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# Report to CK Rumboll & Partners on a Geotechnical Investigation carried out for the Louw's Bos South RE/502, Cemetery Site, Stellenbosch, Western Cape

**Project No.: 18-820R02**

**Date Issued: June 2019**

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| | PREPARED: | APPROVED: |
|---|---|---|
| DATE: | June 2019 | June 2019 |
| NAME: | Colin Hartley | Mark Richter |
| SIGNATURE: |  |  |

# Report to CK Rumboll & Partners on a Geotechnical Investigation carried out for the Louw's Bos South RE/502, Cemetery Site, Stellenbosch, Western Cape

## 1. INTRODUCTION

As requested by Ms Anelia Coetzee of CK Rumboll & Partners, Gondwana Geo Solutions (Pty) Ltd (GGS) submitted a proposal to carry out a geotechnical investigation for the proposed Louw's Bos South RE/502, Cemetery Site on the 1st June 2018. The appointment of GGS to proceed as proposed was confirmed in a signed contract with CK Rumboll and Partners on the 16th July 2018.

The Phase 1, Preliminary Site Assessment comprised a desktop study of the area with a review of available information and meeting with local land owners, mapping of all surface water bodies and conducting a borehole and spring census of the area. This information is included in this, the Phase 2 report.

The Phase 2 geotechnical investigation comprised the excavation of eight trial pits at locations around the site. The trial pits were put down to obtain logging and sampling of the soils and, where possible, the depth to bedrock. Eight Dynamic Cone Penetrometer Light (DPL) Tests were carried out adjacent to the inspection pits to establish the consistency of the soils with depth.

Recommendations for the suitability of the site for use as a cemetery are provided.

## 2. INFORMATION SUPPLIED

The following information was supplied for use in the investigation:

- Google Earth Kmz file showing the site position.
- Western Cape Government Dept Agriculture Contour Plan
- Site Development Plan Louws Bos RE/502 Reference STELL/9494AC/RB
- Site Development Plan Louws Bos RE/502 Reference STELL/9494AC/RB (2)

## 3. SITE DESCRIPTION

The area on which the geotechnical investigations were carried out consist of a site with an area of approximately 37Ha.

The site is bounded on the northern side by Annandale Road and cultivated farm land and on the south, east and west sides side by municipal land, some of which is cultivated (Figure 2).

The site slopes down towards the Bonterivier in the north. The slope is gentle in the south steepening up closer to the river. The slope on the east side of the site slopes towards the east and includes an area which slopes at >6°. The remainder of the site slopes at between 4.7% and 6%. (Figure 2). Vegetation on the site consists of a vineyard, planted pastures or fallow agricultural land. The fallow agricultural land is covered in weeds and small bushes.

Plates 1 and 2 below give a detailed perspective of the site.

**Plate 1: Site viewed towards the east at TP6**

**Plate 2: Site viewed towards the north at TP7**

## 4. FIELDWORK

The fieldwork for the investigation was conducted during July 2018 and comprised the following:

- Trial Pits, and
- Dynamic Cone Penetrometer Light (DPL) Tests

### 4.1 Trial Pits

The trial pits were excavated using a JCB3CX Tractor Loader Backhoe (TLB) supplied by Burcon Plant Hire from Cape Town.

Eight trial pits, designated TP1 through TP8 were put down at the location as shown in Figure 2 at the site. TP1 to TP7 were terminated in clay at a depth of between 3.1m and 3.4m below existing ground level. TP8 refused on granite at a depth of 2.00m.

The trial holes were profiled[1] by an engineering geologist and representative soil samples recovered for laboratory testing at Geoscience Laboratories (Pty) Ltd in Cape Town. The detailed logs are provided in Appendix A.

Table 1 below indicates the locations and depths to which the trial holes were excavated.

**Table 1**
**Summary of Trial Pit Details**

| TP No. | GPS Coordinates (WGS84) | | Depth (mbegl) | Comments |
|---|---|---|---|---|
| | 19 Y | X | | |
| TP1 | 18843 | 3762793 | 3.40 | TLB Limit: No water |
| TP2 | 18817 | 3762970 | 3.00 | TLB Limit: No water |
| TP3 | 18852 | 3763126 | 3.20 | TLB Limit: No water |
| TP4 | 18852 | 3763302 | 3.40 | TLB Limit: No water |
| TP5 | 18596 | 3763035 | 3.10 | TLB Limit: No water |
| TP6 | 18636 | 3763035 | 3.10 | TLB Limit: No water |
| TP7 | 18312 | 3763213 | 3.10 | TLB Limit: No water |
| TP8 | 18324 | 3762910 | 2.00 | Refusal: Seeping water at 1.50m |

**Note: begl = depth below existing ground level**

[1] Geoterminology Workshop (2002) – Guidelines for Soil and Rock Logging - SAIEG-AEG-SAICE (Geotech Div) pp47

### 4.2 Dynamic Cone Penetrometer Light (DPL) Tests

Eight Dynamic Cone Penetrometer Light, or DPL tests, designated DPL1 to DPL8 were undertaken. All tests were undertaken from surface adjacent to the corresponding trial holes. A maximum depth of 2.7mbegl was achieved, in order to assess the consistency of the insitu soils, as well as to provide an indication of the depth to bedrock where possible. DPL8 was advanced to refusal depth of 2.0m. DPL1 to DPL7 were advanced to between 3.10m and 3.40m and terminated.

Table 2 below indicates the depth to which the DPL tests were undertaken. The results of the DPL test, comprising plots of blow count per 300mm advance and inferred consistency against depth are provided in Appendix B.

**Table 2**
**Summary of DPL Test Results**

| DPL No. | GPS Coordinates (WGS84) | | Depth (mbegl) | Comments |
|---|---|---|---|---|
| | 19 Y00 | X | | |
| DPL1 | 18843 | 3762793 | 2.70 | Medium dense to 0.3m, stiff to 0.6m, soft to 1.2m, firm to 2.1m and stiff to 2.47m. Terminated. |
| DPL2 | 18817 | 3762970 | 2.70 | Medium dense to 0.3m, dense to 0.6m, firm to 1.2m, stiff to 1.5m, firm to 1.8m, stiff to 2.4m and very stiff to 2.7m. Terminated. |
| DPL3 | 18852 | 3763126 | 2.70 | Loose to 0.3m, firm to 1.5m and stiff to 2.7m. Terminated. |
| DPL4 | 18852 | 3763302 | 2.70 | Loose to 0.3m, dense to 0.6m, stiff to 0.9m, firm to 1.8m and stiff to 2.7m. Terminated. |
| DPL5 | 18596 | 3763035 | 2.70 | Loose to 0.3m, medium dense to 0.9m, soft to 1.2m, firm to 2.4m and stiff to 2.7m. Terminated. |
| DPL6 | 18636 | 3763035 | 2.70 | Very loose to 0.3m, medium dense to 0.6m, stiff to 0.9m, firm to 1.2m, stiff to 1.8m and very stiff to 2.7m. Terminated |
| DPL7 | 18312 | 3763213 | 2.70 | Loose to 0.3m, medium dense to 0.9m, firm to 1.2m, stiff to 2.4m and very stiff to 2.7m. Terminated. |
| DPL8 | 18324 | 3762910 | 2.10 | Loose to 1.2m, medium dense to 1.5m, firm to 1.8m and stiff to 2.1m. Refusal. |

## 5. REGIONAL GEOLOGY

The regional geology of the area is shown in the extract presented in Figure 3 and taken from the 1:250 000 Cape Town 3318 geological map prepared by the Council for Geosciences. The regional geology consists of:

- Gravelly clay loam, Quaternary, overlying
- Granite Plutons comprising mainly coarse grained porphyritic with porphyritic biotite, fine grained leucocratic, hybridic and medium grained tourmaline-bearing variants of the Cape Granite Suite, outcrop around the site.

### 5.1 Site Geology

The site is underlain by a mantle of colluvial and residual soils overlying the granite of the Cape Granite Suite.

The site is underlain by a soil mantle comprising, from ground surface, grey brown medium dense, medium to coarse grained sand with small ferricrete pebbles and cobbles. Colluvium overlying

- Cream brown dense intact silty medium grained SAND with ferricrete pebbles and cobbles: Colluvium overlying
- Olive brown medium dense intact silty GRAVEL: Colluvium or
- Cream to cream brown to red brown firm to stiff to soft intact silty CLAY Residual Granite overlying
- Light cream grey completely to highly weathered widely jointed medium hard rock GRANITE.

## 6. GROUNDWATER

Seeping groundwater was only encountered in TP8 at a depth of 1.50m. This is consistent with the shallow bedrock in this area which was encountered at 2m and resulted in refusal of the TLB excavator. Similarly, groundwater can be expected to occur above the bedrock, however, this depth is largely well below the depth to which grave excavations will be dug.

## 7. LABORATORY TESTING

### 7.1 Materials Usage

In order to classify materials and to assess their suitability for a cemetery development the following laboratory testing was conducted on soils taken from the trial pits.

- Foundation Indicator Tests to determine Atterberg Limits, Particle Size Distribution and clay activity.
- Permeability Tests to determine soil permeability.
- In-Situ Permeability tests to determine in-situ soil permeability.

The results of the laboratory tests are provided in Appendix C and summarised in Tables 3 and 4 below.

**Table 3**
**Summary of Results of Particle Size Distribution Analysis and Atterberg Limit Determinations**

| TP No. | Depth (m) | Description | Particle Size % | | | | Atterberg Limits | | | GM | Classification |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Clay | Silt | Sand | Gravel | LL | PI | LS % | | |
| TP2 | 0.60-3.00 | Slightly moist cream brown to red brown firm to very stiff intact silty CLAY. Residual Granite. | 27 | 24 | 47 | 2 | 31 | 14 | 7.0 | 0.81 | A-6(4); ML; Medium heave; Type D Gravel Wearing Course |
| TP3 | 0.30-3.20 | Slightly moist cream brown to red brown firm to stiff intact silty CLAY. Residual Granite. | 34 | 30 | 36 | 0 | 32 | 14 | 7.0 | 0.56 | A-6(7); ML; Medium heave; Type D Gravel Wearing Course |
| TP5 | 0.00-0.60 | Slightly moist grey brown loose intact silty SAND. Colluvium. | 7 | 3 | 86 | 4 | - | NP | - | 1.50 | A-3(1); SW; Low heave; Type B Gravel Wearing Course |
| TP7 | 1.00-3.10 | Slightly moist olive brown to red brown stiff to very stiff intact silty CLAY. Residual Granite. | 26 | 23 | 50 | 1 | 32 | 15 | 7.0 | 0.89 | A-4 (4); ML; Medium heave; Type D Gravel Wearing Course |

LL - Liquid Limit
PI - Plasticity Index
LS - Linear Shrinkage

GM - Grading Modulus

Classification in Terms of: USPRA[2]
Unified Soil Classification System[3]
D.H. Van Der Merwe (1964)[4]
TRH20 (1990), Suitability for gravel wearing course[5]
Type A Erodible materials
Type B Ravels & corrugates
Type C Ravels
Type D Slippery when wet
Type E Good but may be dusty

[2] US Public Roads Administration Classification (Modified from Allen 1945)
[3] ASTM D 2487-06 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System). June 2006
[4] D.H. Van Der Merwe (1964). The Prediction of Heave from the Plasticity Index and Percentage Clay Fraction of Soils. The Civil Engineer, pp 103-107
[5] TRH 20 (1990) - The Structural Design, Construction and Maintenance of Unpaved Roads, Committee of State Road Authorities

**Table 4**
**Summary of Results of Permeability Testing**

| TP No. | Depth (m) | Description | Test Type | Permeability k (m/s) | Result[6] [7] |
|---|---|---|---|---|---|
| TP3 | 0.30-3.20 | Slightly moist cream brown to red brown firm to stiff intact silty CLAY. Residual Granite. | Falling Head. Permeability* | 1.71E-08 | Semi-pervious to impervious |
| TP5 | 0.00-0.60 | Slightly moist grey brown loose intact silty SAND. Colluvium. | Falling Head. Permeability* | 1.31E-06 | Semi Pervious to pervious |
| | 1.10-3.10 | Slightly moist grey brown medium dense intact silty SAND with abundant ferricrete nodules. Colluvium. | Falling Head. Permeability* | 2.36E-05 | Semi Pervious |
| TP6 | 0.00-0.20 | Slightly moist light grey brown very loose intact silty SAND. Colluvium. | In situ Permeability | 2.46E-03 | Pervious |
| TP7 | 0.00-0.20 | Slightly moist grey brown loose intact silty SAND. Colluvium. | In situ Permeability | 3.22E-03 | Pervious |
| | 0.60-1.00 | Slightly moist olive brown medium dense intact silty GRAVEL. Colluvium. | Falling Head. Permeability* | 1.37E-05 | Semi Pervious |

*Note: Test carried out on material compacted to 92% MDD

### 7.2 Permeability Evaluation

The materials underlying the site have been classified in terms of their permeability characteristics. The results are shown in Table 4 above.

The silty gravel and silty sand in TP5 and TP7 are generally pervious to semi-pervious. The silty clay derived from residual granite in TP3 is semi-pervious to impervious. The silty sand at surface in TP6 and TP7 is found to be pervious as expected.

## 8. DEPARTMENT OF WATER AND SANITATION (DWS) REQUIREMENTS

DWS requirements with regards to the siting of cemeteries are that the following areas[8] should be avoided. The area recommended for the siting of a cemetery is shown in Figure 2.

### 8.1 Below the 1 in 50 year flood line of a river

The site is above the 1:50 year flood line of the river and this requirement will be met.

### 8.2 In close proximity to water bodies such as wetlands, vleis, pans and floodplains

There are seven dams around the situated around the site area and the Bonterevier in the north. The proposed site boundaries as shown in Figure 2 are drawn in to exclude all the area closer than 300m from these water bodies. There are no vleis or wetlands in the area. If the above areas are avoided the proposed site will comply (Figure 2).

### 8.3 Situated in unstable areas

As there are no fault zones, seismic zones, dolomite or cast areas on the site, sinkholes and ground subsidence are unlikely.

### 8.4 Sensitive ecological areas

There are no areas of protected vegetation on the site.

[6] Williams 1993 in Stapelberg FDJ 2005, The Engineering Geology of Cape Town and Environs, Western Cape South Africa.
[7] SA National Convention on Large Dams – classification of permeability of materials
[8] National Water Act No 36 of 1998. Sections 22(3) and 22(4).

### 8.5 Areas with flat gradients with shallow or emergent groundwater

There are no areas of flat gradients. Most of the site slopes to the north down to Annandale Road and the Bonterivier. The average slope over most of the site is between 4.7% and 6.0%. There is an area on the east side that slopes at >6%. This has been excluded in the proposed site boundary (Figure 2). These steeper slopes are unsuitable for use as a cemetery site.

Groundwater was intersected in TP8 which falls outside the proposed site boundary (Figure 2).

### 8.6 Areas characterised by steep gradients or shallow bedrock with little soil cover

As mentioned, the site slopes towards the north and east where the gradient is >6%. This area is unsuitable for use as a cemetery and is excluded in the proposed cemetery site boundary (Figure 2). Bedrock was intersected in TP8 at 2.0m. As mentioned this area has in any case been excluded from the proposed site.

The Stellenbosch Municipality Bye-Laws pertaining to Burial Parks and Cemeteries[9] defines a grave as being 1.80m deep. Bye-Law 2.9(a) states that after a coffin is covered it rests at least 1.00m below the ground surface. This implies that the grave depth should not be shallower than 1.80m from surface. This depth criterion is met over the area proposed for the cemetery (Figure 2).

### 8.7 Areas of groundwater recharge on account of topography and/or highly permeable soils

Impervious clay layers in the lower soil profile will limit the groundwater recharge capability These conditions may lead to a shallow perched water table in the normally wet winter months or periods of high rainfall.

### 8.8 Areas overlaying or adjacent to important aquifers where these are to be used for water supply purposes

The area is classified as a Minor Aquifer[10] and as a result complies.

## 9. BOREHOLES AND DOMESTIC WATER SOURCES

There are no known boreholes on the site. The position of the boreholes on the neighbouring farms are shown in Figure 2. Table 5 summarises the details.

**Table 5**
**Summary of Borehole Details**

| TP No. | Approximate GPS Coordinates (WGS84) | | Depth (mbegl) | Yield (litres/hr) | Approximate Distance from Suitable Site (m) | Comments |
|---|---|---|---|---|---|---|
| | 19 Y | X | | | | |
| BH1 | 0018121 | 3762674 | 120 | 80 000 | 600 | Water quality good. Bulk sales to the public |
| BH2 | 0018061 | 3762724 | 120 | Domestic use | 600 | Water quality good |
| BH3 | 0018086 | 3762741 | 120 | Domestic use | 600 | Water quality good |

## 10. DEVELOPMENT RECOMMENDATIONS

### 10.1 Proposed Development

The proposed development will comprise of a memorial park with cemetery areas, remembrance wall and park areas with trees and grass.

[9] Stellenbosch Municipality, Burial Parks / Cemeteries By -Laws 2007
[10] Aquifer Classification of South Africa.Department of Water Affairs 2012

## 10.2 Grave Excavations

As a general observation the insitu materials over the proposed site to a maximum depth of between 3.10m and 3.40m below existing ground level, as determined by trial pit excavations and DPL tests, will classify as Soft Excavation (SABS1200 DM). This of course excludes the area shown in Figure 2 in which TP8 was dug

Furthermore, sidewall collapse was only observed in TP8 which is outside the proposed cemetery site boundary. No sidewall collapse was observed in any of the other trial pits put down and it is therefore assumed that grave excavations will stay open for a reasonable length of time. It must be noted that when the soils are wet by precipitation or otherwise, sidewall collapse is possible. The recommended stand-up time for open grave sidewalls is maximum 24 hours, however, wet periods will have a significant effect on the stability of the open graves and should be assessed individually.

## 10.3 Leachate Migration

All eight trial pits put down on the proposed site indicated pervious to semi pervious silty sand down to a maximum depth of 0.70mbgl overlying, in some cases, semi pervious gravel down to between 0.70mbgl and 1.0mbgl and impervious clay down to between 3.00m and 3.40mbgl.

Leachate migration from the graves is therefore unlikely.

## 10.4 Basal Buffer Zone

No water was intersected in any of the trial pits put down on the proposed cemetery site (TP8 excluded from the proposed site). The depth to the water table on the site proposed, is therefore unknown. The requirement that the basal buffer zone of 2.5m between grave and water table is met but it should be noted that this investigation was carried out during a severe drought and that in times of winter rain or heavy rain fall, the water table may be present at shallower depths.

## 10.5 Soil Workability

The sands in the profile will compact without difficulty on return to the grave. The clays in the profile will also compact but not as easily as the sands.

# 11. RATING OF CEMETERY ATTRIBUTES

Since a large degree of research was conducted by several geotechnical consultants[11]; [12] over the period 1990 to 2005 on the siting of cemeteries the rating of a cemetery site in terms of selected attributes is normally carried out and provides a useful guideline for planning.

The attributes used for cemetery rating are the following:

- Excavatability
- Grave stability
- Soil workability
- Groundwater
- Soil permeability, and
- Backfill Permeability

The above attributes are each further subdivided into graduations with rating values assigned to each. The site attributes are then scored against the rating values given in Tables 1 through Table 6 in Appendix D. A total rating score for the site is obtained and compared with the Site Suitability Rating in Table 6 below.

[11] Hall, B. & Hanbury, R (1990) Some Geotechnical Considerations in the Selection of Cemetery Sites. IMIESA March 1990.

[12] Welland, A.M and Venter, J.P (1997). Guidelines for the Investigation of Cemetery Sites: Adaptation of "Minimum Requirements for Waste Disposal by Landfill" Applicable to Cemetery Site Investigations. Prepared by BKS (Pty); Report No 108/568; project reference P412680.

**Table 6**
**Site Suitability Rating**

| Rating Total Score | Site Suitability Rating |
|---|---|
| >90 | Very good |
| 75 to 90 | Satisfactory |
| 60 to 75 | Poor – precautions needed |
| <60 | Unacceptable |

In terms of the ratings, the following scores are determined for the Louws Bos South cemetery site:

| Attribute | Score |
|---|---|
| Excavatability | 10 |
| Grave stability | 20 |
| Soil workability | 2 |
| Groundwater | 15 |
| Subsoil permeability | 20 |
| Backfill permeability | 15 |
| **Total Score** | 82 |

Therefore, in terms of the ratings of the site attributes, the proposed site is assessed as being **satisfactory** for use as a Cemetery site. The site is therefore considered generally suitable for its intended use as a cemetery provided the recommendations in this report are adhered to.

## 12. CONCLUSION

This report presents the results of the geotechnical investigation conducted for the proposed new cemetery at the Louw's Bos South site.

The proposed site is underlain by a soil mantle comprising, from ground surface, loose to very loose to medium dense sands and gravel of colluvial origin overlying clays of residual origin all of which classify as Soft Excavation (SABS1200 DM).

Provided that the cemetery is sited in the area proposed and shown in Figure 2, the DWS requirements for the siting of cemeteries are met.

Leachate migration is unlikely as the clays in the profile are impervious.

The cemetery site was rated in terms of the attribute rankings and a score of 82 obtained. This indicates that in terms of the **Site Suitability Rating Index**, the site is considered **satisfactory** for development as a cemetery.

In conclusion, the information and recommendations provided in this report relates to the location of the trial holes and DPL tests put down on site. It is quite possible that variations to the ground conditions will be encountered elsewhere on the site during construction. Therefore, it is recommended that GGS be appointed to carry out periodic inspections on the earthworks and foundation excavations during construction to confirm the recommendations given in this report.

# APPENDIX A

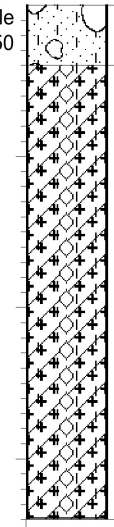
GONDWANA GEO SOLUTIONS

**CK RUMBOLL AND PARTNERS**
**Louw's Bos South Cemetery**

HOLE No: **TP1**
Sheet 1 of 1

JOB NUMBER: 18-820

Scale 1:50



0.00 Moist grey brown medium dense intact silty medium grained SAND with occasional small pebbles and cobbles over bottom 0.10m. Colluvium.

0.40 Moist cream to cream brown to red brown stiff to soft intact silty CLAY. Residual Granite.

3.40

NOTES

1) Final depth at 3.40m. TLB limit.
2) No groundwater seepage.
3) No sidewall collapse.
4) No samples taken.

CONTRACTOR :
MACHINE : JCB 3CX
DRILLED BY :
PROFILED BY : CLH

TYPE SET BY : MC
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
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DATE : 20/07/2018

DATE : 25/07/2018 11:42
TEXT : ..Cemetery\Logs\TP1TP8.doc

ELEVATION :
X-COORD : 3762793
Y-COORD : 19Y 0018843

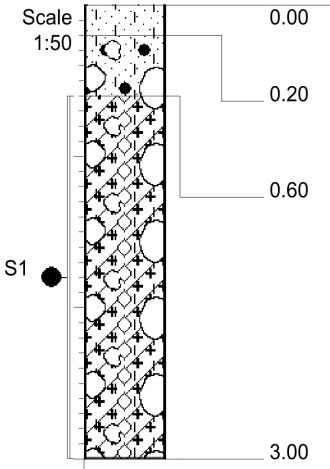
HOLE No: **TP1**

GONDWANA GEO SOLUTIONS

**CK RUMBOLL AND PARTNERS**
**Louw's Bos South Cemetery**

HOLE No: **TP2**
Sheet 1 of 1

JOB NUMBER: 18-820




Slightly moist cream brown medium dense intact silty medium grained SAND. Colluvium.

Slightly moist cream brown dense intact silty medium grained SAND with abundant ferricrete pebbles and cobbles. Colluvium.

Slightly moist cream brown to red brown firm to very stiff intact silty CLAY with occasional cobbles of completely weathered granite. Residual Granite.

NOTES

1) Final depth at 3.00m. TLB limit.

2) No groundwater seepage.

3) No sidewall collapse.

4) Samples taken :
S1 0.60--3.00m

CONTRACTOR :
MACHINE : JCB 3CX
DRILLED BY :
PROFILED BY : CLH

TYPE SET BY : MC
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE : 20/07/2018
DATE : 20/07/2018

DATE : 25/07/2018 11:42
TEXT : ..Cemetery\Logs\TP1TP8.doc

ELEVATION :
X-COORD : 3762970
Y-COORD : 19Y 0018817

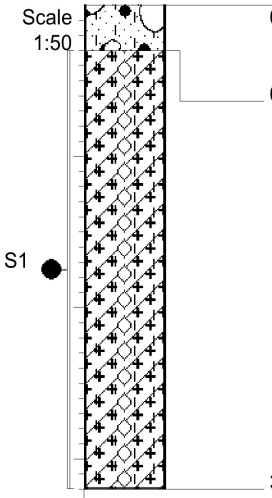
HOLE No: **TP2**

GONDWANA GEO SOLUTIONS

**CK RUMBOLL AND PARTNERS**
**Louw's Bos South Cemetery**

HOLE No: **TP3**
Sheet 1 of 1

JOB NUMBER: 18-820




0.00 Slightly moist grey brown loose intact silty SAND with ferricrete pebbles and cobbles. Colluvium.

0.30 Slightly moist cream brown to red brown firm to stiff intact silty CLAY. Residual Granite.

3.20

NOTES

1) Final depth at 3.20m. TLB limit.
2) No groundwater seepage.
3) No sidewall collapse.
4) Samples taken :
   S1 0.30--3.20m

CONTRACTOR :
MACHINE : JCB 3CX
DRILLED BY :
PROFILED BY : CLH

TYPE SET BY : MC
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
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DATE : 20/07/2018

DATE : 25/07/2018 11:42
TEXT : ..Cemetery\Logs\TP1TP8.doc

ELEVATION :
X-COORD : 3763126
Y-COORD : 19Y 0018852

HOLE No: **TP3**

GONDWANA GEO SOLUTIONS

**CK RUMBOLL AND PARTNERS**
**Louw's Bos South Cemetery**

HOLE No: **TP4**
Sheet 1 of 1

JOB NUMBER: 18-820

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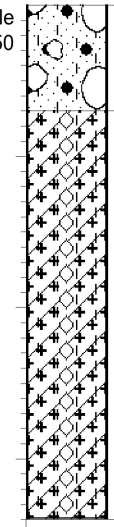


0.00 Moist dark grey loose intact silty SAND with ferricrete pebbles and cobbles. Colluvium.

0.70 Slightly moist cream brown to red brown firm to stiff intact silty CLAY. Residual Granite.

3.40

NOTES

1) Final depth at 3.40m. TLB limit.
2) No groundwater seepage.
3) No sidewall collapse.
4) No samples taken.

CONTRACTOR :
MACHINE : JCB 3CX
DRILLED BY :
PROFILED BY : CLH

TYPE SET BY : MC
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE : 20/07/2018
DATE : 20/07/2018

DATE : 25/07/2018 11:42
TEXT : ..Cemetery\Logs\TP1TP8.doc

ELEVATION :
X-COORD : 3763302
Y-COORD : 19Y 0018852

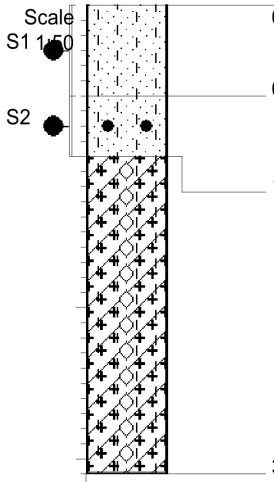
HOLE No: **TP4**

GONDWANA GEO SOLUTIONS

**CK RUMBOLL AND PARTNERS**
**Louw's Bos South Cemetery**

HOLE No: **TP5**
Sheet 1 of 1

JOB NUMBER: 18-820




Slightly moist grey brown loose intact silty SAND. Colluvium.

Slightly moist grey brown medium dense intact silty SAND with abundant ferricrete nodules up to 30mm. Colluvium.

Slightly moist cream brown to pink brown soft to stiff intact silty CLAY. Residual Granite.

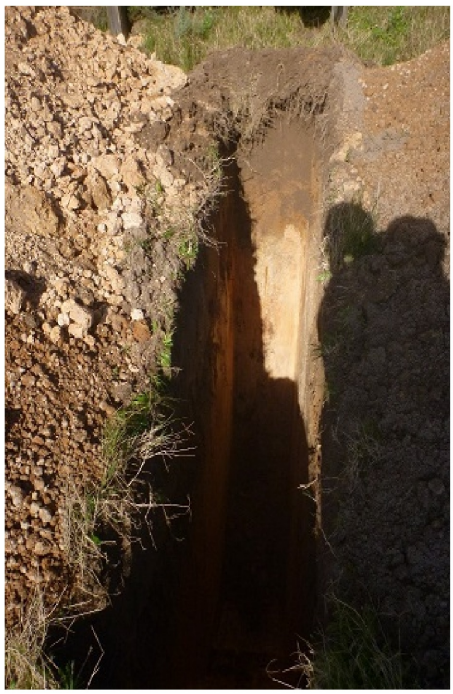
NOTES

1) Final depth at 3.10m. TLB limit.

2) No groundwater seepage.

3) No sidewall collapse.

4) Samples taken :
S1 0.00--0.60m
S2 0.60--1.00m



CONTRACTOR :
MACHINE : JCB 3CX
DRILLED BY :
PROFILED BY : CLH

TYPE SET BY : MC
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE : 20/07/2018
DATE : 20/07/2018

DATE : 25/07/2018 11:42
TEXT : ..Cemetery\Logs\TP1TP8.doc

ELEVATION :
X-COORD : 3763035
Y-COORD : 19Y 0018596

HOLE No: **TP5**

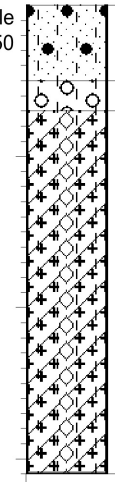
GONDWANA GEO SOLUTIONS

**CK RUMBOLL AND PARTNERS**
**Louw's Bos South Cemetery**

HOLE No: **TP6**
Sheet 1 of 1

JOB NUMBER: 18-820

Scale 1:50



| | |
|---|---|
| 0.00 | Slightly moist light grey brown very loose intact silty SAND with rare small ferricrete pebbles. Colluvium. |
| 0.50 | Slightly moist olive brown medium dense intact silty GRAVEL. Colluvium. |
| 0.70 | Slightly moist yellow brown to red brown to cream stiff to very stiff intact silty CLAY. Residual Granite. |
| 3.10 | |

NOTES

1) Final depth at 3.10m. TLB limit.
2) No groundwater seepage.
3) No sidewall collapse.
4) No samples taken.

CONTRACTOR :
MACHINE : JCB 3CX
DRILLED BY :
PROFILED BY : CLH

TYPE SET BY : MC
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE : 20/07/2018
DATE : 20/07/2018

DATE : 25/07/2018 11:42
TEXT : ..Cemetery\Logs\TP1TP8.doc

ELEVATION :
X-COORD : 3763035
Y-COORD : 19Y 0018636

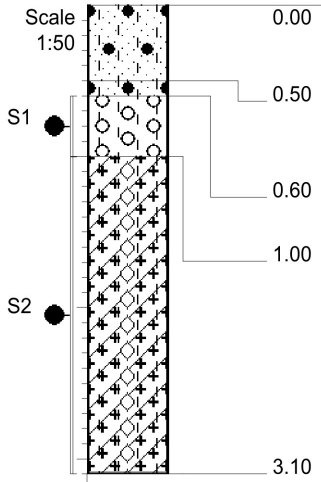
HOLE No: **TP6**

GONDWANA GEO SOLUTIONS

**CK RUMBOLL AND PARTNERS**
**Louw's Bos South Cemetery**

HOLE No: **TP7**
Sheet 1 of 1

JOB NUMBER: 18-820




Slightly moist grey brown loose intact silty SAND with a few ferricrete pebbles. Colluvium.

Slightly moist brown medium dense intact silty medium to coarse grained SAND with ferricrete nodules up to 40mm. Colluvium.

Slightly moist olive brown medium dense intact silty GRAVEL. Colluvium.

Slightly moist olive brown to red brown stiff to very stiff intact silty CLAY. Residual Granite.

NOTES

1) Final depth at 3.10m. TLB limit.

2) No groundwater seepage.

3) No sidewall collapse.

4) Samples taken :
S1 0.60--1.00m
S2 1.00--3.10m

CONTRACTOR :
MACHINE : JCB 3CX
DRILLED BY :
PROFILED BY : CLH

TYPE SET BY : MC
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE : 20/07/2018
DATE : 20/07/2018

DATE : 25/07/2018 11:42
TEXT : ..Cemetery\Logs\TP1TP8.doc

ELEVATION :
X-COORD : 3763213
Y-COORD : 19Y 0018312

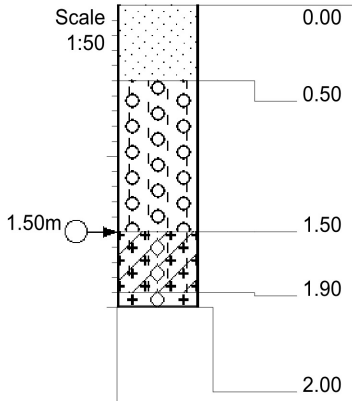
HOLE No: **TP7**

GONDWANA GEO SOLUTIONS

**CK RUMBOLL AND PARTNERS**
**Louw's Bos South Cemetery**

HOLE No: **TP8**
Sheet 1 of 1

JOB NUMBER: 18-820




| | |
|---|---|
| 0.00 – 0.50 | Slightly moist brown loose intact medium to coarse grained SAND. Colluvium. |
| 0.50 – 1.50 | Moist olive brown loose to medium dense intact silty GRAVEL. Colluvium. |
| 1.50 – 1.90 | Moist cream brown stiff to firm intact silty CLAY. Residual Granite. |
| 1.90 – 2.00 | Light cream grey completely to highly weathered widely jointed medium hard rock GRANITE. Cape Granite Suite. |

NOTES

1) Final depth at 2.00m. Refusal.
2) Groundwater seepage at 1.50m.
3) Sidewall collapse in gravel.
4) No samples taken.

CONTRACTOR :
MACHINE : JCB 3CX
DRILLED BY :
PROFILED BY : CLH

TYPE SET BY : MC
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE : 20/07/2018
DATE : 20/07/2018

DATE : 25/07/2018 11:42
TEXT : ..Cemetery\Logs\TP1TP8.doc

ELEVATION :
X-COORD : 3762910
Y-COORD : 19Y 0018324

HOLE No: **TP8**

# APPENDIX B

GONDWANA GEO SOLUTIONS

Consulting Geotechnical Engineers & Engineering Geologists

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DURBAN
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Email: markrichter.ggs@gmail.com

Cape Town
C. Hartley
108 Upper Kenridge Avenue
Kenridge, Durbanville
CAPE TOWN, 7550
Cell: (+27) 82 771 0117
Email: colin.ggs@gmail.com

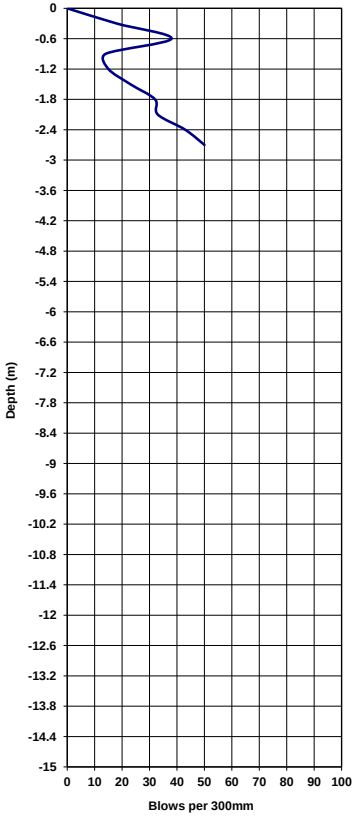
**Client:** CK RUMBOLL AND PARTNERS
**Project:** Louw's Bos South Cemetery
**Section:**

**Ref.No.** 18-820
**Date:** 20/07/2018
**Operator:** CLH

*Light Dynamic Penetrometer Probe* ---------- ***Test No. DPL 1***

| Depth metres | Blows per 300mm | Inferred Consistency |
|---|---|---|
| 0 | | |
| 0.3 | 18 | Med.Dense |
| 0.6 | 38 | Stiff |
| 0.9 | 14 | Soft |
| 1.2 | 15 | Soft |
| 1.5 | 23 | Firm |
| 1.8 | 32 | Firm |
| 2.1 | 33 | Firm |
| 2.4 | 43 | Stiff |
| 2.7 | 50 | Stiff |
| | End | |

Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings



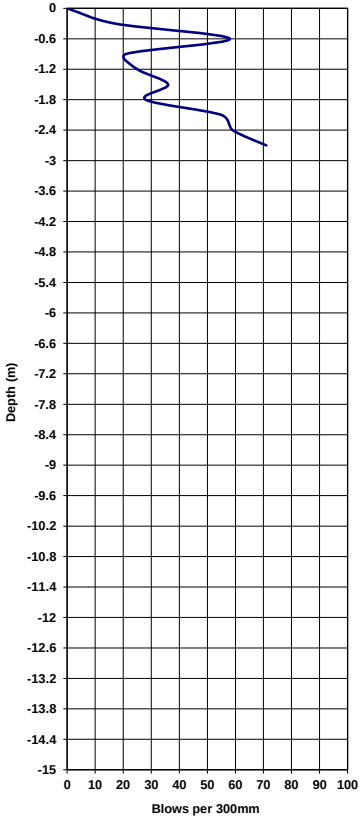

C=1
Phi=0

*Light Dynamic Penetrometer Probe* ---------- ***Test No. DPL 2***

| Depth metres | Blows per 300mm | Inferred Consistency | C=1 |
|---|---|---|---|
| 0 | | | |
| 0.3 | 17 | Med.Dense | 1 |
| 0.6 | 58 | Dense | 1 |
| 0.9 | 21 | Firm | 1 |
| 1.2 | 25 | Firm | 1 |
| 1.5 | 36 | Stiff | 1 |
| 1.8 | 28 | Firm | 1 |
| 2.1 | 55 | Stiff | 1 |
| 2.4 | 59 | Stiff | 1 |
| 2.7 | 71 | Very Stiff | 1 |
| | End | | |

Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings

C=1
Phi=0

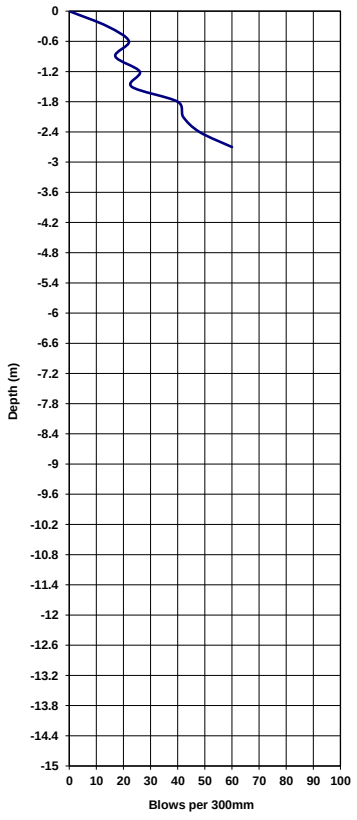



*Light Dynamic Penetrometer Probe* ---------- ***Test No. DPL 3***

| Depth metres | Blows per 300mm | Inferred Consistency | C=1 |
|---|---|---|---|
| 0 | | | |
| 0.3 | 14 | Loose | 1 |
| 0.6 | 22 | Firm | 1 |
| 0.9 | 17 | Firm | 1 |
| 1.2 | 26 | Firm | 1 |
| 1.5 | 23 | Firm | 1 |
| 1.8 | 40 | Stiff | 1 |
| 2.1 | 42 | Stiff | 1 |
| 2.4 | 48 | Stiff | 1 |
| 2.7 | 60 | Stiff | 1 |
| | End | | |

Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings

C=1
Phi=0




THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

GONDWANA GEO SOLUTIONS

Consulting Geotechnical Engineers & Engineering Geologists

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Cape Town
C. Hartley
108 Upper Kenridge Avenue
Kenridge, Durbanville
CAPE TOWN, 7550
Cell: (+27) 82 771 0117
Email: colin.ggs@gmail.com

**Client:** CK RUMBOLL AND PARTNERS
**Project:** Louw's Bos South Cemetery
**Section:**

**Ref.No.** 18-820
**Date:** 20/07/2018
**Operator:** CLH

*Light Dynamic Penetrometer Probe* ---------- ***Test No. DPL 4***

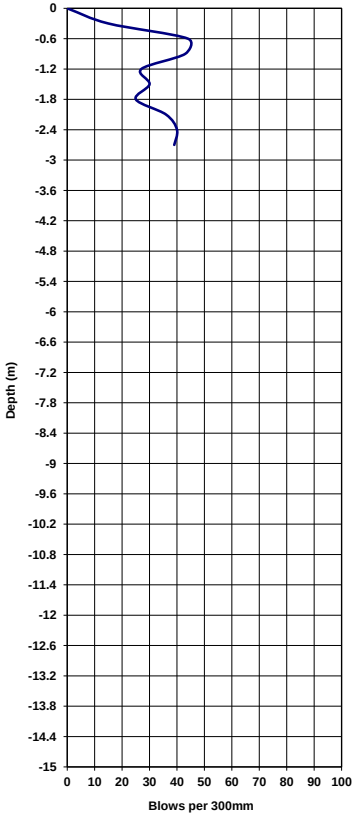
*Light Dynamic Penetrometer Probe* ---------- ***Test No. DPL 5***

*Light Dynamic Penetrometer Probe* ---------- ***Test No. DPL 6***

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

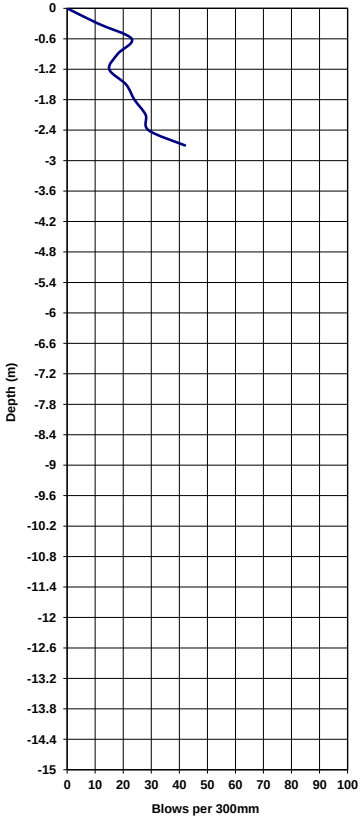
Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings
C=1
Phi=0

| Depth metres | Blows per 300mm | Inferred Consistency |
|---|---|---|
| 0 | | |
| 0.3 | 15 | Loose |
| 0.6 | 44 | Dense |
| 0.9 | 43 | Stiff |
| 1.2 | 27 | Firm |
| 1.5 | 30 | Firm |
| 1.8 | 25 | Firm |
| 2.1 | 36 | Stiff |
| 2.4 | 40 | Stiff |
| 2.7 | 39 | Stiff |
| | End | |



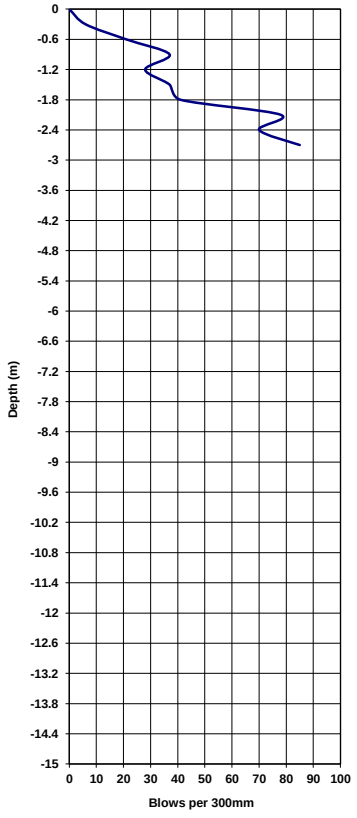

Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings
C=1
Phi=0

| Depth metres | Blows per 300mm | Inferred Consistency | |
|---|---|---|---|
| 0 | | | |
| 0.3 | 11 | Loose | 1 |
| 0.6 | 23 | Med.Dense | 1 |
| 0.9 | 18 | Med.Dense | 1 |
| 1.2 | 15 | Soft | 1 |
| 1.5 | 21 | Firm | 1 |
| 1.8 | 24 | Firm | 1 |
| 2.1 | 28 | Firm | 1 |
| 2.4 | 29 | Firm | 1 |
| 2.7 | 42 | Stiff | 1 |
| | End | | |




Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings
C=1
Phi=0

| Depth metres | Blows per 300mm | Inferred Consistency | |
|---|---|---|---|
| 0 | | | |
| 0.3 | 6 | Very Loose | 1 |
| 0.6 | 21 | Med.Dense | 1 |
| 0.9 | 37 | Stiff | 1 |
| 1.2 | 28 | Firm | 1 |
| 1.5 | 37 | Stiff | 1 |
| 1.8 | 41 | Stiff | 1 |
| 2.1 | 78 | Very Stiff | 1 |
| 2.4 | 70 | Very Stiff | 1 |
| 2.7 | 85 | Very Stiff | 1 |
| | End | | |



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**Client:** CK RUMBOLL AND PARTNERS
**Project:** Louw's Bos South Cemetery
**Section:**

**Ref.No.** 18-820
**Date:** 20/07/2018
**Operator:** CLH

*Light Dynamic Penetrometer Probe* ---------- ***Test No. DPL 7***

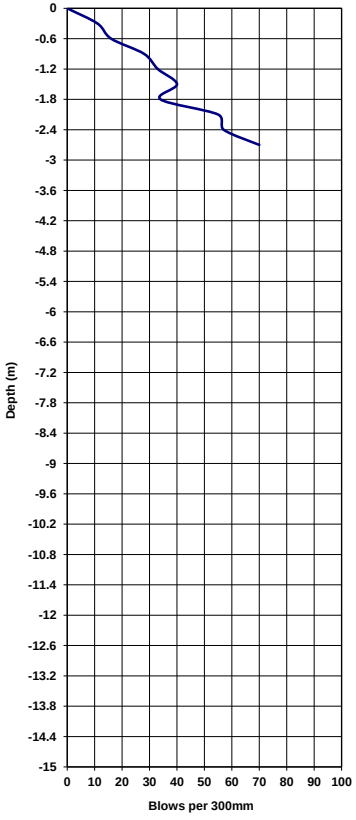
*Light Dynamic Penetrometer Probe* ---------- ***Test No. DPL 8***

*Light Dynamic Penetrometer Probe* ---------- ***Test No. DPL***

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings
C=1
Phi=0

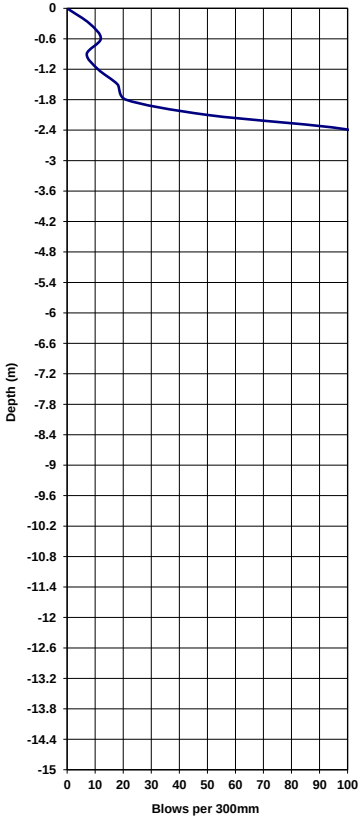
| Depth metres | Blows per 300mm | Inferred Consistency |
|---|---|---|
| 0 | | |
| 0.3 | 11 | Loose |
| 0.6 | 16 | Med.Dense |
| 0.9 | 28 | Med.Dense |
| 1.2 | 33 | Firm |
| 1.5 | 40 | Stiff |
| 1.8 | 34 | Stiff |
| 2.1 | 55 | Stiff |
| 2.4 | 57 | Stiff |
| 2.7 | 70 | Very Stiff |
| | End | |




Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings
C=1
Phi=0

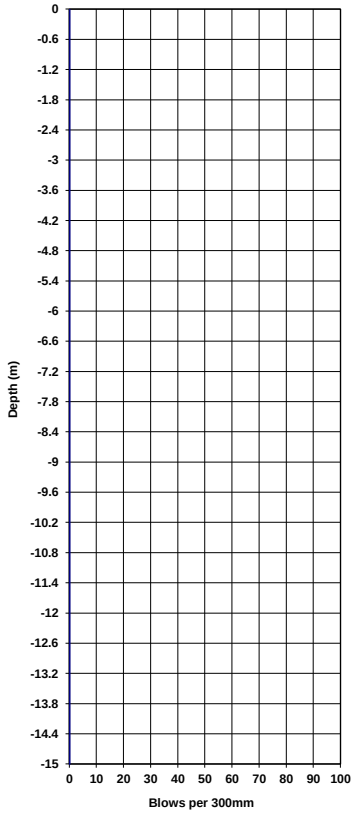
| Depth metres | Blows per 300mm | Inferred Consistency |
|---|---|---|
| 0 | | |
| 0.3 | 8 | Loose |
| 0.6 | 12 | Loose |
| 0.9 | 7 | Loose |
| 1.2 | 11 | Loose |
| 1.5 | 18 | Med.Dense |
| 1.8 | 21 | Med.Dense |
| 2.1 | 50 | Dense |
| | Ref | |

1
1
1
1
1
1




Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings
C=1
Phi=0

| Depth metres | Blows per 300mm | Inferred Consistency |
|---|---|---|
| 0 | | |



# APPENDIX C

GEOSCIENCE LABORATORIES (PTY) LTD

| | | | |
|---|---|---|---|
| **CLIENT:** | Gondwana Geo Solutions<br>108 Upper Kenridge Avenue<br>Durbanville<br>7550 | **PROJECT:** | Louw's Bos South Cemetry |
| | | **DATE:** | 31-07-2018 |
| **ATT:** | Colin Hartley | **REF:** | L180749 |

# *ASTM D422 SIEVE ANALYSIS*

| | | | |
|---|---|---|---|
| **DESCRIPTION :** | brown to red silty clay | **SAMPLE NO. :** | 30710 |
| **POSITION :** | TP 02 @ 0.60-3.00m | **CLIENT SAMPLE NO. :** | |

| Sieve Analysis | | Percent Passing |
|---|---|---|
| SIEVE SIZE (mm) | 75,00 | |
| | 63,00 | |
| | 53,00 | |
| | 37,50 | |
| | 26,50 | |
| | 19,00 | |
| | 13,20 | |
| | 9,50 | 100 |
| | 6,70 | 99 |
| | 4,75 | 98 |
| | 2,36 | 97 |
| | 2,00 | 97 |
| | 1,18 | 93 |
| | 0,600 | 79 |
| | 0,425 | 71 |
| | 0,300 | 64 |
| | 0,150 | 56 |
| | 0,0750 | 51 |

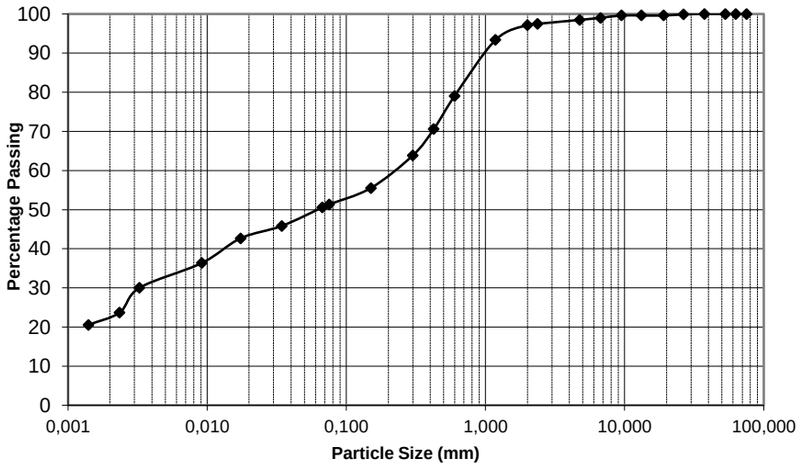
| Hydrometer Analysis | |
|---|---|
| Diameter of particle (mm) | Percentage of soil suspension (%) |
| 0,0671 | 51 |
| 0,0343 | 46 |
| 0,0173 | 43 |
| 0,0091 | 36 |
| 0,0033 | 30 |
| 0,0023 | 24 |
| 0,0014 | 21 |

| SCS Dispersion Test | |
|---|---|
| Diameter of particle (mm) | Percentage of soil suspension (%) |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

| | |
|---|---|
| **% SCS Dispersion:** | |
| **Initial Moisture Content (%) :** | |
| **pH:** | |
| **Conductivity mS/m:** | |

| *Atterberg Limits :* | |
|---|---|
| Liquid Limit | 31 |
| Plastic Index | 14 |
| Linear Shrinkage | 7,0 |

**Particle Size Distribution**




| *MOD AASHTO ; C.B.R. :* | |
|---|---|
| MOD AASHTO (Kg/m³) | |
| O.M.C. (%) | |
| C.B.R. @ 100% Comp. | |
| C.B.R. @ 98 % Comp. | |
| C.B.R. @ 95 % Comp. | |
| C.B.R. @ 93 % Comp. | |
| C.B.R. @ 90 % Comp. | |
| Swell ( max ) % | |

| Tabulated Summary | Percentage |
|---|---|
| **Gravel** : Percentage - 4.75 mm | 2 |
| **Sand** : Percentage - 4.75mm and + 0.075mm | 47 |
| **Silt** : Percentage - 0.075mm and + 0.002mm | 24 |
| **Clay** : Percentage - 0.002mm | 27 |



For Geoscience:

Remarks:

ConSR22

GEOSCIENCE LABORATORIES (PTY) LTD

| | | | |
|---|---|---|---|
| **CLIENT:** | Gondwana Geo Solutions<br>108 Upper Kenridge Avenue<br>Durbanville<br>7550 | **PROJECT:** | Louw's Bos South Cemetry |
| | | **DATE:** | 31-07-2018 |
| **ATT:** | Colin Hartley | **REF:** | L180749 |

# *ASTM D422 SIEVE ANALYSIS*

| | | | |
|---|---|---|---|
| **DESCRIPTION :** | brown to red silty clay | **SAMPLE NO. :** | 30711 |
| **POSITION :** | TP 03 @ 0.30-3.20m | **CLIENT SAMPLE NO. :** | |

| Sieve Analysis | | Percent Passing |
|---|---|---|
| SIEVE SIZE (mm) | 75,00 | |
| | 63,00 | |
| | 53,00 | |
| | 37,50 | |
| | 26,50 | |
| | 19,00 | |
| | 13,20 | |
| | 9,50 | |
| | 6,70 | |
| | 4,75 | 100 |
| | 2,36 | 99 |
| | 2,00 | 99 |
| | 1,18 | 95 |
| | 0,600 | 86 |
| | 0,425 | 81 |
| | 0,300 | 76 |
| | 0,150 | 69 |
| | 0,0750 | 64 |

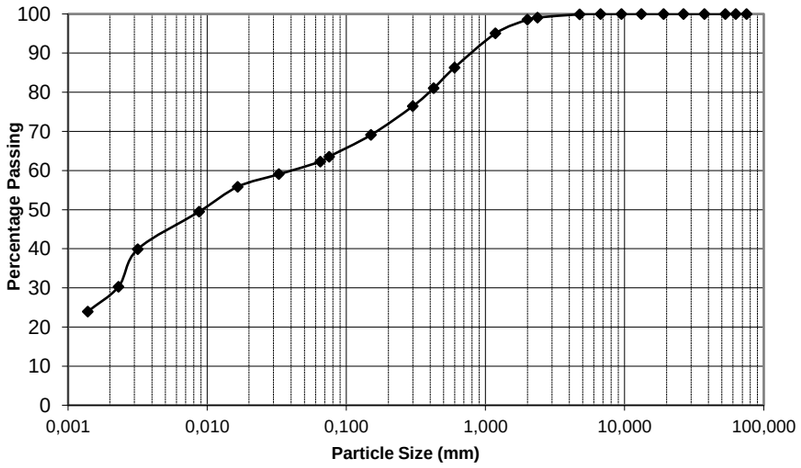
| Hydrometer Analysis | |
|---|---|
| Diameter of particle (mm) | Percentage of soil suspension (%) |
| 0,0649 | 62 |
| 0,0327 | 59 |
| 0,0166 | 56 |
| 0,0087 | 49 |
| 0,0032 | 40 |
| 0,0023 | 30 |
| 0,0014 | 24 |

| SCS Dispersion Test | |
|---|---|
| Diameter of particle (mm) | Percentage of soil suspension (%) |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

| | |
|---|---|
| **% SCS Dispersion:** | |
| **Initial Moisture Content (%) :** | |
| **pH:** | |
| **Conductivity mS/m:** | |

| *Atterberg Limits :* | |
|---|---|
| Liquid Limit | 32 |
| Plastic Index | 14 |
| Linear Shrinkage | 7,0 |

**Particle Size Distribution**




| *MOD AASHTO ; C.B.R. :* | |
|---|---|
| MOD AASHTO (Kg/m³) | 1756 |
| O.M.C. (%) | 16,2 |
| C.B.R. @ 100% Comp. | |
| C.B.R. @ 98 % Comp. | |
| C.B.R. @ 95 % Comp. | |
| C.B.R. @ 93 % Comp. | |
| C.B.R. @ 90 % Comp. | |
| Swell ( max ) % | |

| Tabulated Summary | Percentage |
|---|---|
| **Gravel** : Percentage - 4.75 mm | 0 |
| **Sand** : Percentage - 4.75mm and + 0.075mm | 36 |
| **Silt** : Percentage - 0.075mm and + 0.002mm | 30 |
| **Clay** : Percentage - 0.002mm | 34 |



For Geoscience:

Remarks:

GEOSCIENCE LABORATORIES (PTY) LTD

# LABORATORY TEST RESULTS

CLIENT : Gondwana
PROJECT NAME : Louw's Bos South Cemetry

admin only
JOB NO : L180749
SAMPLE NO : 30711

## COMPACTION MOULD PERMEAMETER

POSITION : TP 03 @ 0,30-3,20m
SOIL DESCRIPTION : brown to red silty clay
PERMEANT USED : TAP WATER

| SAMPLE DATA | | |
|---|---|---|
| Standard Proctor | kg/m$^3$ | 1756 |
| OMC | % | 16,20 |
| Percent of Proctor specified | % | 92,00 |
| Dry density of soil required | kg/m$^3$ | 1615,52 |
| Moisture content of sample | % | 16,20 |
| Length of sample | mm | 125,00 |
| Diameter of sample | mm | 150,00 |
| Area of sample | mm$^2$ | 17671,46 |
| Volume of sample | mm$^3$ | 2208932,33 |
| Mass of dry soil required | g | 3568,57 |
| Mass of wet soil required | g | 4146,68 |

| ACTUAL DATA | | |
|---|---|---|
| Mould Number | | P1 |
| Mass of Mould | g | 4386 |
| Mass of Mould and wet soil | g | 8532,68 |
| Mass of wet soil | g | 4146,68 |
| moisture content | % | 16,20 |
| Bulk Density | kg/m$^3$ | 1877,23 |
| Dry Density | kg/m$^3$ | 1615,52 |
| Percentage Proctor | % | 92,00 |

| | | |
|---|---|---|
| Standpipe dia | mm | 3,75 |
| Standpipe area | mm$^2$ | 11,04 |

TEST READINGS

| | Start Test | | | | End Test | | | Comments |
|---|---|---|---|---|---|---|---|---|
| Test | Height | Time | | | Height | Time | | |
| | mm | min | sec | | mm | min | sec | |
| 1 | 2200 | | | | 2150 | 2 | 46 | |
| 2 | 2200 | | | | 2150 | 3 | 35 | |
| 3 | 2200 | | | | 2150 | 1 | 4 | |
| 4 | 2200 | | | | 2150 | 1 | 24 | |

CALCULATIONS FOR FALLING HEAD

| Log H1/H2 | Elapsed Time | COEFFICIENT OF PERMEABILITY |
|---|---|---|
| mm | sec | m/s |
| 0,0100 | 166,00 | 1,08E-08 |
| 0,0100 | 215,00 | 8,34E-09 |
| 0,0100 | 64,00 | 2,80E-08 |
| 0,0100 | 84,00 | 2,14E-08 |

Number of tests = 4

| | | |
|---|---|---|
| AVERAGE = | 1,71E-08 | m/s |
| AVERAGE = | 1,71E-06 | cm/s |

Notes :

GEOSCIENCE LABORATORIES (PTY) LTD

| | | | |
|---|---|---|---|
| **CLIENT:** | Gondwana Geo Solutions<br>108 Upper Kenridge Avenue<br>Durbanville<br>7550 | **PROJECT:** | Louw's Bos South Cemetry |
| | | **DATE:** | 31-07-2018 |
| **ATT:** | Colin Hartley | **REF:** | L180749 |

# *ASTM D422 SIEVE ANALYSIS*

| | | | |
|---|---|---|---|
| **DESCRIPTION :** | grey brown silty sand | **SAMPLE NO. :** | 30712 |
| **POSITION :** | TP 05 @ 0.0-0.60m | **CLIENT SAMPLE NO. :** | |

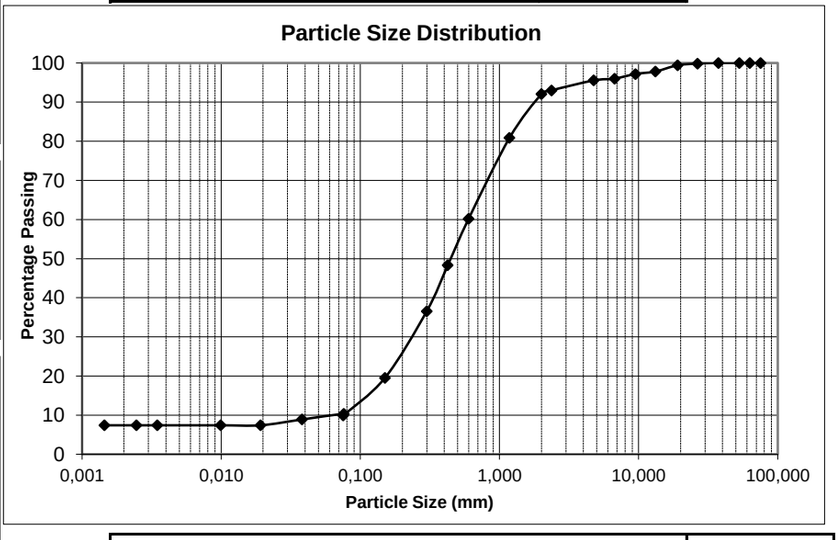
| Sieve Analysis | | Percent Passing |
|---|---|---|
| SIEVE SIZE (mm) | 75,00 | |
| | 63,00 | |
| | 53,00 | |
| | 37,50 | |
| | 26,50 | 100 |
| | 19,00 | 99 |
| | 13,20 | 98 |
| | 9,50 | 97 |
| | 6,70 | 96 |
| | 4,75 | 96 |
| | 2,36 | 93 |
| | 2,00 | 92 |
| | 1,18 | 81 |
| | 0,600 | 60 |
| | 0,425 | 48 |
| | 0,300 | 37 |
| | 0,150 | 19 |
| | 0,0750 | 10 |

| Hydrometer Analysis | |
|---|---|
| Diameter of particle (mm) | Percentage of soil suspension (%) |
| 0,0760 | 10 |
| 0,0380 | 9 |
| 0,0192 | 7 |
| 0,0099 | 7 |
| 0,0035 | 7 |
| 0,0025 | 7 |
| 0,0014 | 7 |

| SCS Dispersion Test | |
|---|---|
| Diameter of particle (mm) | Percentage of soil suspension (%) |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

| | |
|---|---|
| **% SCS Dispersion:** | |
| **Initial Moisture Content (%) :** | |
| **pH:** | |
| **Conductivity mS/m:** | |

| *Atterberg Limits :* | |
|---|---|
| Liquid Limit | |
| Plastic Index | N-P |
| Linear Shrinkage | |




| *MOD AASHTO ; C.B.R. :* | |
|---|---|
| MOD AASHTO (Kg/m³) | 1960 |
| O.M.C. (%) | 8,1 |
| C.B.R. @ 100% Comp. | |
| C.B.R. @ 98 % Comp. | |
| C.B.R. @ 95 % Comp. | |
| C.B.R. @ 93 % Comp. | |
| C.B.R. @ 90 % Comp. | |
| Swell ( max ) % | |

| Tabulated Summary | Percentage |
|---|---|
| **Gravel** : Percentage - 4.75 mm | 4 |
| **Sand** : Percentage - 4.75mm and + 0.075mm | 86 |
| **Silt** : Percentage - 0.075mm and + 0.002mm | 3 |
| **Clay** : Percentage - 0.002mm | 7 |



For Geoscience:

Remarks:

ConSR22

GEOSCIENCE LABORATORIES (PTY) LTD

# LABORATORY TEST RESULTS

CLIENT : Gondwana
PROJECT NAME : Louw's Bos South Cemetry

admin only
JOB NO : L180749
SAMPLE NO : 30712

## COMPACTION MOULD PERMEAMETER

POSITION : TP 05 @ 0,0-0,60m
SOIL DESCRIPTION : grey brown silty sand
PERMEANT USED : TAP WATER

| SAMPLE DATA | | |
|---|---|---|
| MDD (100%) | kg/m$^3$ | 1960 |
| MDD (100%) moisture content | % | 8,1 |
| Percent of MDD specified | % | 92 |
| Dry density of soil required | kg/m$^3$ | 1803,20 |
| Moisture content of sample | % | 8,1 |
| Length of sample | mm | 125,00 |
| Diameter of sample | mm | 150,00 |
| Area of sample | mm$^2$ | 17671,46 |
| Volume of sample | mm$^3$ | 2208932,33 |
| Mass of dry soil required | g | 3983,15 |
| Mass of wet soil required | g | 4305,78 |

| ACTUAL DATA | | |
|---|---|---|
| Mould Number | | P3 |
| Mass of Mould | g | 4371 |
| Mass of Mould and wet soil | g | 8676,78 |
| Mass of wet soil | g | 4305,78 |
| moisture content | % | 8,10 |
| Bulk Density | kg/m$^3$ | 1949,26 |
| Dry Density | kg/m$^3$ | 1803,20 |
| Percentage MDD | % | 92,00 |

| TEST READINGS | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Start Test | | End Test | | Volume | Comments |
| Test | Height | Time | | Time | | outflow | |
| | mm | min | sec | min | sec | ml | |
| 1 | 2200 | | | 16 | 37 | 500 | |
| 2 | 2200 | | | 19 | 46 | 500 | |
| 3 | 2200 | | | 25 | 16 | 500 | |
| 4 | 2200 | | | 22 | 1 | 500 | |

| CALCULATIONS FOR CONSTANT HEAD | | |
|---|---|---|
| Hydraulic gradient | Elapsed Time | COEFFICIENT OF PERMEABILITY |
| mm | sec | m/s |
| 17,60 | 997,00 | 1,61E-06 |
| 17,60 | 1186,00 | 1,36E-06 |
| 17,60 | 1516,00 | 1,06E-06 |
| 17,60 | 1321,00 | 1,22E-06 |

Number of tests = 4

| | | |
|---|---|---|
| AVERAGE = | 1,31E-06 | m/s |
| AVERAGE = | 1,31E-04 | cm/s |

Notes :

GEOSCIENCE LABORATORIES (PTY) LTD

# LABORATORY TEST RESULTS

CLIENT : Gondwana
PROJECT NAME : Louw's Bos South Cemetry

admin only
JOB NO : L180749
SAMPLE NO : 30713

## COMPACTION MOULD PERMEAMETER

POSITION : TP 05 @ 0,60-1,00m
SOIL DESCRIPTION : grey brown silty sand
PERMEANT USED : TAP WATER

| SAMPLE DATA | | |
|---|---|---|
| MDD (100%) | kg/m$^3$ | 2160 |
| MDD (100%) moisture content | % | 9,7 |
| Percent of MDD specified | % | 92 |
| Dry density of soil required | kg/m$^3$ | 1987,20 |
| Moisture content of sample | % | 9,7 |
| Length of sample | mm | 125,00 |
| Diameter of sample | mm | 150,00 |
| Area of sample | mm$^2$ | 17671,46 |
| Volume of sample | mm$^3$ | 2208932,33 |
| Mass of dry soil required | g | 4389,59 |
| Mass of wet soil required | g | 4815,38 |

| ACTUAL DATA | | |
|---|---|---|
| Mould Number | | P4 |
| Mass of Mould | g | 4724 |
| Mass of Mould and wet soil | g | 9539,38 |
| Mass of wet soil | g | 4815,38 |
| moisture content | % | 9,70 |
| Bulk Density | kg/m$^3$ | 2179,96 |
| Dry Density | kg/m$^3$ | 1987,20 |
| Percentage MDD | % | 92,00 |

| TEST READINGS | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Start Test | | End Test | | Volume | Comments |
| Test | Height | Time | | Time | | outflow | |
| | mm | min | sec | min | sec | ml | |
| 1 | 2200 | | | 1 | 1 | 500 | |
| 2 | 2200 | | | 1 | 7 | 500 | |
| 3 | 2200 | | | 1 | 10 | 500 | |
| 4 | 2200 | | | 1 | 16 | 500 | |

| CALCULATIONS FOR CONSTANT HEAD | | |
|---|---|---|
| Hydraulic gradient | Elapsed Time | COEFFICIENT OF PERMEABILITY |
| mm | sec | m/s |
| 17,60 | 61,00 | 2,64E-05 |
| 17,60 | 67,00 | 2,40E-05 |
| 17,60 | 70,00 | 2,30E-05 |
| 17,60 | 76,00 | 2,12E-05 |

Number of tests = 4

| | | |
|---|---|---|
| AVERAGE = | 2,36E-05 | m/s |
| AVERAGE = | 2,36E-03 | cm/s |

Notes :

GEOSCIENCE LABORATORIES (PTY) LTD

# LABORATORY TEST RESULTS

CLIENT : Gondwana
PROJECT NAME : Louw's Bos South Cemetry

admin only
JOB NO : L180749
SAMPLE NO : 30714

## COMPACTION MOULD PERMEAMETER

POSITION : TP 07 @ 0,60-1,00m
SOIL DESCRIPTION : olive brown silty gravel
PERMEANT USED : TAP WATER

| SAMPLE DATA | | |
|---|---|---|
| MDD (100%) | kg/m$^3$ | 2150 |
| MDD (100%) moisture content | % | 7,9 |
| Percent of MDD specified | % | 92 |
| Dry density of soil required | kg/m$^3$ | 1978,00 |
| Moisture content of sample | % | 7,9 |
| Length of sample | mm | 125,00 |
| Diameter of sample | mm | 150,00 |
| Area of sample | mm$^2$ | 17671,46 |
| Volume of sample | mm$^3$ | 2208932,33 |
| Mass of dry soil required | g | 4369,27 |
| Mass of wet soil required | g | 4714,44 |

| ACTUAL DATA | | |
|---|---|---|
| Mould Number | | P5 |
| Mass of Mould | g | 4589 |
| Mass of Mould and wet soil | g | 9303,44 |
| Mass of wet soil | g | 4714,44 |
| moisture content | % | 7,90 |
| Bulk Density | kg/m$^3$ | 2134,26 |
| Dry Density | kg/m$^3$ | 1978,00 |
| Percentage MDD | % | 92,00 |

| TEST READINGS | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Start Test | | End Test | | Volume | Comments |
| Test | Height | Time | | Time | | outflow | |
| | mm | min | sec | min | sec | ml | |
| 1 | 2200 | | | 1 | 59 | 500 | |
| 2 | 2200 | | | 1 | 53 | 500 | |
| 3 | 2200 | | | 1 | 56 | 500 | |
| 4 | 2200 | | | 2 | 1 | 500 | |

Number of tests = 4

| CALCULATIONS FOR CONSTANT HEAD | | |
|---|---|---|
| Hydraulic gradient | Elapsed Time | COEFFICIENT OF PERMEABILITY |
| mm | sec | m/s |
| 17,60 | 119,00 | 1,35E-05 |
| 17,60 | 113,00 | 1,42E-05 |
| 17,60 | 116,00 | 1,39E-05 |
| 17,60 | 121,00 | 1,33E-05 |

| | | |
|---|---|---|
| AVERAGE = | 1,37E-05 | m/s |
| AVERAGE = | 1,37E-03 | cm/s |

Notes :

GEOSCIENCE LABORATORIES (PTY) LTD

| | | | |
|---|---|---|---|
| **CLIENT:** | Gondwana Geo Solutions<br>108 Upper Kenridge Avenue<br>Durbanville<br>7550 | **PROJECT:** | Louw's Bos South Cemetry |
| | | **DATE:** | 31-07-2018 |
| **ATT:** | Colin Hartley | **REF:** | L180749 |

# *ASTM D422 SIEVE ANALYSIS*

| | | | |
|---|---|---|---|
| **DESCRIPTION :** | olive brown to red silty clay | **SAMPLE NO. :** | 30715 |
| **POSITION :** | TP 07 @ 1.00-3.10m | **CLIENT SAMPLE NO. :** | |

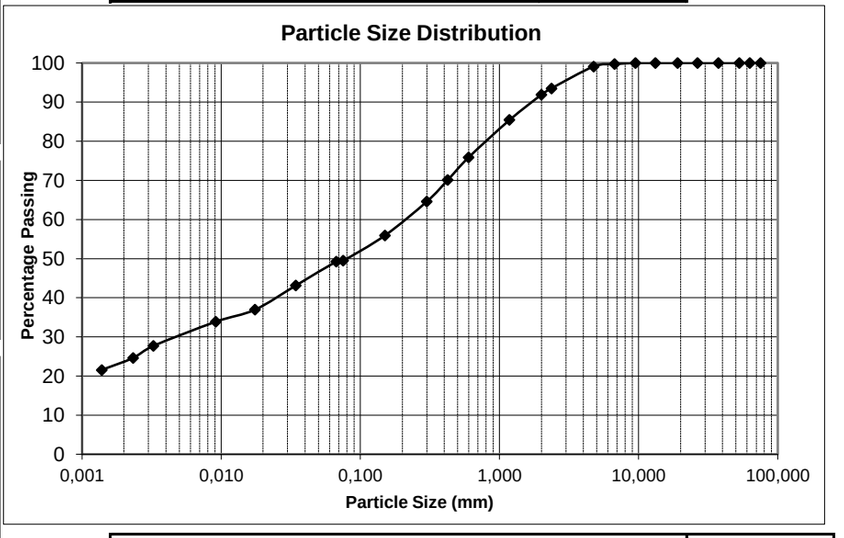
| Sieve Analysis | | Percent Passing |
|---|---|---|
| SIEVE SIZE (mm) | 75,00 | |
| | 63,00 | |
| | 53,00 | |
| | 37,50 | |
| | 26,50 | |
| | 19,00 | |
| | 13,20 | |
| | 9,50 | |
| | 6,70 | 100 |
| | 4,75 | 99 |
| | 2,36 | 94 |
| | 2,00 | 92 |
| | 1,18 | 85 |
| | 0,600 | 76 |
| | 0,425 | 70 |
| | 0,300 | 65 |
| | 0,150 | 56 |
| | 0,0750 | 49 |

| Hydrometer Analysis | |
|---|---|
| Diameter of particle (mm) | Percentage of soil suspension (%) |
| 0,0671 | 49 |
| 0,0343 | 43 |
| 0,0175 | 37 |
| 0,0091 | 34 |
| 0,0033 | 28 |
| 0,0023 | 25 |
| 0,0014 | 22 |

| SCS Dispersion Test | |
|---|---|
| Diameter of particle (mm) | Percentage of soil suspension (%) |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

| | |
|---|---|
| **% SCS Dispersion:** | |
| **Initial Moisture Content (%) :** | |
| **pH:** | |
| **Conductivity mS/m:** | |

| *Atterberg Limits :* | |
|---|---|
| Liquid Limit | 32 |
| Plastic Index | 15 |
| Linear Shrinkage | 7,0 |




| *MOD AASHTO ; C.B.R. :* | |
|---|---|
| MOD AASHTO (Kg/m³) | |
| O.M.C. (%) | |
| C.B.R. @ 100% Comp. | |
| C.B.R. @ 98 % Comp. | |
| C.B.R. @ 95 % Comp. | |
| C.B.R. @ 93 % Comp. | |
| C.B.R. @ 90 % Comp. | |
| Swell ( max ) % | |

| Tabulated Summary | Percentage |
|---|---|
| **Gravel** : Percentage - 4.75 mm | 1 |
| **Sand** : Percentage - 4.75mm and + 0.075mm | 50 |
| **Silt** : Percentage - 0.075mm and + 0.002mm | 23 |
| **Clay** : Percentage - 0.002mm | 26 |



For Geoscience:

Remarks:

ConSR22

# APPENDIX D

**TABLE 1**
**EXCAVATABILITY RATINGS**

| DESCRIPTION | ASSESSMENT | RATING |
|---|---|---|
| Easy Spade | Pick point to 50mm | 15 |
| Pick and Spade | Slight indentation | 10 |
| Machine | Firm blows (1-3mm) | 5 |
| Blasting | Backactor refusal | 0 |

**TABLE 2**
**STABILITY RATINGS**

| DESCRIPTION | ASSESSMENT | RATING |
|---|---|---|
| Stable | Excavation can be profiled safely | 20 |
| Overbreak | Excavation stable: Overbreak 1.3 - 1.8 * | 15 |
| Slightly unstable | Minor falls of material | 8 |
| Unstable | Collapse of hole likely | F |

**Note: Overbreak = Ratio of widths top of trench to base**
**F = Fatal flaw**

**TABLE 3**
**WORKABILITY RATINGS**

| DESCRIPTION | UNIFIED CLASS | MDD (kg/m$^3$) | RATING |
|---|---|---|---|
| Excellent / Good | GW / SW / GP | +1800 | 10 |
| Fair | SP / SM | <1800 | 5 |
| Poor | OL / CL / ML | <1700 | 2 |
| Very poor | OH / CH / MH | >1800 | 0 |

**TABLE 4**
**WATER TABLE RATINGS**

| DESCRIPTION | WATER TABLE DEPTH (m) * | RATING |
|---|---|---|
| Deep water table | +8 | 25 |
| Intermediate | 4 - 8 | 15 |
| Possible perched water | 0 - 4 | 5 |
| Water logged soil | 0 - 4 | F |

**TABLE 5**
**SUBSOIL PERMEABILITY RATINGS**

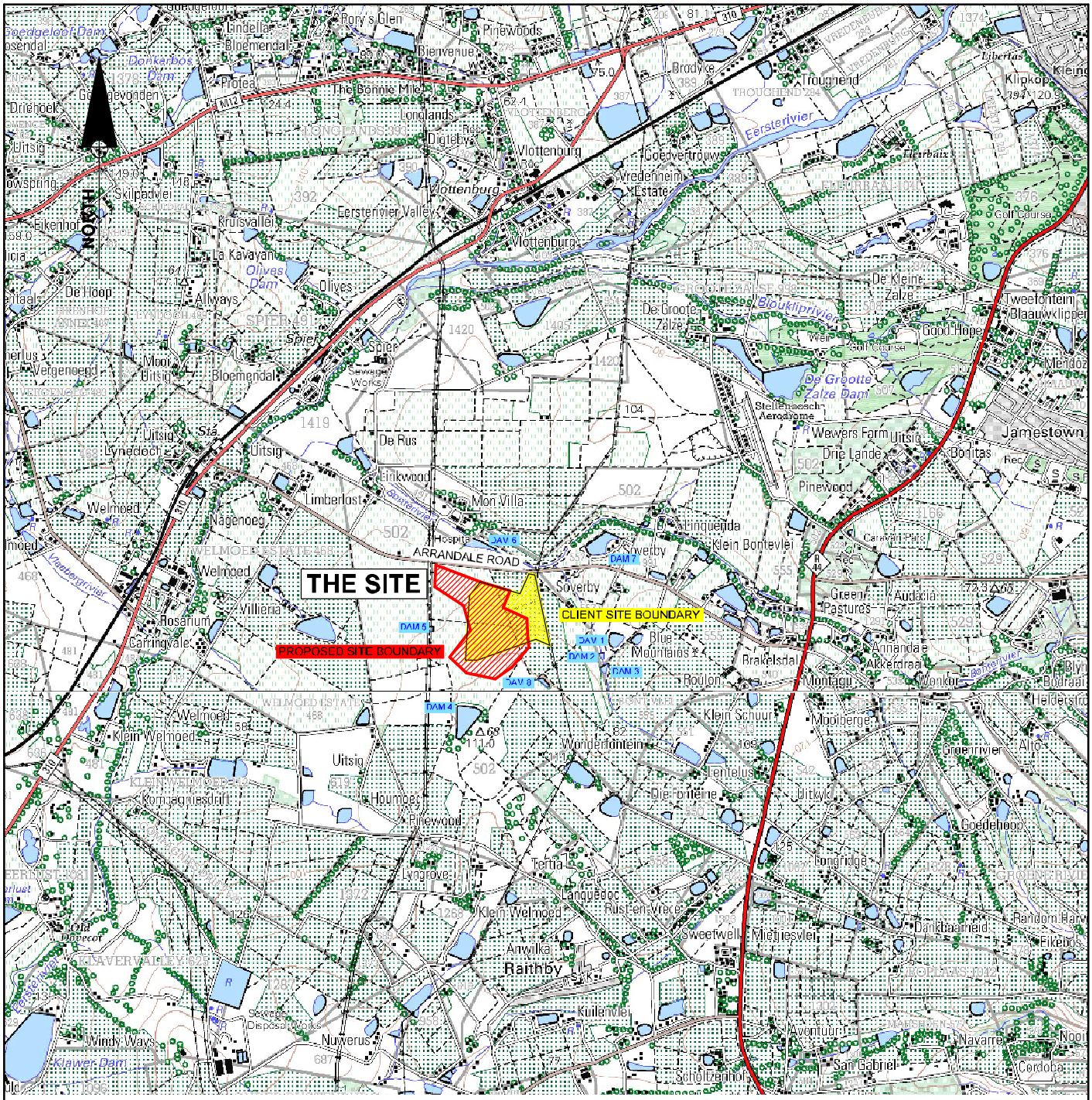
| DESCRIPTION | PERCOLATION RATE (mm/hr) | APPROX. PERMEABILITY (cm/sec) | RATING |
|---|---|---|---|
| Impermeable | Not measurable | $<10^{-5}$ | 15 |
| Relatively impermeable | 10 - 15 | $10^{-4}$ to $10^{-5}$ | 20 |
| Relatively permeable | 15 - 50 | $10^{-3}$ to $10^{-4}$ | 10 |
| Permeable | 50 - 1000 | $>10^{-3}$ | 0 |

**TABLE 6**
**BACKFILL PERMEABILITY RATINGS**

| DESCRIPTION | ASSESSMENT | RATING |
|---|---|---|
| Impermeable | OH / CI / CH | 5 |
| Relatively impermeable | GC / SC / MH | 10 |
| Relatively permeable | GP / SP / GW | 7 |
| Very permeable | SW / SP | 0 |

**Note: * Measured from ground level**

# FIGURES




0m 1km 2km 3km 4km 5km

Graphic Scale
1 / 50 000

NB . Please note that the bar scale supercedes the verbal scale due to print sizes etc.

Drawing prepared from 1 / 50 000 TOPOGRAPHICAL SERIES : 3318 DD

DRAWING DESCRIPTION

**Locality Plan**

**Scale 1 : 50 000 (On A4 Original)**

CLIENT

**C.K. RUMBOLL**

PROJECT

**Geotechnical Investigation for Louws Bos South Cemetery**

GONDWANA GEO SOLUTIONS

DATE **26/07/2018**

DRAWN **A.S.**

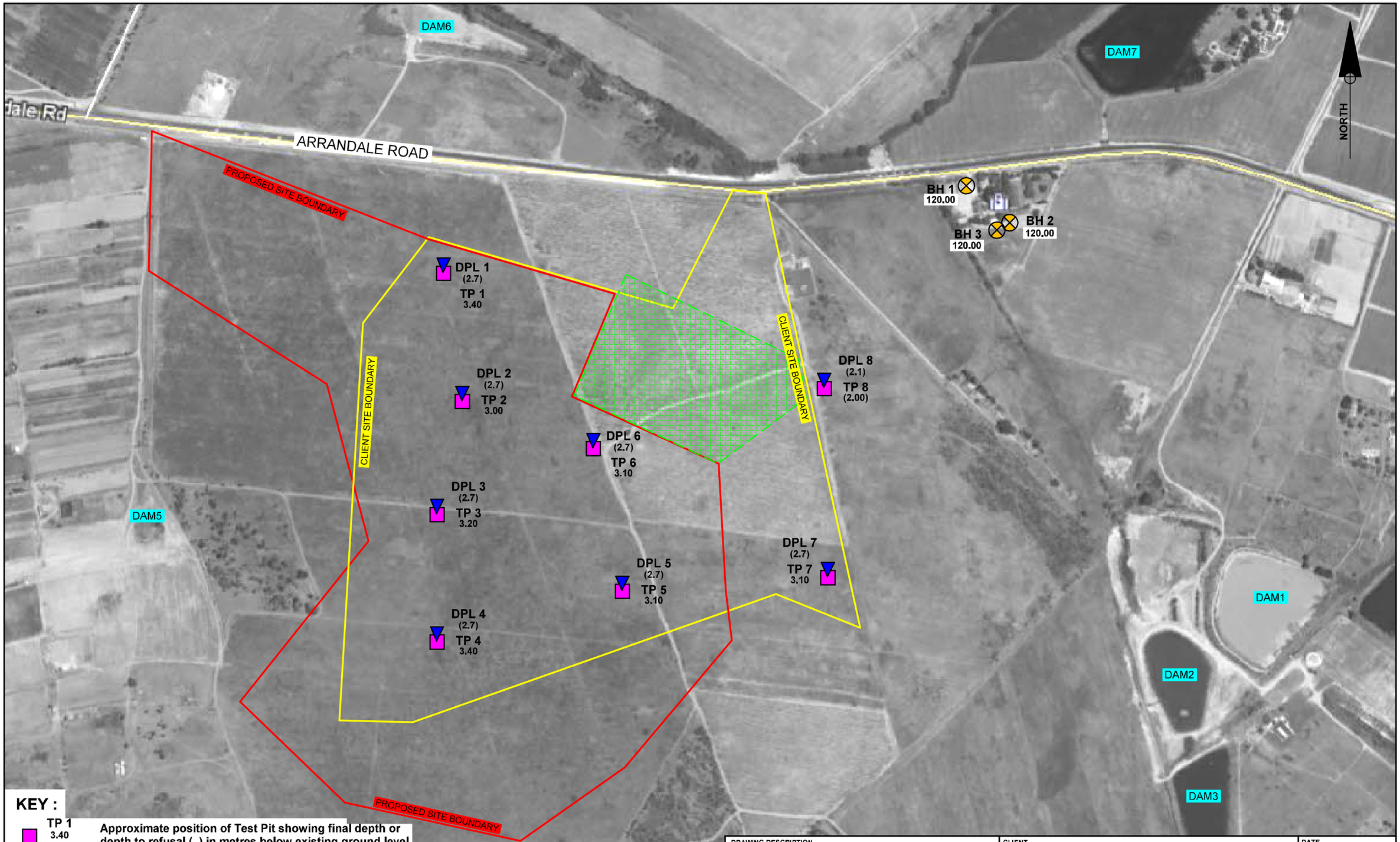
CHECK **M.V.R.**

REFERENCE No. **18 - 820**

FIGURE No. **1**

REV. **0**

18-820 Fig 1 Locality.dr4




NB : Please note that the bar scale supercedes the verbal scale due to print sizes etc.

**KEY :**

| | |
|---|---|
| TP 1 3.40 (2.00) | Approximate position of Test Pit showing final depth or depth to refusal ( ) in metres below existing ground level. |
| DPL 1 (2.7) | Approximate position of Dynamic Cone Penetrometer Test (Light) showing depth to refusal in metres below existing ground level. |
| BH 1 120.00 | Approximate position of Borehole showing final depth in metres below existing ground level. |
| | Area where slopes are >6% |

DRAWING DESCRIPTION

Site Plan showing approximate positions of :

a.) Test Pits.

b.) Dynamic Cone Penetrometer Tests (Light)

c.) Boreholes

Scale 1 : 5000 (On A3 Original)

CLIENT: C.K. RUMBOLL

PROJECT: Geotechnical Investigation for Louws Bos South Cemetery

GONDWANA GEO SOLUTIONS

| | |
|---|---|
| DATE | 26/07/2018 |
| DRAWN | A.S. |
| CHECK | M.V.R. |
| REFERENCE No. | 18 - 820 |
| FIGURE No. | 2 |
| REV. | 0 |

18 - 820 Fig. 2.dr4


## LEGEND

- Alluvium
- Qgg — Gravelly clay/loam soil
- Qg — Loam and sandy loam
- Qs — Sandy soil - Springfontyn Formation
- Qq/Qf — Silcrete (Qq) and ferricrete (Qf)
- do — Dolerite - intrusive rock
- Os — Quartzitic sandstone with thin siltstone/ shale - Peninsula Formation
- N-Ck — Granite - porphyritic, biotitic, with tourmaline-bearing variants. CAPE GRANITE SUITE
- N-Cs — Granite - porphyritic with leucocratic, hybridic, biotitic variants. CAPE GRANITE SUITE
- Nt — Greywacke, phyllite and quartzitic sandstone - interbedded lava and tuff - Tygerberg Formation. MALMESBURY GROUP

0m 2km 4km 6km 8km 10km

Graphic Scale
1 / 100 000
NB : Please note that the bar scale supercedes the verbal scale due to print sizes etc.

Drawing prepared from 1 / 250 000 GEOLOGICAL SERIES : CAPE TOWN 3318

DRAWING DESCRIPTION

**Locality Plan showing Regional Geology**

**Scale 1 : 100 000 (On A4 Original)**

CLIENT **C.K. RUMBOLL**

PROJECT **Geotechnical Investigation for Louws Bos South Cemetery**

GONDWANA GEO SOLUTIONS

DATE **26/07/2018**

DRAWN **A.S.**

CHECK **M.V.R.**

REFERENCE No. **18 - 820**

FIGURE No. **3**

REV. **0**

18-820Fig 3 Reg Geo.drg