Crossman, Pape & Associates

Consulting Geotechnical Engineers & Engineering Geologists

P.O.Box 3557 Cramerview 2060. Tel: (011) 465-1699. Fax: (011) 465-4586. Cell 082 556 7302 & 076 966 8445

REPORT NO 15/119/D **AUGUST 2015**

GEOTECHNICAL INVESTIGATION FOR PROPOSED 10 MEGA LITRE WATER RESEVOIR CARLSWALD

1. INTRODUCTION AND NATURE OF DEVELOPMENT

At the request of Mrs. J Heera of Zitholele Consulting we have carried out a geotechnical investigation for the proposed Carlswald 10ML Resevoir Project, Midrand. Confirmation of our appointment to proceed with the investigation was received via a sub-consultant agreement from Zithole Consulting. Copies of the site locality plan as well as three site layout options were received to facilitate the investigation.

The proposed reservoir will comprise either a 50m diameter by 5,5m high circular concrete structure or two 35m diameter by 5,5m high circular concrete reservoirs. The exact layout and positioning of the reservoirs is still to be finalized. Exact earthworks details are unknown at this stage.

2. TERMS OF REFERENCE

The terms of reference for the investigation are as follows:

i) to establish the nature and relevant engineering properties of the upper soil and rock strata underlying the site.

ii) to comment on suitable excavation procedures for cut terrace excavations and for the installation of services.

iii) to present comments on the use of the on-site soils in the construction of bulk fill terraces and as layerworks for access roads / parking areas.

iv) to give foundation recommendations for the proposed reservoir(s).

v) to comment on any other geotechnical aspects that may affect the development.

3. SITE DESCRIPTION

The area of investigation occurs across the eastern portions of the area of open land to the east of the intersection of Whisken Avenue and Walton Road,

Carlswald. The site slopes moderately to the south and is covered by veld grass and large trees across the eastern portions of the site.

4. NATURE OF INVESTIGATION

4.1 Fieldwork

Six test pits (TP15 to TP20) were excavated across the site on 13 July 2015 using a Cat 422E tractor-loader-backhoe (backactor). The test pits were excavated to refusal or to the excavation limit of the machine. All test pits were profiled in situ by an engineering geologist and where necessary disturbed soil samples were obtained for laboratory testing. The positions of the test pits are shown on the site plan enclosed in Appendix A. Copies of the recorded test pit soil profiles are presented in Appendix B.

4.2 Laboratory Testing

The following laboratory tests are currently being carried out on the soil samples recovered from the test pits during the field investigation.

(i) Atterberg limits and particle size distribution analyses to determine basic engineering properties and to effect classification.

(ii) Moisture/density and California Bearing Ratio (CBR) tests to evaluate compaction and related strength characteristics.

(iii) Soil chemistry tests to determine the pH and electrical conductivity of the in situ soils.

The report will be suitably amended and resubmitted once the laboratory test results become available.

5. SITE GEOLOGY/SOIL PROFILE

Available geological maps indicate that the area of investigation is underlain by **granite** of the Johannesburg Granite Dome. This was confirmed during the current investigation. Residual soils have developed from the weathering of the granite bedrock. The general soil profile is described below.

The upper soil layer across the site comprises 0,3m to 0,4m of loose to medium dense intact silty sand of **transported hillwash** origin. The hillwash is underlain by loose to medium dense / medium dense intact silty sand with abundant quartz gravel. This gravel layer represents the **transported pebble marker**. The pebble marker extends to depths varying between 0,55m and 0,7m.

The pebble marker is underlain by medium dense and dense in places cemented and ferruginised silty sand **reworked residual granite.** The reworked residual granite extends to depths varying between 1,0m and 1,3m. Refusal of the backactor was obtained upon very dense reworked residual granite at 1,3m depth in test pit TP16. The reworked residual granite is underlain by medium dense to dense jointed silty sand **residual granite.** Refusal of the machine was obtained upon dense residual granite / very soft rock granite at depths varying between 1,0m and 2,3m (average depth 1,7m). The excavation limit of the backactor was obtained at 3,0m depth within the residual granite in test pit TP18.

No perched water table or zones of seepage were noted in any of the test pits excavated across the site.

6. EXCAVATION PROCEDURES

Excavation procedures for earthworks and for the installation of services have been evaluated according to the South African National Standards standardized classifications for excavations (SANS 1200D, DA & DB). According to this classification the area of investigation classifies as **soft excavation** to depths varying between 1,0m and 2,3m (average depth 1,7m).

Below these depths the site classifies as **intermediate excavation** material on very dense reworked / residual granite and/or very soft rock granite. The intermediate excavation material is envisaged to be of the order of 0,5m to 1,0m thick and could be removed using medium to heavy earthmoving equipment and / or power tools.

Hard rock excavation on granite bedrock is envisaged below the intermediate excavation material. The hard rock excavation material would require excavation by **blasting.**

An exception to the above was noted in the vicinity of test pit TP18 where the soft excavation material extends to depths in excess of 3,0m.

7. MATERIALS USAGE

Laboratory testing is currently being carried out on the upper soil layers to assess their suitability for use in the construction of bulk fill terraces and as layerworks for access roads / parking areas. However, based on a visual assessment from the fieldwork the following comments are considered pertinent to the on-site soils with regards to the above operations.

- The upper 150mm of in situ soils across the site contains abundant organic matter and is unsuitable for use as construction material. This material should be removed to spoil. It is envisaged that in the vicinity of the large trees,that

at least the upper 0,5m of in situ soil would have to be spoiled owing to the presence of abundant tree roots. This depth would have to be verified upon commencement of the site cleaning.

- The in situ soils (hillwash, pebble marker and reworked / residual granite) are suitable for use as general fill and selected layer material. Should these soils be required for use as subbase then they would have to be stabilised. Further laboratory testing would however have to be carried out to establish suitable stabilising agents and to optimize mix ratios.

8. EVALUATION OF FOUNDING CONDITIONS AND FOUNDATION RECOMMENDATIONS

8.1 Areas of Cut

The hillwash and pebble marker soils are considered to be potentially highly compressible / collapsible. These soil layers are thus unsuitable for use as founding layers, even for proposed lightly loaded structures.

An allowable bearing pressure of 200kPa could be utilized for the medium dense or better reworked / residual granite. These founding layers occur at depths varying between 0,55m and 0,7m below current ground level. Under the above load conditions total settlements of the order of 5mm to 10mm are envisaged. Differential settlements should be taken as 50% of the total settlements. Conventional strip / spread foundations could be employed for the proposed reservoir structure(s).

8.2 Areas of Fill

Consideration could be given to placing strip / spread foundations within engineered fill with the following provisos:

- The fill must be compacted in 150mm layers to 95% of Mod AASHTO density at optimum moisture content.

- Allowable bearing pressures must be limited to 150kPa.

- All hillwash and pebble marker soils would have to be removed in their entirety to stockpile below the footprint of the reservoir within areas of the fill and to 1,0m beyond the edge of the reservoir footprint. Levels must then be reinstated within this removed hillwash / pebble marker in 150mm layers to 95% of Mod AASHTO density at optimum moisture content. This would have to be undertaken to prevent the sphere of influence of the foundation load extending down into the underlying collapsible hillwash / compressible pebble marker.

- It is important that a **high degree of engineering quality control** is implemented on the site with regard to the recompaction of the hillwash and the overlying bulk fill. **Density testing** using a suitable calibrated nuclear gauge device (Troxler) should be carried out on all compacted layers. The natural moisture content of the soils should be determined by oven drying in a soils laboratory, that is, the Troxler device should not be used to determine the natural moisture content of the engineered fill material. It is recommended that the density testing be carried out by an **independent soils laboratory.**

9. ACCESS ROADS AND PARKING AREAS

The following comments are pertinent to the design and construction of the access roads and parking areas.

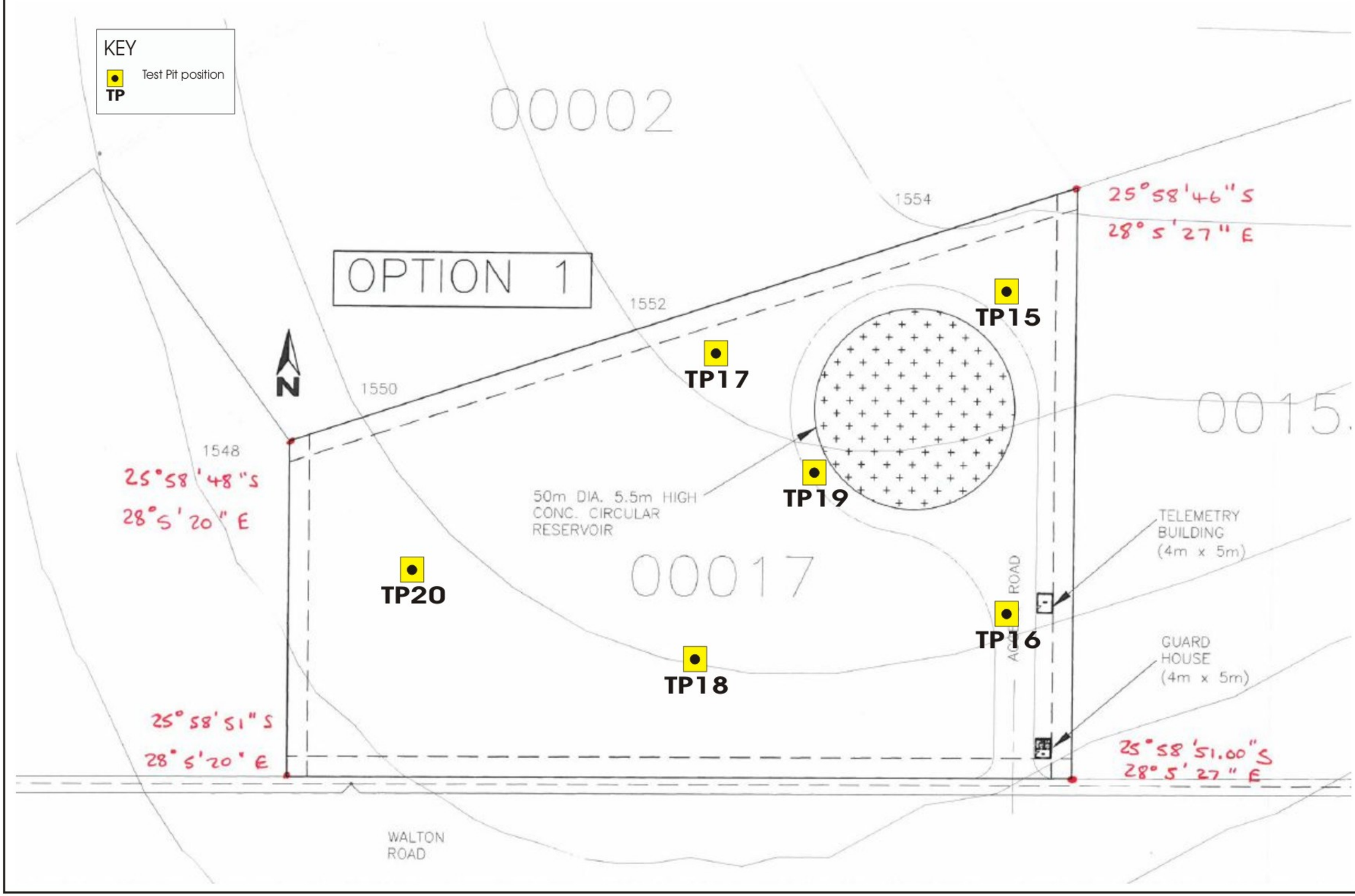
- For pavement design purposes, it is estimated that the upper in situ subgrade material would have a CBR of the order of 10 percent if compacted to 90% of Mod AASHTO density at optimum moisture content, and of the order of 15 percent if compacted to 93% of Mod AASHTO density at optimum moisture content.

- If access roads and parking areas comprise brick paving it is recommended that the layer immediately below the brick paving and bedding sand be stabilised. The purpose of the stabilised layer immediately below the bedding sand would be to seal the layerworks from stormwater ingress from ground surface.

M CROSSMAN Pr Eng **J DAVEL Pr.Sci.Nat**
CROSSMAN, PAPE & ASSOCIATES

APPENDIX A

SITE LAYOUT PLAN



PROJECT: 15/119/D
OML RESERVOIR CARSLWALD

SITE PLAN INDICATING
APPROXIMATE POSITIONS OF TEST PITS

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Scale: Not to scale

Date: AUGUST 2015

APPENDIX B

TEST PIT SOIL PROFILES

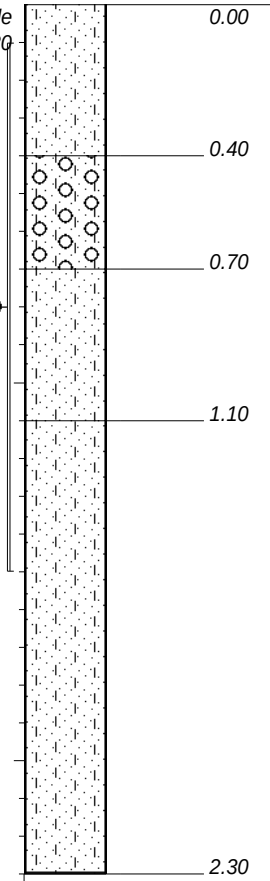
Crossman, Pape and Associates
Consulting Geotechnical Engineers and Engineering Geologists

Zitholele Consulting
10ML Resevoir Carlswald

HOLE No: TP15
Sheet 1 of 1

JOB NUMBER: 15/119/TP

Scale 1:20



0.00	Moist light brown loose to medium dense intact silty sand. Hillwash. Also contains abundant roots in the upper 0,15m.
0.40	As above but contains abundant fine to coarse quartz gravel. Pebble marker.
0.70	Moist mottled and blotched red orange brown medium dense cemented and ferruginised silty sand. Reworked residual granite.
1.10	Moist orange brown speckled yellow dark brown medium dense to dense jointed silty sand. Residual granite.
2.30	

NOTES

1) Refusal at 2,3m on very dense residual granite / very soft rock granite.

2) No evidence of water.

3) Disturbed sample taken at 0,1--1,5m.

CONTRACTOR :
MACHINE : Cat 522E
DRILLED BY :
PROFILED BY : Justin Davel

TYPE SET BY : Renee
SETUP FILE : STANDARD.SET

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DIAM :
DATE :
DATE : 17/07/2015

DATE : 06/08/2015 12:17
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ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TP15

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Zitholele Consulting
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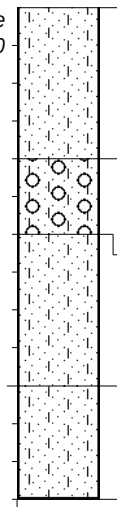
HOLE No: TP16
Sheet 1 of 1

JOB NUMBER: 15/119/TP

Scale 1:20



0.00	Slightly moist light brown loose to medium dense intact silty sand. Hillwash. Also contains abudant roots in the upper 0,15m.
0.40	As above but contains abundant fine to coarse quartz gravel. Pebble marker.
0.60	Moist orange brown mottled red brown grey medium dense cemented and ferruginised silty sand. Reworked residual granite.
1.00	As above but dense.
1.30	

NOTES

1) Refusal at 1,3m on very dense reworked residual granite.

2) No evidence of water.

CONTRACTOR :
MACHINE : Cat 522E
DRILLED BY :
PROFILED BY : Justin Davel
TYPE SET BY : Renee
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HOLE No: TP16

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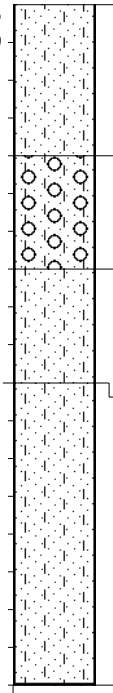
HOLE No: TP17
Sheet 1 of 1

JOB NUMBER: 15/119/TP

Scale 1:20



0.00	Slightly moist dark brown loose to medium dense intact silty sand. Hillwash. Also contains abudant roots in the upper 0,15m.
0.40	As above but contains abundant fine to coarse quartz gravel. Pebble marker.
0.70	Moist orange brown mottled grey brown medium dense cemented and ferruginised silty sand. Reworked residual granite with zones of residual granite.
1.00	Moist orange brown speckled yellow dark brown medium dense to dense jointed silty sand. Residual granite.
1.80	

NOTES

1) Refusal at 1,8m on very dense residual granite / very soft rock granite.

2) No evidence of water.

CONTRACTOR :
MACHINE : Cat 522E
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PROFILED BY : Justin Davel

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HOLE No: TP17

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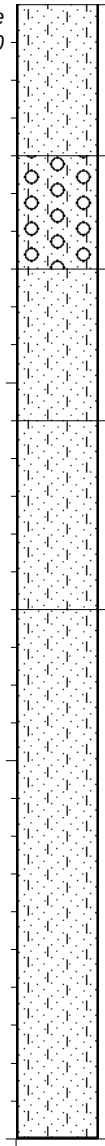
HOLE No: TP18
Sheet 1 of 1

JOB NUMBER: 15/119/TP

Scale 1:20



0.00	Moist light brown loose to medium dense intact silty sand. Hillwash. Also contains abundant roots in the upper 0,15m.
0.40	As above but medium dense with abundant fine to coarse quartz gravel. Pebble marker.
0.70	Moist orange brown blotched grey brown mottled red brown medium dense and medium dense to dense in places cemented and ferruginised silty sand. Reworked residual granite with zones of residual granite.
1.10	Moist orange brown mottled grey red brown medium dense to dense jointed silty sand. Residual granite with zones of reworked residual granite.
1.60	As above but medium dense and medium dense to dense in places with no zones reworked residual granite.
3.00	

NOTES

1) No refusal at 3,0m.

2) No evidence of water.

CONTRACTOR :
MACHINE : Cat 522E
DRILLED BY :
PROFILED BY : Justin Davel

TYPE SET BY : Renee
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE : 17/07/2015

DATE : 06/08/2015 12:17
TEXT : ..OMLResevoirCarlswald.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TP18

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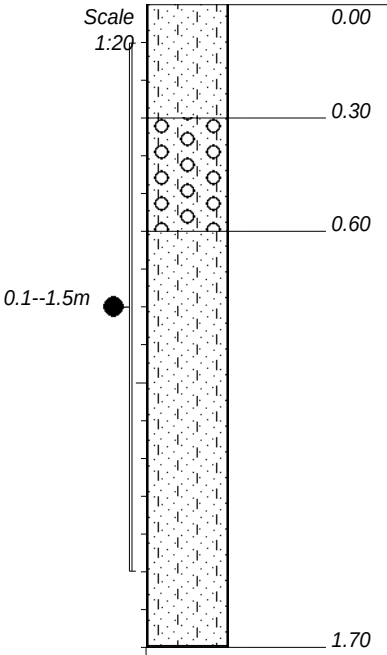
HOLE No: TP19
Sheet 1 of 1

JOB NUMBER: 15/119/TP



Slightly moist light brown loose to medium dense intact silty sand. Hillwash. Also contains abundant roots in the upper 0,15m.

As above but contains abundant fine to coarse quartz gravel. Pebble marker.

Moist orange brown speckled yellow brown dark brown medium dense to dense and dense in places jointed silty sand. Residual granite with scattered zones of reworked residual granite.

NOTES

1) Refusal at 1,7m on very soft rock granite.

2) No evidence of water.

3) Disturbed sample taken at 0,1--1,5m.

CONTRACTOR :
MACHINE : Cat 522E
DRILLED BY :
PROFILED BY : Justin Davel

TYPE SET BY : Renee
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE : 17/07/2015

DATE : 06/08/2015 12:17
TEXT : ..OMLResevoirCarlswald.txt

ELEVATION :
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Y-COORD :

HOLE No: TP19

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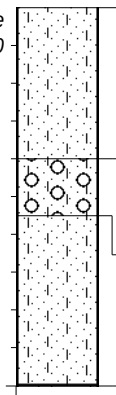
10ML Resevoir Carlswald

HOLE No: TP20
Sheet 1 of 1

JOB NUMBER: 15/119/TP

Scale 1:20



0.00	Slightly moist dark brown loose to medium dense intact silty sand. Hillwash. Also contains abundant roots in the upper 0,15m.
0.40	As above but contains abundant fine to coarse quartz gravel. Pebble marker.
0.55	Slightly moist orange brown speckled off white dark brown dense jointed silty sand. Residual granite.
1.00	

NOTES

1) Refusal at 1,0m on very soft rock granite.

2) No evidence of water.

CONTRACTOR :
MACHINE : Cat 522E
DRILLED BY :
PROFILED BY : Justin Davel

TYPE SET BY : Renee
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE : 17/07/2015

DATE : 06/08/2015 12:17
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ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TP20

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LEGEND
Sheet 1 of 1

JOB NUMBER: 15/119/TP

	GRAVEL	{SA02}
	SAND	{SA04}
	SILTY	{SA07}
Name ●	DISTURBED SAMPLE	{SA38}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

INCLINATION :
DIAM :
DATE :
DATE :

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : Renee
SETUP FILE : STANDARD.SET

DATE : 06/08/2015 12:17
TEXT : ..OMLResevoirCarlswald.txt

LEGEND
SUMMARY OF SYMBOLS