Geological and Geotechnical - Impact Assessment for Mabopane Cemetery

City of Tshwane Municipality

26 March 2015

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Keywords	Mabopane	Cemetery	Residual Granite
	Excavatibility	Environmental assessment	Sidewall stability

	Co-ordinates (UTM Zone 35, WGS84)	
	Latitude	Longitude
	25°28'45.437" S	28°1'17.653" E

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1 Introduction

Aurecon was appointed by City of Tshwane to conduct a geological and geotechnical assessment for the Basic Assessment phase of the proposed development. The project entails the extension of the existing Mabopane cemetery. The proposed site is currently operating as a cemetery however the burial site has reached a full capacity hence the need for expansion. The total property area is 305.31 hectares in extent of which the 18,5 hectares is full and therefore requires expansion. The proposed area of expansion measures approximately 44.76 hectares in extent.

The field visit was carried out by an Aurecon engineering geologist on 20 January 2015. The aim of this report is to provide an overview of the geological and geotechnical conditions which may contribute to environmental impacts of the proposed development.

The high level geotechnical assessment is required to identify potential geotechnical impacts and constraints on the proposed cemetery extension, as follows:

- Unstable sidewalls;
- Excavatability;
- Shallow groundwater; and
- Soil types with reference to their internal drainage characteristics.

The assessment for this study is based on a desk study and on observations made during the field investigation. The assessment relies on experience in cemetery geotechnical studies elsewhere in South Africa

2 Site locality and description

The site is located on the Remainder of Portion 33 of the farm Mabopane 702-JR, Mabopane, 60 km north of Pretoria in Gauteng Province. The sites are on the northwest of the existing cemetery. The existing cemetery occupies a total area of 31,8 hectares in extent.

The surface topography is relatively flat, sloping at approximately 1° SW. Vegetation cover consists predominantly of veld grass, a few small shrubs and trees on the site. On the SE of the site there is a borrow area which has a cutting of approximately 6m.

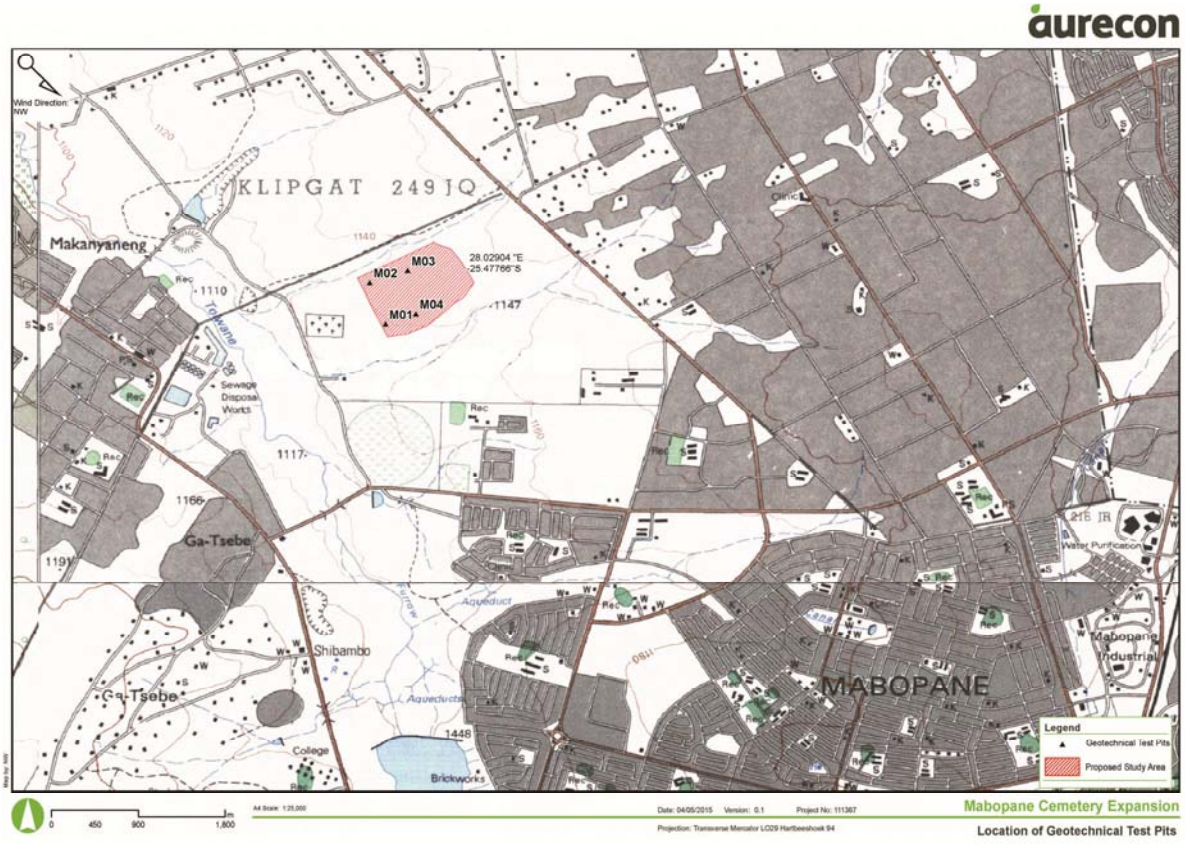


Figure 1: Showing the existing cemetery site and the proposed site

3 Climate

Mabopane normally receives about 464mm of rain per year, with most rainfall occurring during summer. It receives the lowest rainfall (0mm) in June and the highest (87mm) in January. The average midday temperatures for Mabopane range from 19.4°C in June to 28.7°C in January. The region is the coldest during July when the mercury drops to 2.1°C on average during the night.

The region is classified as having a climatic N-value (after Weinert, 1980) of about 2.5, which indicates a more humid part of the country. Chemical weathering is predominant in this part of the country.

4 Available information

At the time of the investigation the following information was available:

- The 1:250 000 scale geological map of the Pretoria Sheet 2528 (Council for Geoscience, 1986).
- The 1:50 000 scale soil land type map of the Pretoria Sheet 2528 (Soil and Research Institute, 1985).

5 Investigation methodology

The site investigation comprised excavation of four (4 No) test pits with a JCB 3CX excavator.

The test pit points were marked using a hand-held GPS, using the UTM grid and WGS84 datum. The locations of the test pits are presented in Table 1 and indicated in Figure 1.

A two-person team carried out the test pitting in order to comply with accepted safety requirements as reflected in the South African Code of Practice (SAICE: 2007). The test pits were profiled by an engineering geologist according to the method proposed in SANS 633 (2009). The test pits were excavated to the TLB machine refusal. The excavations were loosely backfilled after completion of soil profiling and sampling.

Representative samples were recovered and sent to Geostrada, an engineering materials laboratory in Pretoria, for testing.

Testing included the determination of physical soil parameters (comprising grading analyses – both sieve and hydrometer analyses – and Atterberg Limits).

The positions and depths of the test pits are also listed in Table 1. The detailed test pit logs are attached in Appendix B.

Table 1 Test Pit Summary

Test Pit No	Coordinates (UTM ZONE 35, WGS84)		Depth (m)	Remarks
	Easting	Southing		
M-01	603278	7181480	3.00	No Refusal
M-02	603097	7181810	3.00	No Refusal
M-03	603453	7181950	3.00	No Refusal
M-04	603609	7181675	3.00	No Refusal

6 General geology

According to the 1:250 000 geological map of the Pretoria Sheet 2528 (CGS, 1986), the proposed cemetery site is underlain by the rocks of the Lebowa Granite Suite, Bushveld complex. These rocks include grey to pink coarse grained granite as shown in Figure 2. Residual granite formed a prominent layer of the soil profile in the site.

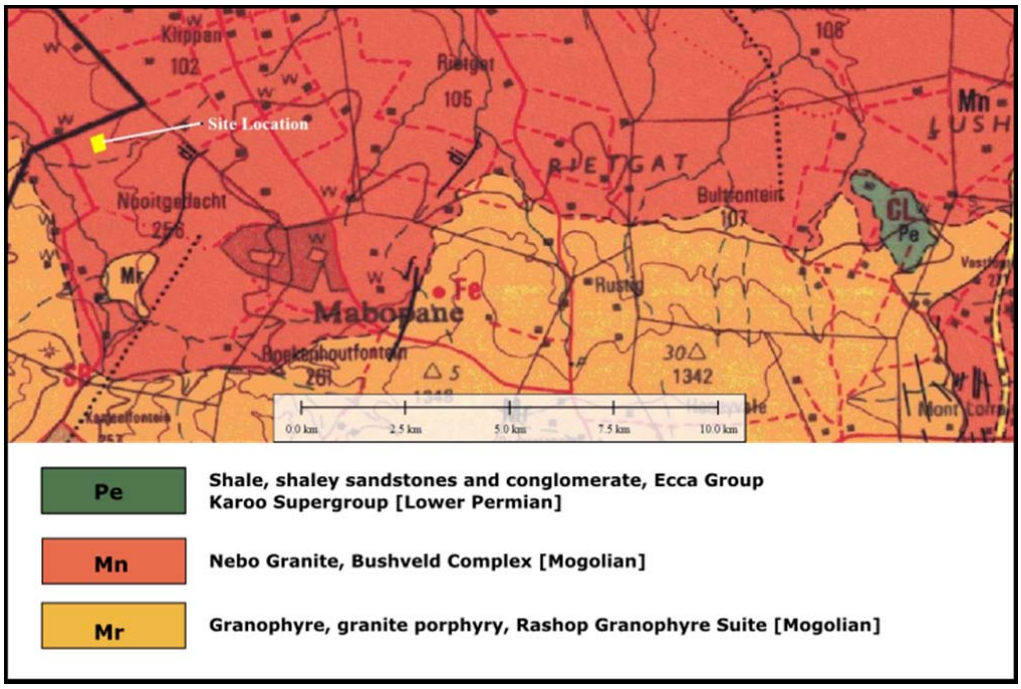


Figure 2: Showing the site geology Geological map of the site area (highlighted by yellow polygon) (Source: Council for Geoscience, 1978).

7 Results of investigation

The detailed descriptions of the soil profiles encountered in the test pits are presented in Appendix B; while the geological profiles are summarised in Table 2 below.

Table 2 Test Pit Profile Summary

Test Pit No	Topsoil (m)	Colluvium (m)	Residual Gabbro (m)
M-01	0-0,25	0,25-1,60	1,60-3,00
M-02	0-0,20	0,20-1,70	1,70-3,00
M-03	0-0,30	0,30-1,70	1,70-3,00
M-04	0-0,45	0,45-1,80	1,80-3,00

The geotechnical investigation revealed that the profile across the site comprises the following three horizons:

- Topsoil;
- Colluvium; and
- Residual Granite.

Each layer is described separately below.

7.1 Topsoil

The topsoil is classified as slightly moist, reddish brown, intact, silty clayey sand containing plant roots and is present across the entire site. It has an average thickness of approximately 0,30 m. The topsoil was profiled as having a general loose consistency.

7.2 Colluvium

The transported horizon underlies the top layer. It is evident from the test pits that this layer is also prevalent across the investigated site. The predominantly sandy layer is colluvial in origin, comprising slightly moist, reddish brown, intact, silty sand and abundant gravels. The horizon was profiled as having a generally medium dense consistency. The horizon has an average thickness of approximately 1,40 m.

7.3 Residual

The residual layer is also prevalent across the investigated site. The layer comprises of slightly ferrugined, slightly moist, pinkish brown to orangish brown, intact, silty sand. This horizon was profiled as having a generally dense consistency. The layer has a minimum thickness of 1,30 m and extends beyond depths of 3,00 m.

7.4 Moisture Conditions

No groundwater seepage was encountered in any of the test pits, and no surface evidence of shallow groundwater was observed.

8 Laboratory tests

8.1 Foundation Indicators

Representative samples were collected for laboratory testing at specific positions. The test results are attached in Appendix D and summarised in Table 3.

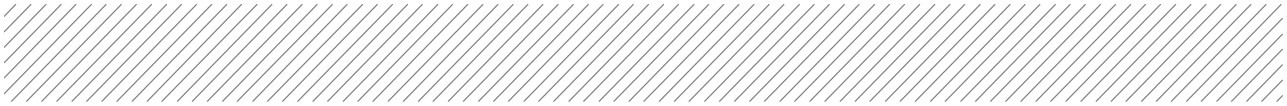
Table 3 Foundation Indicator Results for Mabopane

Sample No	Depth (m)	Soil Composition				GM	Atterberg Limits			Activity	Unified Soil Classification
		Clay (%)	Silt (%)	Sand (%)	Gravel (%)		LL (%)	WPI (%)	LS (%)		
Residual											
M04-1	0,45-1,80	11	11	34	44	1,83	31	5	7,0	Low	SC

Legend GM = Grading modulus
LL = Liquid Limit
WPI = Weighted Plasticity Index
LS = Linear Shrinkage
Activity = Potential expansiveness of the soil according to Van der Merwe's method (Van der Merwe, 1973)

Results for the tests carried out on the disturbed sample retrieved from the transported horizon are summarised in Table 3 above and further explained below:

The colluvial layer covering the site consists of gravelly sand with gravel content up to 44%. The layer has a very high grading modulus of 1,83. The fine fractions of this material also exhibit moderate (31,0 %) liquid limit as well as a moderate (7,0 %) linear shrinkage. The weighted plasticity index (WPI) of the soil is low, indicating that the material has low to non-plastic characteristics. The material has a low potential expansiveness, according to the method proposed by Van der Merwe (1973).



9 Geological / Geotechnical considerations

The objective of the proposed project was to assess the following geotechnical factors relevant to cemetery development:

- Sidewall Stability;
- Soil types with reference to permeability;
- Excavatability;
- The possible presence of shallow groundwater;
- Site topography

9.1 Sidewall Stability

Grave stability refers to the competence of the grave sides and the grave verge or lip. Stability is required for the following reasons: A period of a few days usually elapses after the excavation of a grave and the actual burial.

- At the time of burial many people move around the sides of the grave causing a disturbance.
- Excessive crumbling of the excavation verge may hinder the smooth lowering of a coffin.

Sidewalls of the test pits excavations were stable to 3.00 m maximum depth achieved during this investigation. Although this was the case, it is still advisable that the grave digger contractor should constantly assess sidewall safety on the site and provide shoring for deep excavations. However, shoring will be not necessary since graves are not more than 2.5 m deep.

9.2 Soil Types With Reference to Permeability

Information gathered through literature review showed that the site is general characterized by granite of the Lebowa Granite Suite, Bushveld complex. The main underlying rock formation of the project site is granite.

An analysis of field investigations at the project site revealed that there is thick soil layers, topsoil, colluvium and residual granite which extends to depths of 3,00 m. The soils are expected to exhibit good permeability.

9.3 Excavatibility

The ease at which the soil can be excavated is an important criteria in the selection of a site. The site is covered by a relatively thick soil layer, which is underlain by weathered granite. Grave digging to a depth of 2.5 m can be achieved without difficulty. The majority of cemetery sites use labour to dig the graves and hence it must be possible to excavate a hole to a depth of 2.5 m below ground level with a pick and shovel.

The excavation characteristics have been estimated from the performance of the TLB used for the investigation. Refusal was not encountered in any of the test pits, therefore “Soft Excavation” in terms of SABS 1200D can be expected from surface up to the investigation depths attained.

In places where the bedrock is near the surface excavation will require TLB.

9.4 Shallow seepage or groundwater level

At the time of investigation, no groundwater or seepage was encountered within the depth limits afforded by the TLB. However because of the observed ferruginisation, the presence of groundwater below the maximum depth of test pits and a perched water table within the gravelly sand residual horizon cannot be totally ruled out. The development of perched water tables as a consequence of sustained or intense rainfall periods also cannot be excluded.

9.5 Site Topography

The site is characterised by flat topography. The relatively flat topography may cause drainage problems as the flat topography promotes the ponding of water in the project area. Drainage of surface water would therefore need proper consideration.

According to Croukamp & Richards (2003) the maximum slope angle of the ground should be within 6° to 9°, from the horizontal, in order to enable human and mechanical mobility across the site and to minimize erosion potential. The proposed site meets this criterion as its slope angle is less than the norm.

It must also be noted that the proposed site is not located close to any main drainage features.

10 Conclusions and Recommendations

The recommendations included in this report relates only to the site that has been investigated. Based on the findings of hydrogeological, geological and water sources hydrocensus evaluation, the following conclusions have been reached: No geotechnical factors were found during this investigation that precludes a cemetery expansion on this site. The underlying residual soils are deep enough and grave walls are stable.

In the light of all the foregoing information it is our conclusion that the proposed cemetery site is suitable for cemetery expansion.

11 References

1. Croukamp, L. & Richards, N. P. 2003. Cemetery site investigation guidelines, Preliminary report, Council for Geoscience.

2. SABS 1200D:1988 Standardised specification for civil engineering construction. D: Earthworks, South African Bureau of Standards, Pretoria.

3. SANS [South African National Standards]. 2009. Profiling, and Percussion and Core Borehole Logging in Southern Africa for Engineering Purposes. South African Bureau of Standards. Draft SANS 633:2009. Pretoria.

4. South African Institution of Civil Engineering. Geotechnical Division. 2007. The Safety of Persons Working in Small Diameter Shafts and Test Pits for Geotechnical Engineering Purposes –Code of Practice, First Edition.2007.

5. Van der Merwe, DH. The prediction of heave from the plasticity index and the percentage of clay fraction of soil. The Civil Engineer in South Africa, p 103-107, June1973

Appendix A

SUMMARY OF STANDARD SOIL AND ROCK PROFILE DESCRIPTION TERMINOLOGY

STANDARD DESCRIPTIONS USED IN SOIL PROFILING

1. MOISTURE CONDITION

Term	Description
Dry	
Slightly moist	Requires addition of water to reach optimum moisture content for compaction
Moist	Near optimum content
Very Moist	Requires drying to attain optimum content
Wet	Fully saturated and generally below water table

2. COLOUR

The Predominant colours or colour combinations are described including secondary coloration described as banded, streaked, blotched, mottled, speckled or stained.

3. CONSISTENCY

3.1 Non-Cohesive Soils

Term	Description
Very Loose	Crumbles very easily when scraped with geological pick
Loose	Small resistance to penetration by sharp end of geological pick
Medium Dense	Considerable resistance to penetration by sharp end of geological pick
Dense	Very high resistance to penetration to sharp end of geological pick. Requires many blows of hand pick for excavation.
Very Dense	High resistance to repeated blows of geological pick. Requires power tools for excavation

3.2 Cohesive Soils

Term	Description
Very soft	Easily penetrated by thumb. Sharp end of pick can be pushed in 30 - 40mm. Easily moulded by fingers.
Soft	Pick head can easily be pushed into the shaft of handle. Moulded by fingers with some pressure.
Firm	Indented by thumb with effort. Sharp end of pick can be pushed in up to 10mm. Can just be penetrated with an ordinary spade.
Stiff	Penetrated by thumbnail. Slight indentation produced by pushing pick point into soil. Cannot be moulded by fingers. Requires hand pick for excavation.
Very Stiff	Indented by thumbnail. Slight indentation produced by blow of pick point. Requires power tools for excavation.

4. STRUCTURE

Term	Description
Intact	Absence of fissures or joints
Fissured	Presence of closed joints
Shattered	Presence of closely spaced air filled joints giving cubical fragments
Micro-shattered	Small scale shattering with shattered fragments the size of sand grains
Slickensided	Polished planar surfaces representing shear movement in soil
Bedded Foliated	Many residual soils show structures of parent rock.

5. SOIL TYPE

5.1 Particle Size

Term	Size (mm)
Boulder	>200
Pebbles	60 – 200
Gravel	60 – 2
Sand	2 – 0,06
Silt	0,06 – 0,002
Clay	<0,002

6. ORIGIN

6.1 Transported Soils

Term	Agency of Transportation
Colluvium	Gravity deposits
Talus	Scree or coarse colluvium
Hillwash	Fine colluvium
Alluvial	River deposits
Aeolian	Wind deposits
Littoral	Beach deposits
Estuarine	Tidal – river deposits
Lacustrine	Lake deposits

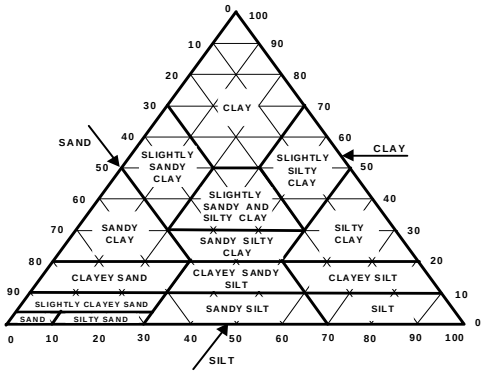
6.2 Residual soils

These are products of in situ weathering of rocks and are described as e.g. Residual Shale

6.3 Pedocretes

Formed in transported and residual soils etc.
calcrete, silcrete, manganocrete and ferricrete.

5.2 Soil Classification



SUMMARY OF DESCRIPTIONS USED IN ROCK CORE LOGGING

1. WEATHERING

Term	Symbol	Diagnostic Features
Residual Soil	W5	Rock is discoloured and completely changed to a soil in which original rock fabric is completely destroyed. There is a large change in volume.
Completely Weathered	W5	Rock is discoloured and changed to a soil but original fabric is mainly preserved. There may be occasional small corestones.
Highly Weathered	W4	Rock is discoloured, discontinuities may be open and have discoloured surfaces, and the original fabric of the rock near the discontinuities may be altered; alternation penetrates deeply inwards, but corestones are still present.
Moderately Weathered	W3	Rock is discoloured, discontinuities may be open and will have discoloured surfaces with alteration starting to penetrate inwards, intact rock is noticeably weaker than the fresh rock.
Slightly Weathered	W2	Rock may be slightly discoloured, particularly adjacent to discontinuities, which may be open and will have slightly discoloured surfaces, the intact rock is not noticeably weaker than the fresh rock.
Unweathered	W1	Parent rock showing no discolouration, loss of strength or any other weathering effects.

2. HARDNESS

Classification	Field Test	Compressive Strength Range MPa
Extremely Soft Rock	Easily peeled with a knife	<1
Very Soft Rock	Can be peeled with a knife. Material crumbles under firm blows with the sharp end of a geological pick.	1 to 3
Soft Rock	Can be scraped with a knife, indentation of 2 to 4 mm with firm blows of the pick point.	3 to 10
Medium Hard Rock	Cannot be scraped or peeled with a knife. Hand held specimen breaks with firm blows of the pick.	10 to 25
Hard Rock	Point load tests must be carried out in order to distinguish between these classifications	25 - 70
Very Hard Rock	These results may be verified by uniaxial compressive strength tests on selected samples.	70 - 200
Extremely Hard Rock		>200

3. COLOUR

The predominant colours or colour combination are described including secondary colouration described as banded, streaked, blotched, mottled, speckled or stained.

4. FABRIC

4.1 Grain Size

Term	Size (mm)
Very Coarse	>2,0
Coarse	0,6 – 2,0
Medium	0,2 – 0,6
Fine	0,06 – 0,2
Very Fine	< 0,06

4.2 Discontinuity Spacing

Description for: Bedding, foliation, laminations	Spacing (mm)	Descriptions for joints, faults, etc.
Very Thickly Bedded	> 2000	Very Widely
Thickly Bedded	600 – 2000	Widely
Medium Bedded	200 – 600	Medium
Thinly Bedded	60 – 200	Closely
Laminated	3 – 60	Very closely
Thinly Laminated	<3	

5. ROCK NAME

Classified in terms of origin:

IGNEOUS	Granite, Diorite, Gabbro, Syenite, , Dolerite, Trachyte, Andesite, Basalt.
METAMORPHIC	Slate, Felsite, Gneiss, Schist, Quartzite
SEDIMENTARY	Shale, Mudstone, Siltstone, Sandstone, Dolomite, Conglomerate, Tillite, Limestone.

6. STRATIGRAPHIC HORIZON

Identification of rock type in terms of stratigraphic horizons.

Appendix B

TEST PIT PROFILE DESCRIPTIONS

Appendix C

LABORATORY RESULTS

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