-0.8	0.8-2.4
Position	DT/04	DT/04
Material Description	DARK RED ORANGE FERRICRETE SILTY SAND	DARK RED ORANGE SILTY SAND
Moisture (%)		
Dispersion %		
SCREEN ANALYSIS (% PASSING) **(TMH 1 A1(a) & A5)**		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	100	100
26.5 mm	100	100
19.0 mm	100	100
13.2 mm	100	100
4.75 mm	91	100
2.00 mm	87	100
0.425 mm	82	95
0.075 mm	54	69
HYDROMETER ANALYSIS (% PASSING) **(TMH 1 A6)**		
0.040 mm	41	42
0.027 mm	36	38
0.013 mm	31	34
0.005 mm	21	28
0.002 mm	18	23
% Clay	18	23
% Silt	30	34
% Sand	39	43
% Gravel	13	0
ATTERBERG LIMITS **(TMH 1 A2 - A4)**		
Liquid Limit	26	25
Plasticity Index	13	12
Linear Shrinkage (%)	6.0	6.0
Grading Modulus	0.77	0.37
Uniformity coefficient	-	-
Coefficient of curvature	-	-
Classification	A-6 (4)	A-6 (5)
Unified Classification	CL	CL
Chart Reference		

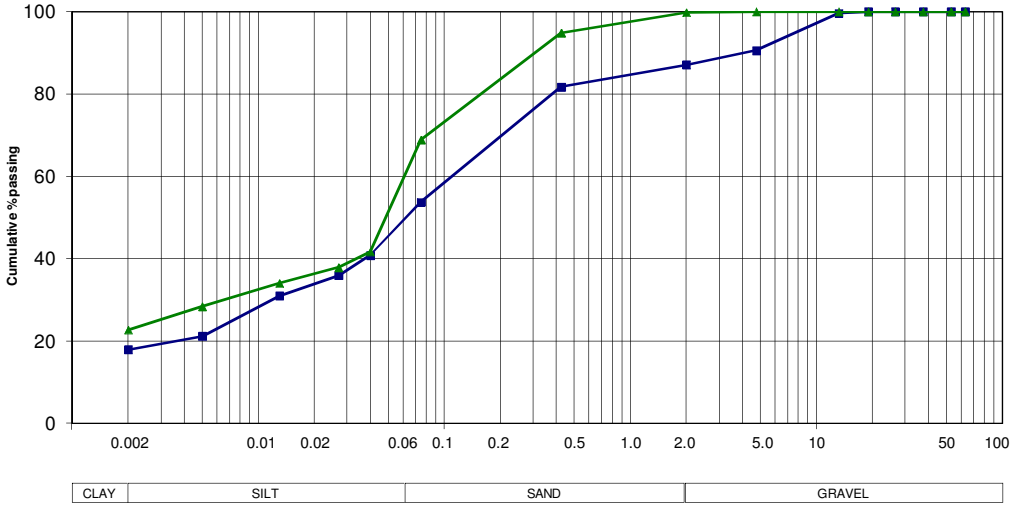
PROJECT : ELOFF ERF 174+175, DELMAS
JOB No. : S11-0985
DATE : 2011-09-20

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





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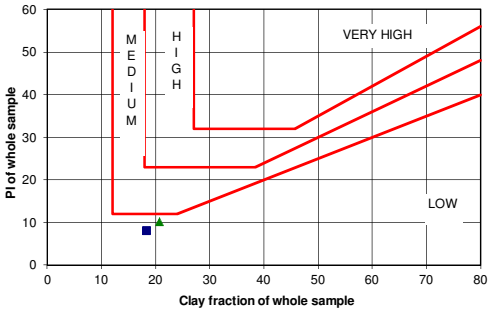
230 Albertus Street
La Montagne 0184
Tel (012) 481-3999
P O Box 72928
Lynnwood Ridge 0040
Fax (012) 481-3812

PARTICLE SIZE ANALYSIS

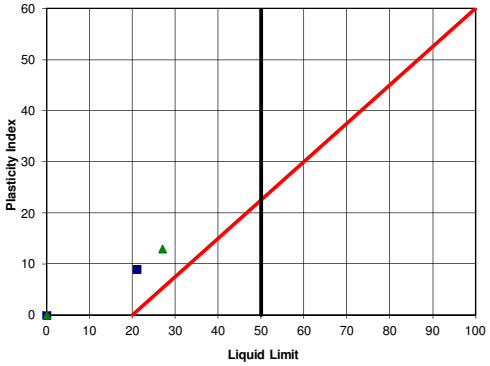
Sample No.		
Soillab sample no.	S11-0985-1	S11-0985-2
Depth (m)	0.3-1.2	0.8-1.5
Position	DT/01	DT/02
Material Description	DARK YELLOW FERRICRETE SILTY SAND	DARK RED ORANGE FERRICRETE SILTY SAND
Moisture (%)		
Dispersion %		
SCREEN ANALYSIS (% PASSING) **(TMH 1 A1(a) & A5)**		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	100	100
26.5 mm	100	100
19.0 mm	100	100
13.2 mm	100	99
4.75 mm	99	89
2.00 mm	96	86
0.425 mm	91	79
0.075 mm	55	57
HYDROMETER ANALYSIS (% PASSING) **(TMH 1 A6)**		
0.040 mm	46	41
0.027 mm	40	37
0.013 mm	35	30
0.005 mm	27	27
0.002 mm	18	21
% Clay	18	21
% Silt	33	29
% Sand	46	36
% Gravel	4	14
ATTERBERG LIMITS **(TMH 1 A2 - A4)**		
Liquid Limit	21	27
Plasticity Index	9	13
Linear Shrinkage (%)	4.0	6.0
Grading Modulus	0.58	0.78
Uniformity coefficient	-	-
Coefficient of curvature	-	-
Classification	A-4 (2)	A-6 (6)
Unified Classification	CL	CL
Chart Reference		

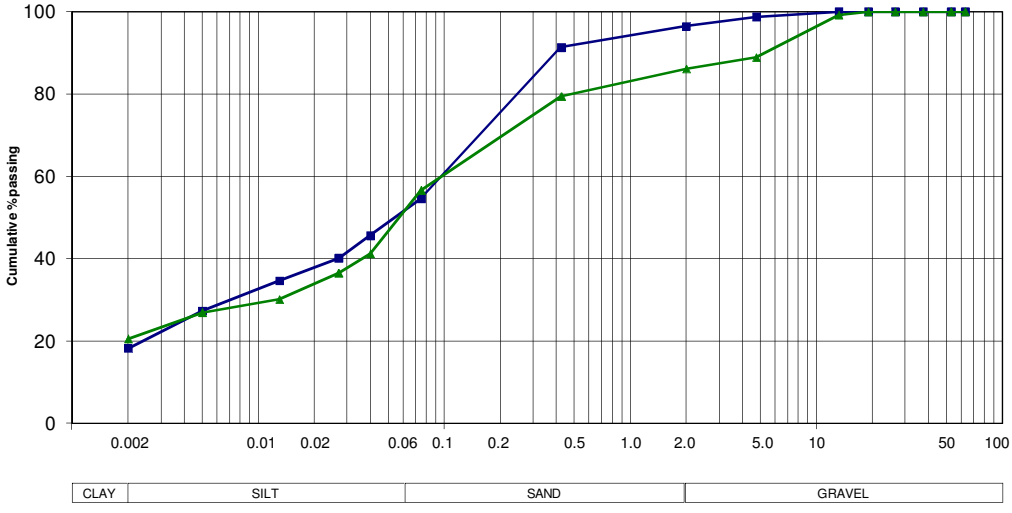
PROJECT : ELOFF ERF 174+175, DELMAS
JOB No. : S11-0985
DATE : 2011-09-20

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





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Lynnwood Ridge 0040
Fax (012) 481-3812

CLIENT : VELA VKE GEOTECH

PROJECT : ELOFF ERF 174+175, DELMAS

PROJECT NO. : S11-0985

DATE : 2011-10-14

pH & CONDUCTIVITY - TMH 1 A20 & A21T

Soillab No.	Sample Position	pH	Electrical Conductivity S/m
S11-0985-01	DT01	4.97	0.0202
S11-0985-02	DT04	5.13	0.0147

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Appendix

Company Profile

Geotechnical Service

Company Profile

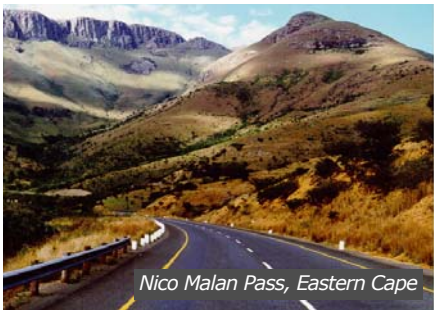
Incorporating Munyai Malaka Engineers

CATEGORIES OF COMPETENCE:

- **Airports**
- **Building Services**
- **Buildings, Stadiums and Industrial Structures**
- **Community, Institutional and Social Development**
- **Community Participation Facilitation**
- **Electrical – Bulk Supply and Reticulation**
- **Electronic Systems for Security, Fire Protection, Sound, PA, TV, etc**
- **Geotechnical Services**
- **Hydraulics, Hydrology and Catchment Assessment**
- **Integrated Environmental Management**
- **Labour-based Construction and Plant Hire**
- **Lighting for Buildings, Roads, Airports, Stadiums, etc.**
- **Materials Investigation and Pavement Design**
- **Municipal Services**
- **Railways**
- **Road Management Systems**
- **Roads and Bridges**
- **Traffic and Transportation**
- **Transaction Advisor – PPP's**
- **Tunnels and Underground Structures**
- **Urban and Regional Planning**

HISTORY

The Firm was founded in 1947 to provide consulting services in road and bridge design. However, the scope of activities and the fields of operations quickly expanded and by 1960 the company was providing comprehensive multidisciplinary services from offices located throughout Southern Africa.

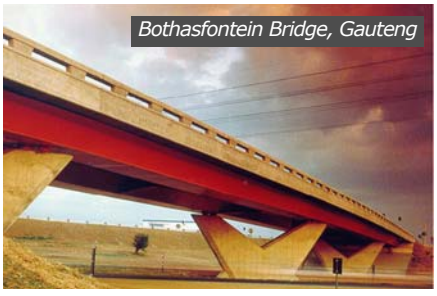


Nico Malan Pass, Eastern Cape

Over the years we have assisted several firms to become established in their own right with a wide range of employees and owners across all the communities and groups in Southern Africa.

Being an employee-owned enterprise with 30% of its ownership vesting in South African Previously Disadvantaged Individuals is reflected in the increased number of employees who have an interest in the firm - from 30 in 1998 to 160 in 2003. Our name and logo project us as the truly South African company we are. Our logo is an African motif symbolizing "life" and "humanity" and also represents the "Ubuntu" philosophy. This highlights the concept of unity and the belief that our people are at the heart of our success.

On the 1st of March, 2008 **Munyai Malaka Engineers**, a highly successful black-owned consulting engineering firm and ***Vela VKE***, merged. The merger was a natural and logical progression from the sense of mutual trust and respect developed through co-operation on successful major projects.



Bothasfontein Bridge, Gauteng

PERSONNEL

The Firm is part of the larger **VKE** Group, which is established throughout Southern Africa and has a staff complement of 550, many of which are professionally registered. The Firm has a stable workforce - many of the staff members have been with the company for over 15 years. This has ensured that experience gained on projects has remained within the company.

Cricket Stadium, Kingsmead

EXPERTISE

The Firm is multi-disciplinary with a wide range of competencies as illustrated in the left-hand column.

Every project is managed by a qualified Professional who, together with his team, ensures that each design is technically correct and optimised to suit the particular needs of both the client and the end user.

Four Level Interchange, Durban

AWARDS FOR EXCELLENCE

Our mission is "to be a preferred provider of appropriate technical solutions in the global environment which enhance the quality of life, ensure affordable sustainable development and enhance stakeholder value".

That the Firm delivers a superior service is demonstrated by the 52 prestigious awards which we have received from various professional societies. These include awards for:

- Most Outstanding Civil Engineering Achievement (7)
- Excellence in Civil Engineering (17)
- Excellence in the Use of Concrete (7)
- Other structural design awards (7)
- Sensitive Planning & Sympathetic Management of the Environment (2)
- Achievement in Community Based Projects (1)
- Excellence in the use of Masonry & Paving (4)
- Project Management Excellence (1)
- Design Award for Multi-Disciplinary Engineering (2)
- Excellence in the preparation of GIS data (1)
- Excellence in Consulting Engineering (1)
- Other miscellaneous awards (2)

PROVIDING A SUPERIOR SERVICE IN FULFILLING THE NEEDS OF ALL OUR CLIENTS

Company Profile (continued)

Incorporating Munyai Malaka Engineers

REGIONAL OFFICES

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Pretoria **South Africa**

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Fax : +27 (0)12 481 3850
e-mail : tautea@velavke.co.za
Website : www.velavke.co.za

LOCAL OFFICES
East London, George, Kimberley, Mossel Bay, Nelspruit, Polokwane, Port Elizabeth, Rustenburg

Contact details are obtainable from Group Head Office

CLIENT BASE & FIELD OF OPERATIONS

The Firm undertakes commissions from central and regional government, industry, commerce, private developers, international agencies and private individuals.

In Africa, our clients include governments and industrial and commercial concerns in:

- Angola
- Botswana
- D.R. Congo
- Kenya
- Lesotho
- Moçambique
- Namibia
- Nigeria
- South Africa
- Swaziland
- Tanzania
- Uganda
- Zambia

The Firm has also undertaken projects in other countries on occasion. In 2003 the Firm established an office in the USA.

In South Africa, the Firm has undertaken many major projects on behalf of Central Government and all nine Provincial Authorities. Many leading commercial and industrial companies also regularly use our services.


Royal Bafokeng Sports Palace

ASSOCIATIONS

In Southern Africa, the Firm works in close co-operation with the associated firm of **ZMCK** Consulting Engineers. **ZMCK** has offices in Zambia, where it was founded, Botswana, Lesotho and Swaziland. It has been operating for over 30 years in the fields of civil, structural, electrical and mechanical engineering.

The Firm is one of the four shareholders in **Consult 4 International**, a grouping of four leading South African firms of consulting engineers. **Consult 4** focuses on dams, tunnels and underground structures worldwide and is extensively involved in the US$ 1,0 billion Lesotho Highlands Water Project and in the Maguga Dam scheme in Swaziland.

We also have associations with several international consulting engineering firms and individual specialists whose particular expertise and experience can be called upon where appropriate.


VKE Centre, Pretoria

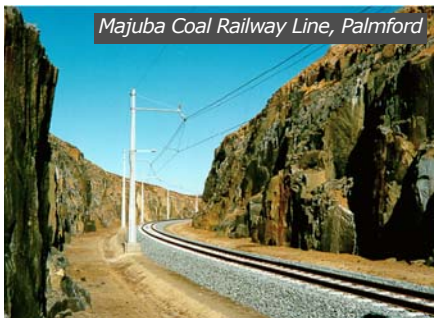
OFFICES

The Firm has active offices in 19 towns and cities around South Africa and Namibia. In other neighbouring states. The Firm operates through **ZMCK** offices located in Maseru (Lesotho), Mbabane (Swaziland), Lusaka and Kitwe (Zambia), and Gaborone (Botswana).


Lesotho Highlands Delivery Tunnel

QUALITY CONTROL ACCREDITATION

The Firm has adopted ISO 9001 procedures in carrying out all projects, and was fully accredited in terms of SABS ISO 9001 : 2000 on the 30th July 2004.


Majuba Coal Railway Line, Palmford

REGISTRATION

The Firm is registered with the following international funding agencies:

- World Bank
- African Development Bank
- European Union

MISSION STATEMENT

The Firm aims to be a preferred provider of appropriate technological solutions which:
*Enhance the quality of life *Ensure affordable sustainable development *Enhance stakeholder value