

DR J P LOURENS (Pr Eng)

SPECIALIST GEOTECHNICAL ENGINEER

217 Lawley Street Waterkloof Pretoria 0181 Cell 0826529531

Our Ref : W733/vgl

2008-11-04

Your Ref : PJL/L0212

Laubscher Engineers Africa
250 Canopus Street
Waterkloof Ridge
Pretoria
0181

For the attention of Mr Pieter Laubscher

**PROPOSED MANOVANI DEVELOPMENT ON PORTIONS 426, 429 & 561 OF
DERDEPOORT 326-JR: GEOTECHNICAL INVESTIGATION**

With reference to your letter PJL/L0212 dated 1 October 2008, we wish to present a report on the abovementioned investigation:

1. TERMS OF REFERENCE

Laubscher Engineers Africa, on behalf of Capicol (Pty) Ltd, appointed Dr JP Lourens on 1 October 2008 to undertake a geotechnical investigation on the abovementioned properties in accordance with our proposal and cost estimate of 26 September 2008.

The purpose of the investigation was:

- to determine the geology on the site.
- to determine the engineering-geological characteristics of the materials.
- to make recommendations regarding the founding of the structures on the site.

2. SITE DESCRIPTION

- 2.1 The site for the proposed development is situated to the south east of the intersection between Zambezi Drive and Molotto Road. It is bounded to the north by the Plantpark nursery and to the west by Molotto Road. The properties are covered by veld grass and slope towards the west.
- 2.2 Inspection of the existing buildings on the perimeter of the site revealed that one outer wall of the Plantpark building has a large diagonal crack, which is a typical sign of differential displacement of the foundation. A brick building bordering the site to the north east is without cracks, but is only about one year old. (Cracks due to active clays typically maximize in about 5 years time). A house to the south east of the site, which was built some 15 years ago, according to the owner, has not developed any cracks.

3. METHOD OF INVESTIGATION

- 3.1 The investigation was carried out by means of seven 760mm diameter auger holes, drilled with a Williams LLDH 120 of Gauteng Piling (Pty) Ltd. The positions of the test pits and auger holes are shown on the site plan, which is appended to the report.
- 3.2 The test pits were profiled by an engineering geologist, Dave Purnell, of JD Geotechnical Services CC, Engineering Geological Consultants. Disturbed samples were taken in the test pits and sent to Matrolab (Pty) Ltd for laboratory testing. The detailed profiles and the laboratory test results are appended to the report.

4. GEOLOGY AND SOIL PROFILES

- 4.1 Prior to the investigation being carried out, reference was made to the 1:50 000 scale Silverton geological map. According to the map the solid geology in the vicinity of the site is masked by transported sands, and the indications from the map were that the geology underlying the sands could be quartzite of the Rayton Formation, Pretoria Group, Transvaal Supergroup, or norite of the Bushveld

Igneous Complex. The quartzite could be intruded locally by diabase (Pre-Karoo dolerite) sheets.

- 4.2 The indications from the investigation were that the site is underlain by a deeply weathered diabase sheet, which is covered by transported materials which range in thickness from approximately 2,0m in the north of the site to approximately 16,0m in the south of the site.
- 4.3 The top layers of transported soil, to an average depth of some 1,5m, have a collapsible grain structure, with a collapse potential of about 2,7%. These soils generally have a low activity, with the exception of the material in hole no. 7, which tested as medium active in the layer from 2,5m to 5,5m depth.
- 4.4 The residual diabase is deeply weathered, generally to a very dense or very stiff clayey silt or sandy clay. Very soft to soft rock diabase was encountered at an average depth of 15,6m below the natural ground surface. Residual highly weathered quartzite and mudrock were found in borehole A1 at a depth of about 12,0m.
- 4.5 The laboratory test results showed the residual diabase to be generally medium to highly active. Only one example of slickensiding was, however, found in a sample brought to the surface. No slickensides were observed in the borehole sides. The paucity of evidence of movement in the profile can be ascribed to the relatively thick cover of transported soil, which would inhibit moisture changes in the residual diabase. The in situ moisture content of the active layers was also found to be relatively high, varying from 17,6% to 28,3%.
- 4.6 The ground water table was found at an average depth of 12,7m in five of the seven boreholes. No water was encountered in boreholes A2 and A3.

5. DISCUSSION

- 5.1 The maximum heave (on the present ground surface) of the residual diabase profile is estimated by means of Van der Merwe's method (Van der Merwe, 1964), to be about 50mm. It should, however, be noted that the moisture content of the active layers are relatively high (23,3% on average). Building activities normally lead to an *increase* in moisture content in the soil below the buildings. An increase in moisture in the soil (which is already close to saturation) will therefore result in heave substantially less than the maximum possible heave. The largest movement in the soil below the buildings is thus likely to be induced by drying out of the soil.

Moisture variation should be limited, as suggested in the recommendations (section 6).

Due to the above considerations, it is estimated that the maximum movement of the profile will be of the order of 20mm to 25mm.

- 5.2 The laboratory test conducted on the transported soil indicates a collapse potential of about 2,7%. This result corroborates the assessment of the consistency of the layers during the in situ profiling. The low allowable bearing capacity of the potentially collapsible transported soil should thus be noted (indicated as the P-value on the profiles).

6. RECOMMENDATIONS

- 6.1 The following measures should be considered to protect the proposed structures against damage, due to the potential heave and shrinkage of the active soils on the site:

- 6.1.1 Provide a soil raft foundation by excavating the active soil to 1,0m beyond the perimeter of the structure, to a depth of 3m, and replace with approved material compacted in 150mm layers to 95% Mod AASHTO, or

- 6.1.2 Provide a concrete raft foundation capable of accommodating the expected differential movement of the soil of about 25mm.
- 6.1.3 Piled foundations may be utilized where large column loads cannot be cost-effectively incorporated into the abovementioned solutions. A soil or concrete raft will nevertheless still be necessary to protect the floors and other structural elements against heave. The type of pile to be used (if considered necessary) and the founding depth can be decided on when the details of the structures are finalized.
- 6.1.4 It is evident that the type of structure and its location on the site has an influence on which of the alternative foundation solutions (or combination thereof) are to be selected. The final foundation selection should be made in conjunction with the geotechnical engineer once the details of the different structures become available.
- 6.1.5 Site drainage must be such that no ponding of water is allowed on the site. Water must be led away from structures by means of lined canals and wide pavements (at least 1m wide) adjacent to walls. The entire development must be properly drained.
- 6.1.6 Water and sewage pipes entering buildings must be fitted with flexible couplings. All storm water, sewage and water pipes and channels must be watertight.
- 6.1.7 Garden beds against buildings must not be allowed. Trees and shrubs which could desiccate the soil should not be planted near to the buildings. No trees should be planted within 1,5 times their mature height from the buildings.
- 6.2 The allowable bearing capacity of the different soil layers for spread and raft foundations is indicated on the soil profiles as P-values. The low bearing capacity of the collapsible transported layers should be noted.

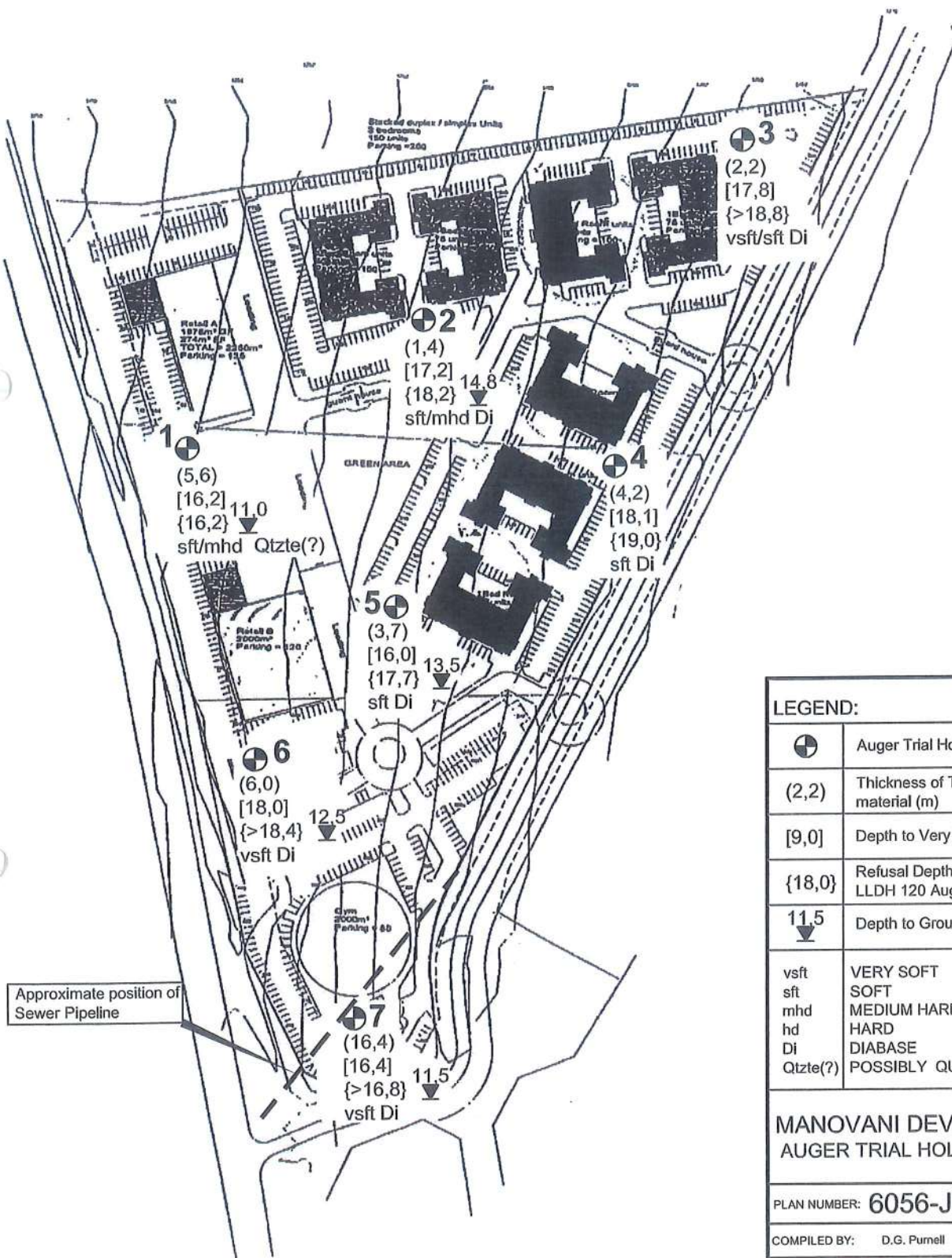
6.3 The maximum dry density and CBR test results for the surface layers (to a maximum depth of 2,2m) which could be utilized for design of the pavements are appended to the report. Table 1 in the appendix contains a summary of all the tests performed during the investigation.

7. REFERENCE

7.1 Van der Merwe, DH (1964). The prediction of heave from the plasticity index and percentage clay fraction of soils. The Civil Engineer in South Africa. June 1964

APPENDIX 1

**SITE PLAN
WITH
BOREHOLE POSITIONS**



LEGEND:

| | |
|-----------|--|
| | Auger Trial Hole Position |
| (2,2) | Thickness of Transported material (m) |
| [9,0] | Depth to Very Soft Rock (m) |
| {18,0} | Refusal Depth of Williams LLDH 120 Auger Drill (m) |
| 11,5 | Depth to Groundwater Table (m) |
| vsft | VERY SOFT |
| sft | SOFT |
| mhd | MEDIUM HARD |
| hd | HARD |
| Di | DIABASE |
| Qtzite(?) | POSSIBLY QUARTZITE |

**MANOVANI DEVELOPMENT
AUGER TRIAL HOLE POSITIONS**

PLAN NUMBER: **6056-JD/01**

COMPILED BY: D.G. Purnell

GEOTECHNICAL SERVICES CC

Reg No. 2007 / 031708 / 23
Vat 4170235701

Unit 4, Durham Place
81 Durham Road
CLUBVIEW
0014

Tel 012 654 5280
Cell 083 234 9023
Fax 012 654 5277
e-mail jdgeotech@telkomsa.net
dave.geotech@gmail.com

SCALE: 1 : 2 500 DATE: October 2008

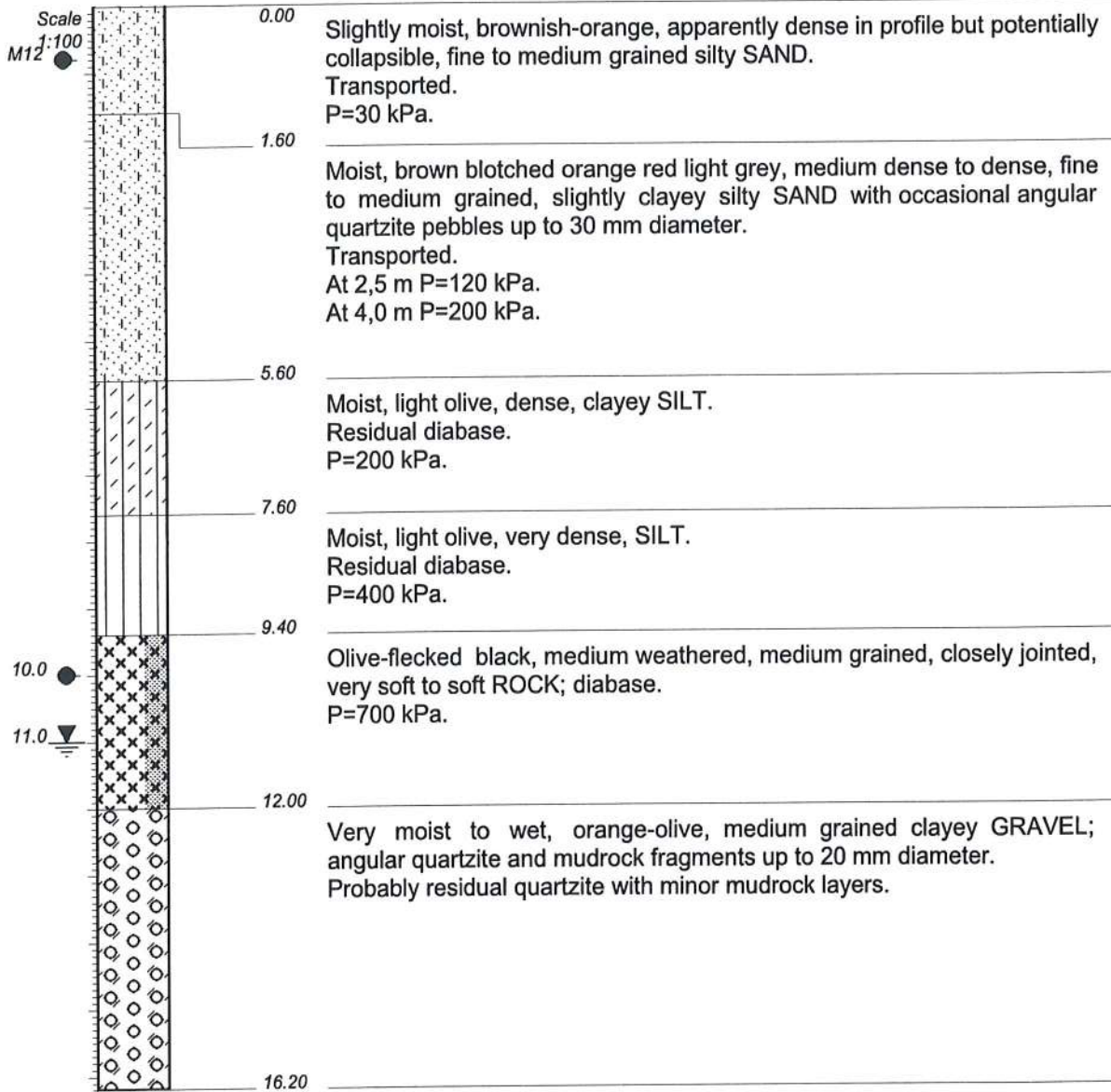
APPENDIX 2

**BOREHOLE
PROFILES**

MANOVANI DEVELOPMENT

HOLE No: A1
Sheet 1 of 1

JOB NUMBER: 6056-JD



NOTES

- 1) Groundwater table at 11,0 m; steady seepage.
- 2) Auger drill refusal at 16,2 m depth, probably on soft to medium hard rock (probably quartzite).
- 3) Could not profile in auger trial hole beneath 10,0 m depth due to level of water in trial hole; the profile beneath this depth has been inferred from the auger flight samples, and the depths have been inferred.
- 4) Disturbed sample taken; M12 at 0,8 m.

CONTRACTOR: GAUTENG PILING
MACHINE: WILLIAMS LLDH 120
DRILLED BY:
PROFILED BY: D G PURNELL
TYPE SET BY: K STEWART
SETUP FILE: STANDARD.SET

INCLINATION :
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DATE: 2007-10-15+16
DATE: 21/10/08 13:35
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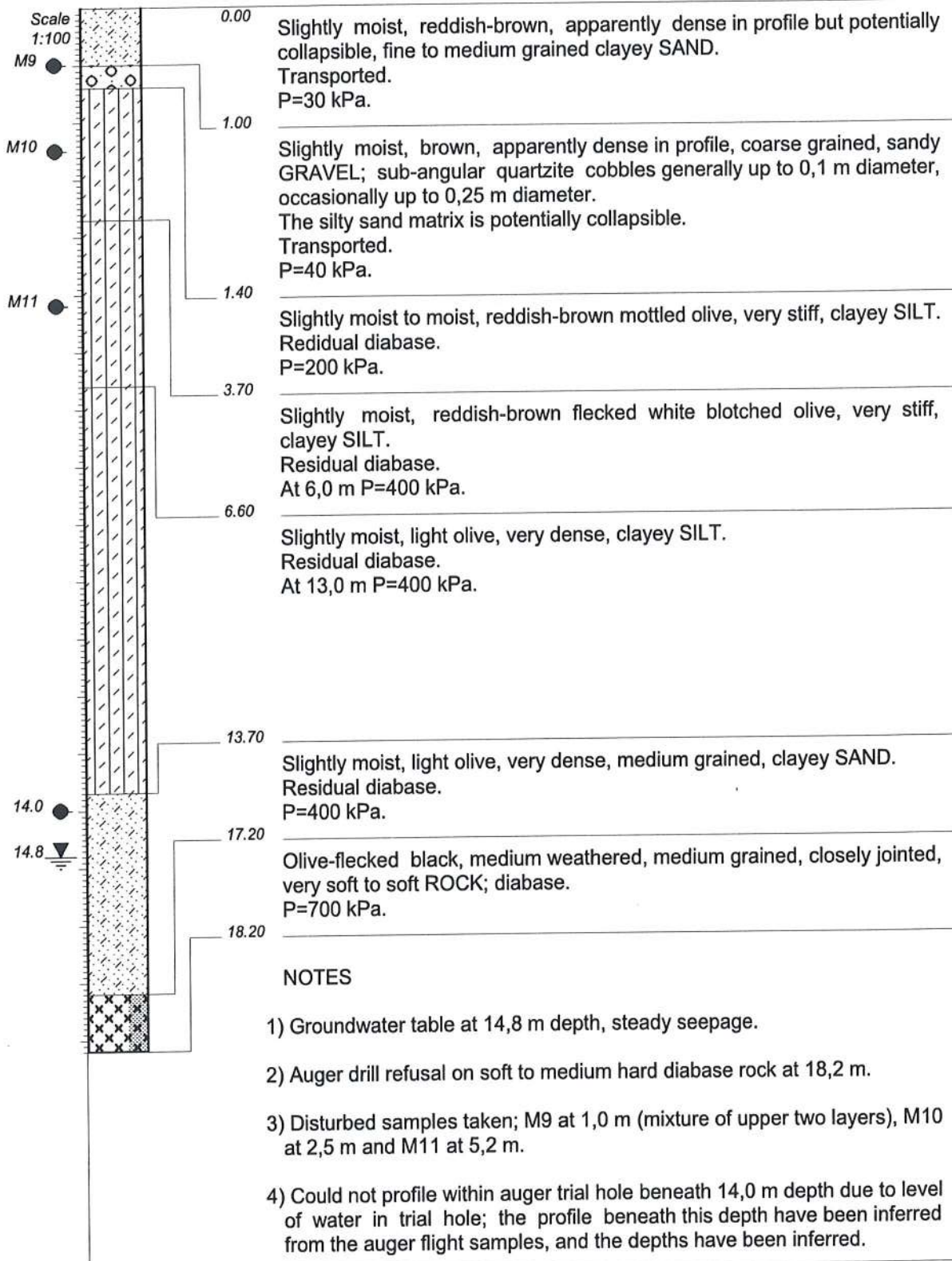
ELEVATION :
X-COORD :
Y-COORD :

HOLE No: A1

MANOVANI DEVELOPMENT

HOLE No: A2
Sheet 1 of 1

JOB NUMBER: 6056-JD



CONTRACTOR : GAUTENG PILING
MACHINE : WILLIAMS LLDH 120
DRILLED BY :
PROFILED BY : D G PURNELL
TYPE SET BY : K STEWART
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM : 760 mm
DATE : 2008-10-15+16
DATE : 2007-10-15+16
DATE : 21/10/08 13:35
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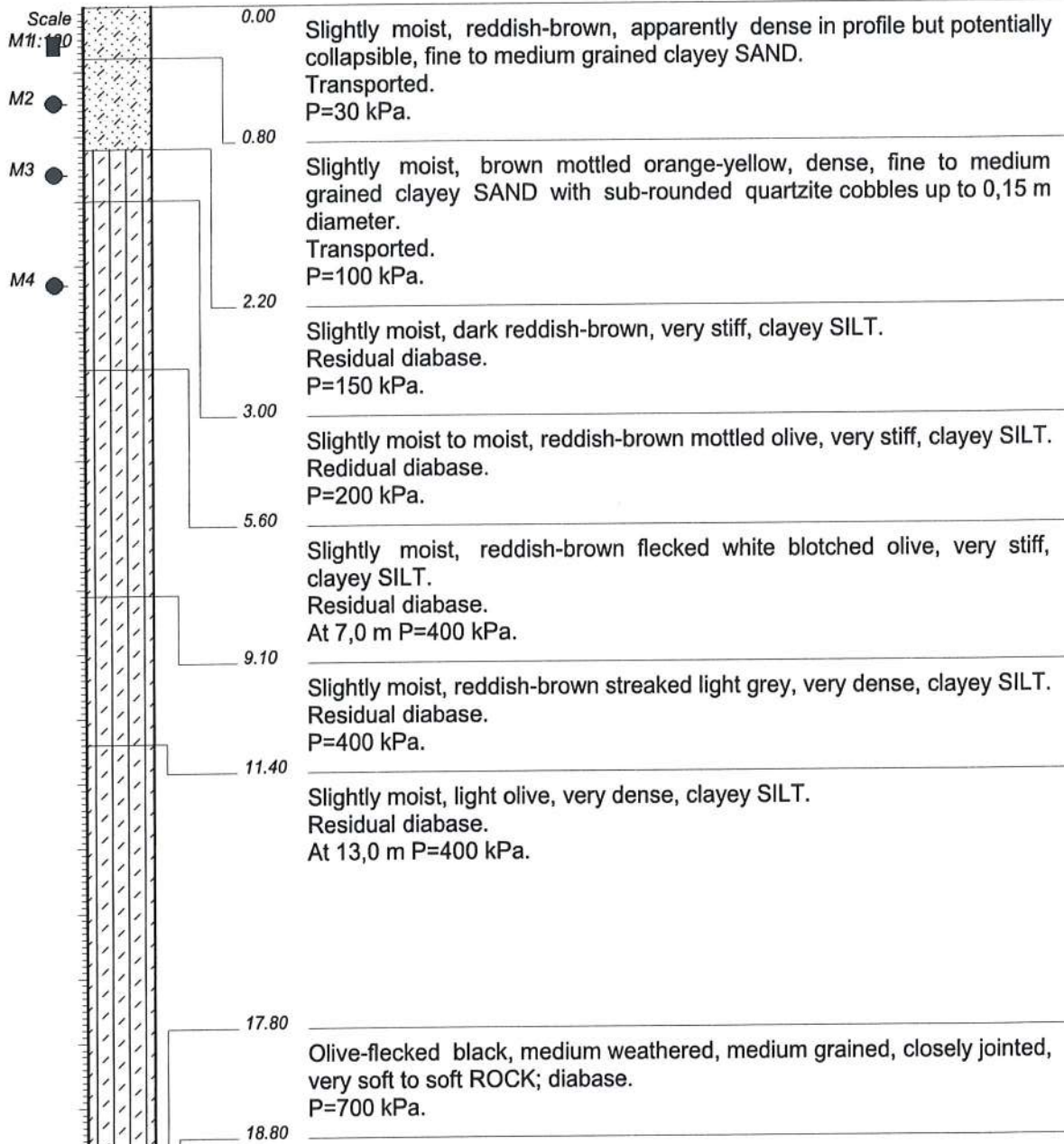
ELEVATION :
X-COORD :
Y-COORD :

HOLE No: A2

MANOVANI DEVELOPMENT

HOLE No: A3
Sheet 1 of 1

JOB NUMBER: 6056-JD



NOTES

- 1) No groundwater seepage.
- 2) Instructed auger to stop drilling at 18,8 m.
- 3) Undisturbed sample taken; M1 at 0,6 m.
- 4) Disturbed samples taken; M2 at 1,5 m, M3 at 2,6 m and M4 at 4,3 m.

CONTRACTOR : GAUTENG PILING
MACHINE : WILLIAMS LLDH 120
DRILLED BY :
PROFILED BY : D G PURNELL
TYPE SET BY : K STEWART
SETUP FILE : STANDARD.SET

INCLINATION :
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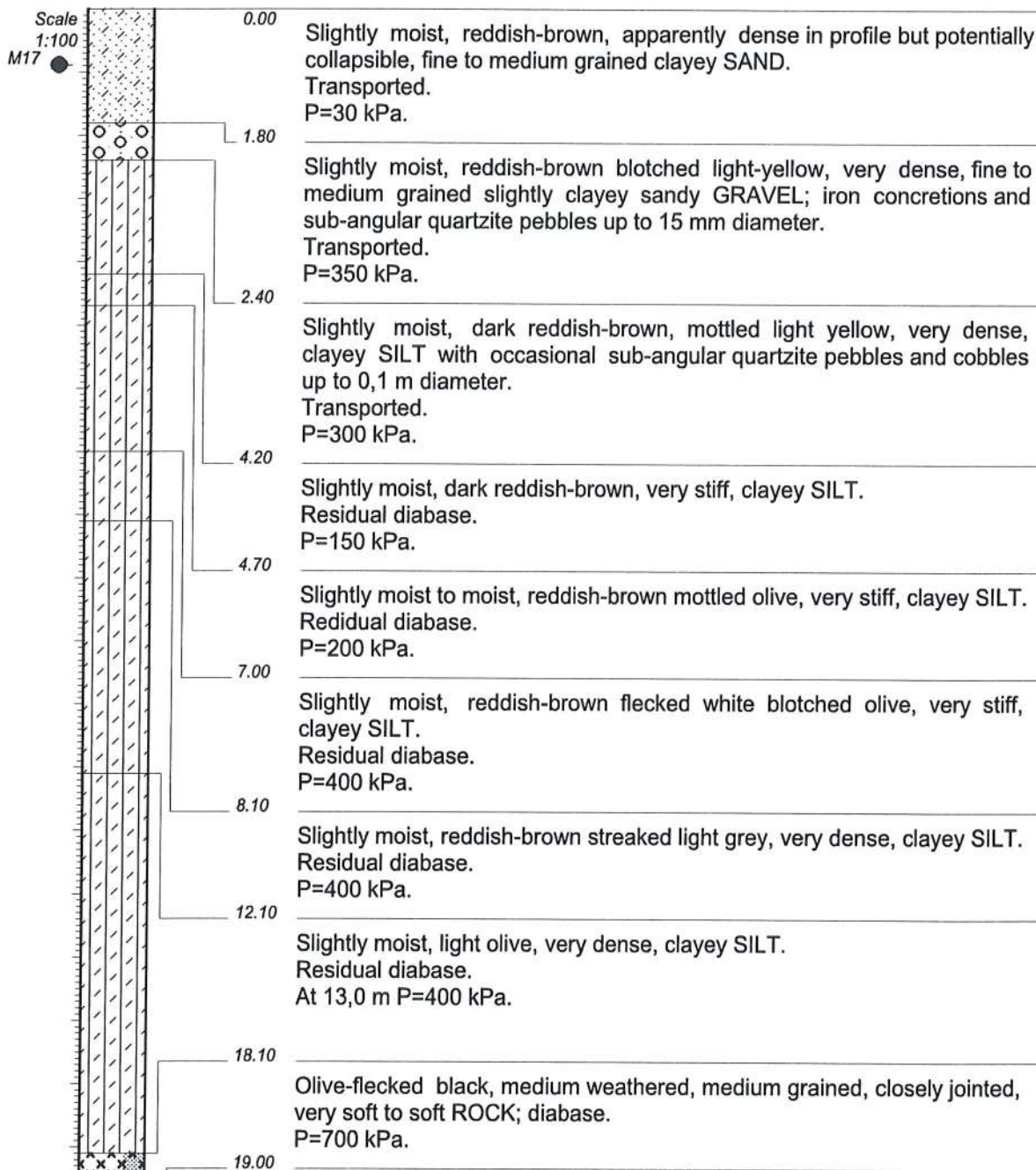
ELEVATION :
X-COORD :
Y-COORD :

HOLE No: A3

MANOVANI DEVELOPMENT

HOLE No: A4
Sheet 1 of 1

JOB NUMBER: 6056-JD



NOTES

- 1) No groundwater seepage.
- 2) Auger drill refusal on soft diabase rock at 19,0 m.
- 3) Disturbed sample taken; M17 at 0,9 m.

CONTRACTOR : GAUTENG PILING
MACHINE : WILLIAMS LLDH 120
DRILLED BY :
PROFILED BY : D G PURNELL
TYPE SET BY : K STEWART
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM : 760 mm
DATE : 2008-10-15+16
DATE : 2007-10-15+16
DATE : 21/10/08 13:35
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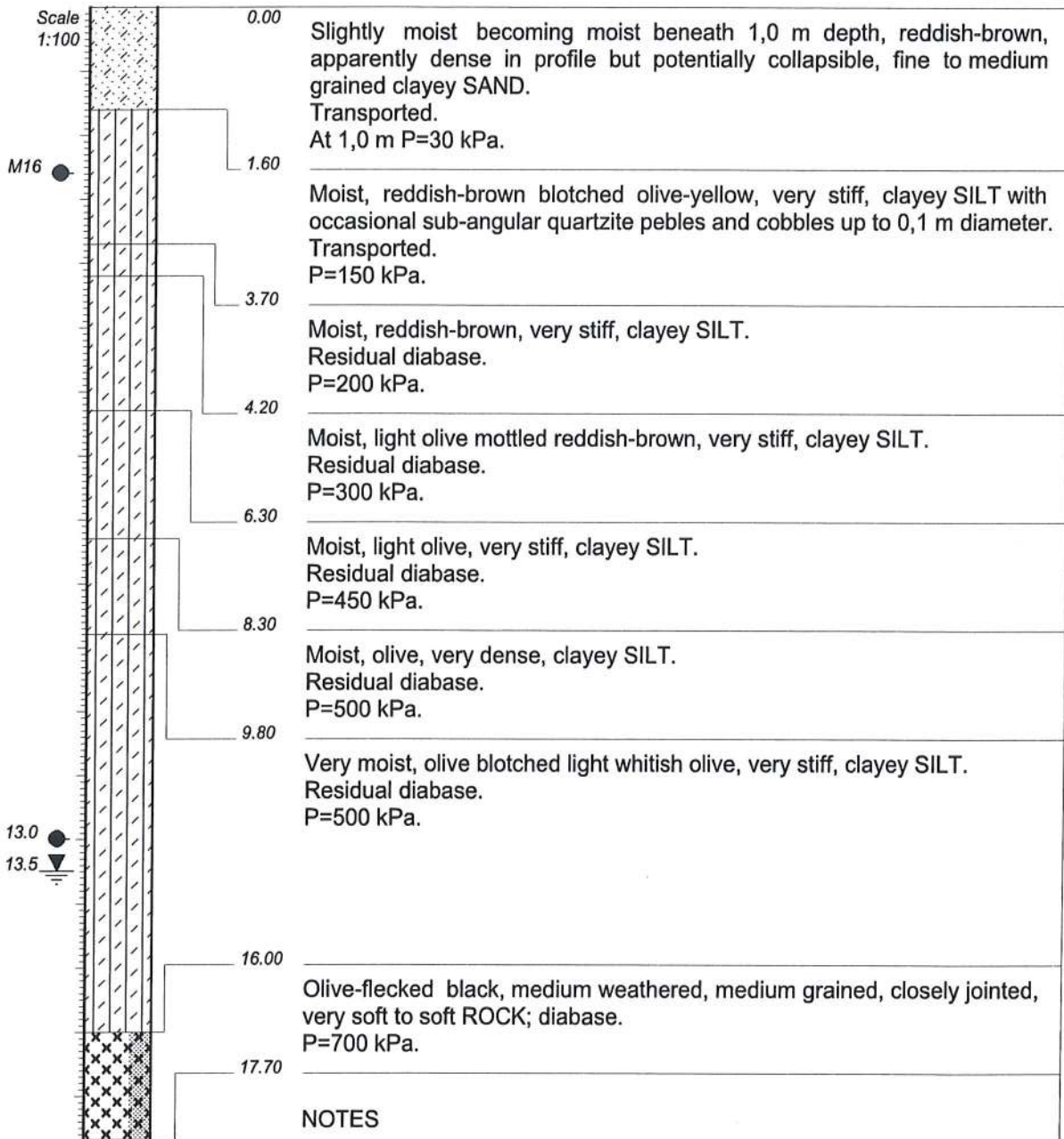
ELEVATION :
X-COORD :
Y-COORD :

HOLE No: A4

MANOVANI DEVELOPMENT

HOLE No: A5
Sheet 1 of 1

JOB NUMBER: 6056-JD



NOTES

- 1) Groundwater table at 13,5 m; steady seepage.
- 2) Auger drill refusal on soft diabase rock at 17,7 m.
- 3) Did not profile in auger trial hole beneath 13,0 m depth due to level of water in trial hole; the profile beneath this depth has been inferred from the auger flight samples, and the depths have been inferred.
- 4) Disturbed sample taken; M16 at 2,6 m.

CONTRACTOR : GAUTENG PILING
MACHINE : WILLIAMS LLDH 120
DRILLED BY :
PROFIED BY : D G PURNELL
TYPE SET BY : K STEWART
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM : 760 mm
DATE : 2008-10-15+16
DATE : 2007-10-15+16
DATE : 21/10/08 13:35
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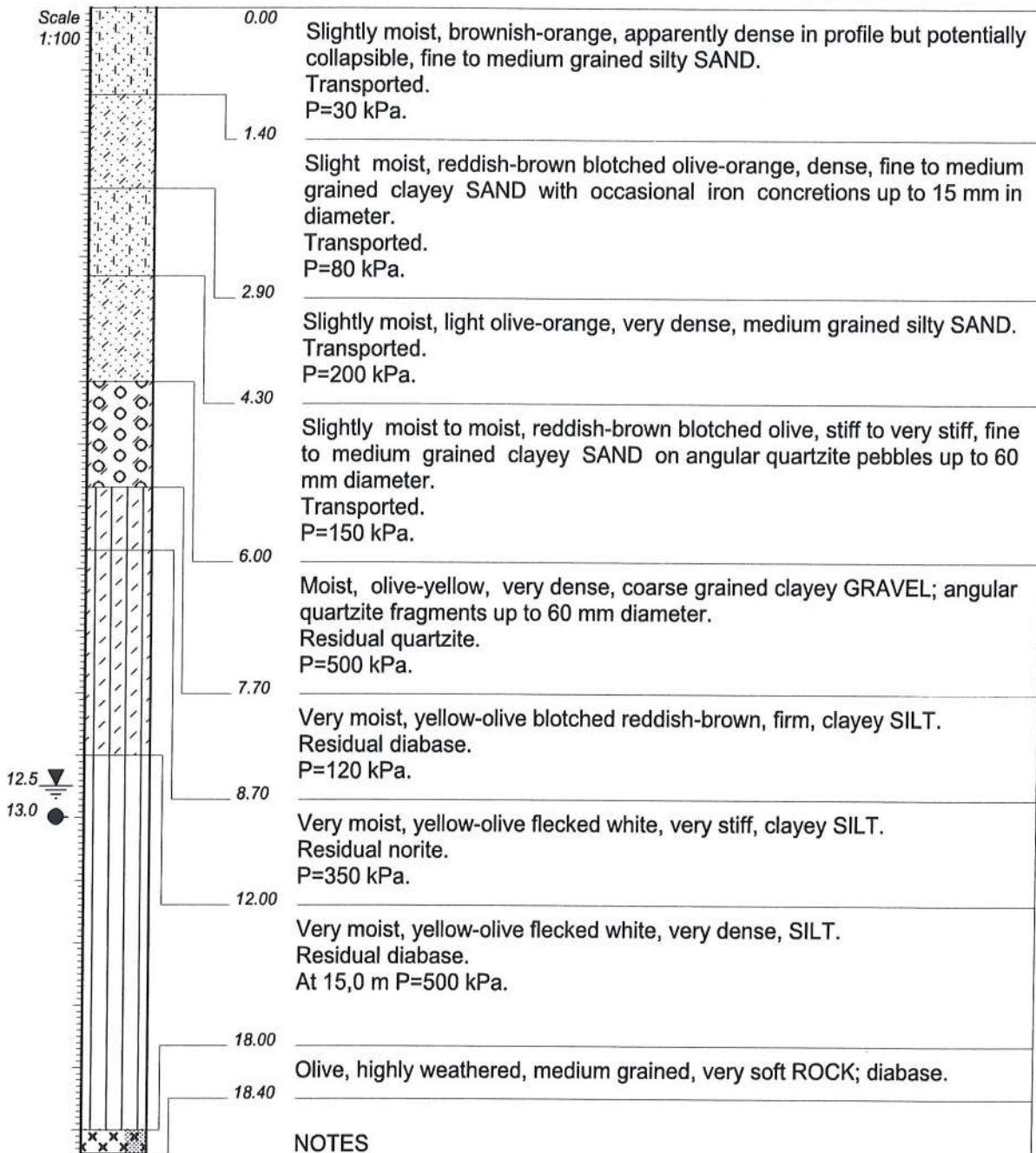
ELEVATION :
X-COORD :
Y-COORD :

HOLE No: A5

MANOVANI DEVELOPMENT

HOLE No: A6
Sheet 1 of 1

JOB NUMBER: 6056-JD



NOTES

- 1) Groundwater table at 12,5 m, steady seepage.
- 2) Auger stopped drilling at 18,4 m due to sides collapsing.
- 3) Did not profile in auger trial hole beneath 13,0 m depth due to level of water in trial hole; the profile beneath this depth has been inferred from the auger flight samples, and the depths have been inferred.

CONTRACTOR : GAUTENG PILING
MACHINE : WILLIAMS LLDH 120
DRILLED BY :
PROFILED BY : D G PURNELL
TYPE SET BY : K STEWART
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM : 760 mm
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DATE : 2007-10-15+16
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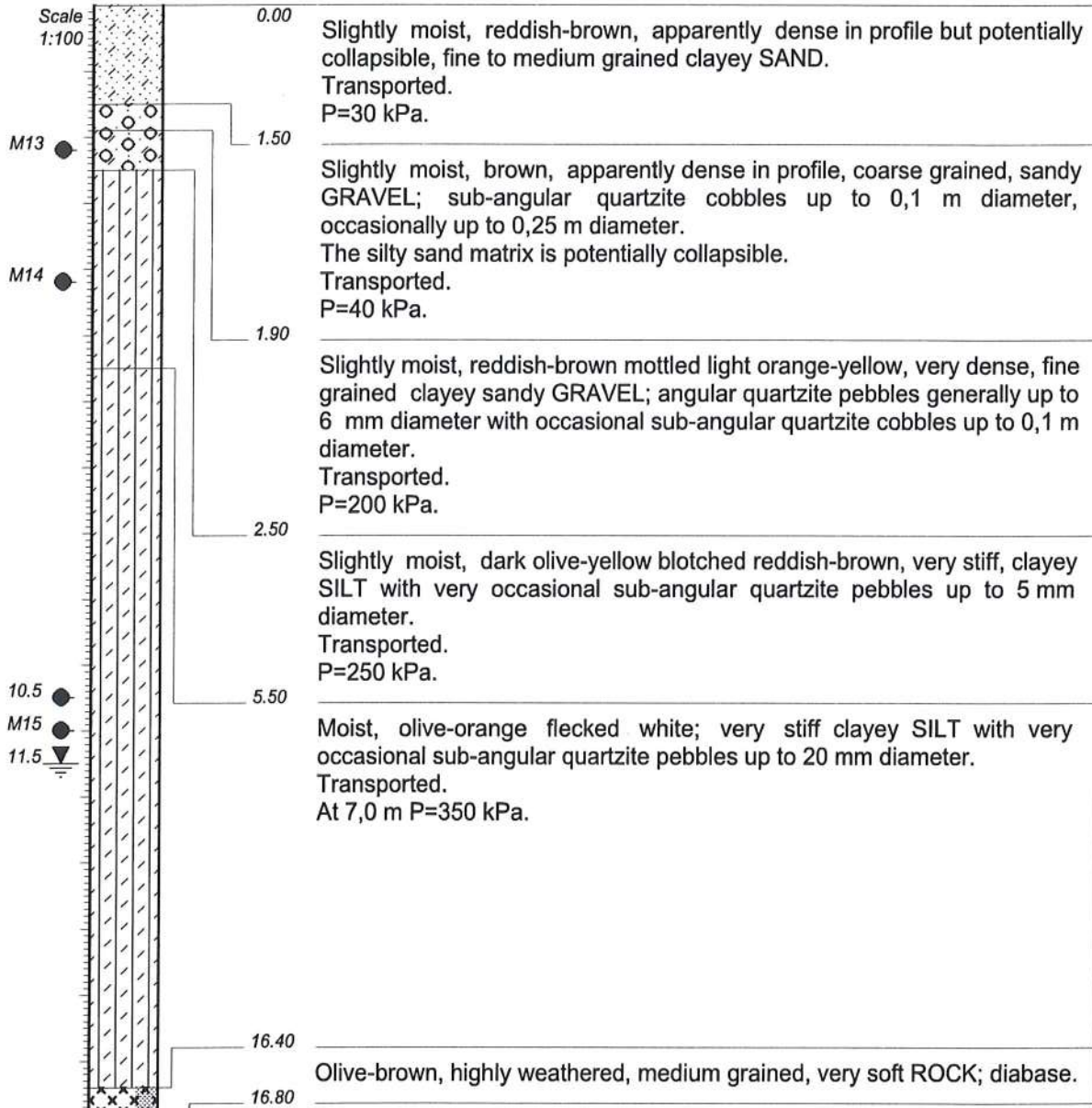
ELEVATION :
X-COORD :
Y-COORD :

HOLE No: A6

MANOVANI DEVELOPMENT

HOLE No: A7
Sheet 1 of 1

JOB NUMBER: 6056-JD



NOTES

- 1) Groundwater table at 11,5 m; steady seepage.
- 2) Auger stopped drilling at 16,8 m depth due to sides collapsing.
- 3) Did not profile within auger trial hole deeper than 10,5 m due to level of water in trial hole; the profile beneath this depth has been inferred from the auger flight samples, and the depths have been inferred.
- 4) Disturbed samples taken; M13 at 2,2 m, M14 at 4,2 m and M15 at 11,0 m.

CONTRACTOR : GAUTENG PILING
MACHINE : WILLIAMS LLDH 120
DRILLED BY :
PROFIED BY : D G PURNELL
TYPE SET BY : K STEWART
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM : 760 mm
DATE : 2008-10-15+16
DATE : 2007-10-15+16
DATE : 21/10/08 13:35
TEXT : ..MONAVO-2AUGERH-1.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: A7

APPENDIX 3

**LABORATORY
TEST RESULTS**



MATROLAB GROUP (PTY.) LTD.

- CIVIL ENGINEERING SERVICES -

Reg No.: 2003/029180/07 - VAT Reg.No.: 4040210587

a SANAS Accredited Testing Laboratory, No. T0025

256 Branders Street, Dan Niemand Park, Pretoria
P.O. BOX 912387, SILVERTON, 0127

Tel : (012) 800 1299
Fax : (012) 800 3043
Email : sunilo@matrolab.co.za

TEST RESULTS

JOHAN LOURENS
Attention: Mr Johan Lourens

Project : Manovani Development

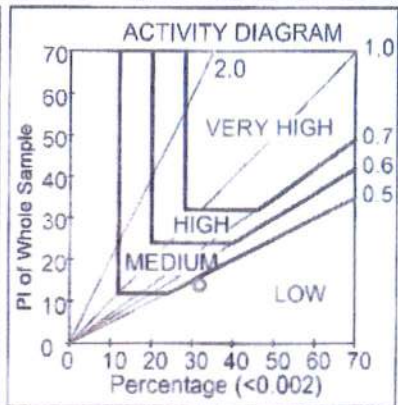
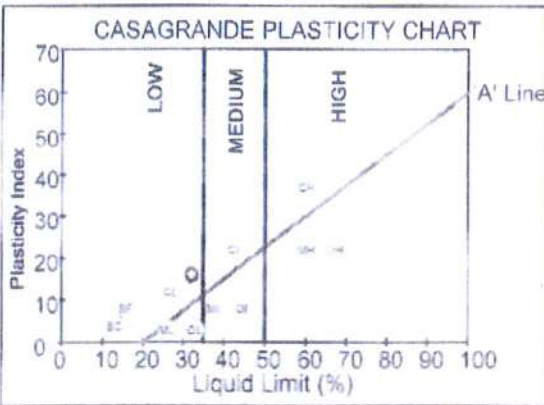
Your Ref :
Our Ref : PL/50016
Date Reported : 27 10 2008

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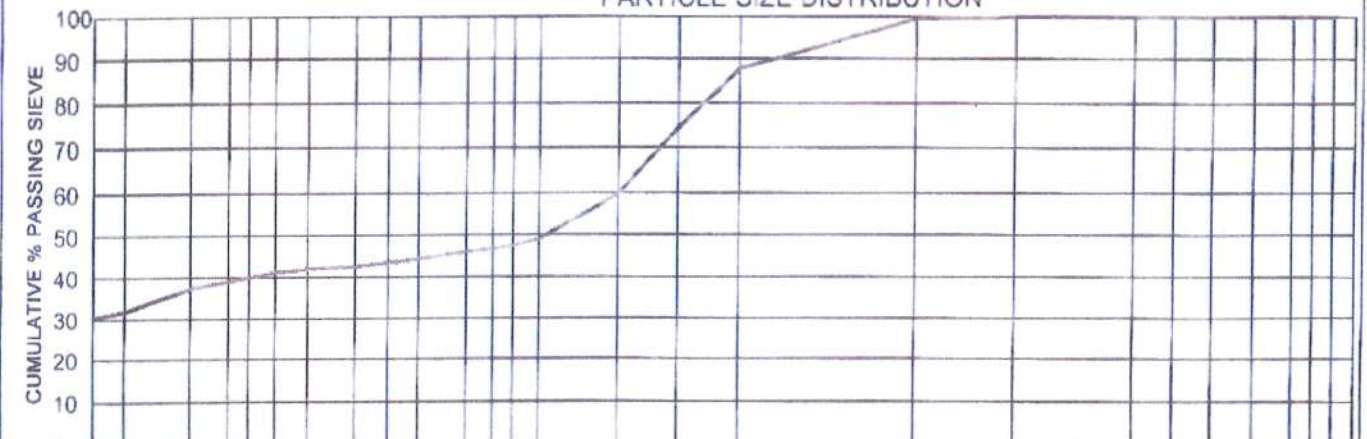
Sample No. : A83993
Hole No. : M1-A3
Depth (mm) : 0-800
Liquid Limit (%) : 32
Plasticity Index : 16
Linear Shrinkage (%) : 8.5
PI of Whole Sample : 14
P.R.A. Classification : A-6(5)
Unified Soil Classifier: SC
Activity : 0.44
Heave Classification : LOW
Grading Modulus : 0.64
Percentage (<0.002) : 32.0
Moisture Content (%) : 9.5

Material Description : Red Brown Silty Clayey Sand

| | Clay (%) | Silt (%) | Sand (%) | Gravel (%) | Classification |
|------------------|----------|----------|----------|------------|----------------|
| Jennings | 38.9 | 7.8 | 52.7 | 0.5 | SANDY CLAY |
| Astm | 38.9 | 10.1 | 50.9 | 0.0 | SANDY CLAY |
| British Standard | 32.0 | 15.5 | 52.0 | 0.5 | SANDY CLAY |



PARTICLE SIZE DISTRIBUTION



| Sieve Size (mm) | 0.0015 | 0.0020 | 0.0036 | 0.0050 | 0.0060 | 0.0075 | 0.0100 | 0.0150 | 0.0200 | 0.0260 | 0.0400 | 0.0500 | 0.0600 | 0.0750 | 0.1500 | 0.2500 | 0.4250 | 2.0000 | 4.7500 | 13.200 | 19.000 | 26.500 | 37.500 | 53.000 | 63.000 | 75.000 | | |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-----|--|
| % Pass. Sieve | 30 | 32 | 37 | 39 | 40 | 41 | 42 | 43 | 44 | 44 | 46 | 47 | 47 | 49 | 60 | 74 | 88 | 99 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | |
| JENN CLAY | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ASTM CLAY | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BS CLAY | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Remarks :



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- CIVIL ENGINEERING SERVICES -
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 P.O. BOX 912387, SILVERTON, 0127

Tel. : (012) 800 1299
 Fax : (012) 800 3043
 Email: suriid@matrolab.co.za

TEST RESULTS

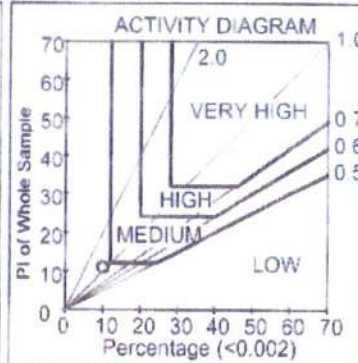
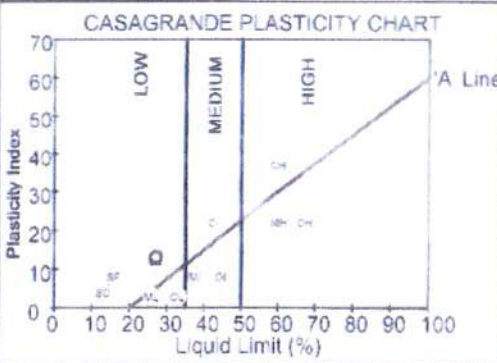
JOHAN LOURENS
 Attention: Mr Johan Lourens

Project : Marovani Development
 Your Ref :
 Our Ref : PL/50016
 Date Reported : 27.10.2008

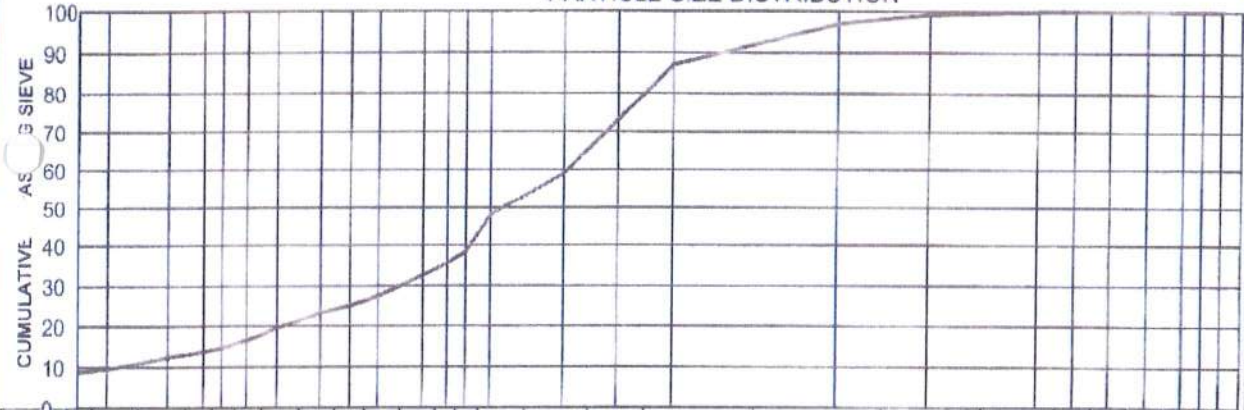
FOUNDATION INDICATOR (ASTM: D422)

Sample No. : A83994
 Hole No. : M2-A3
 Depth (mm) : 800-2200
 Liquid Limit (%) : 27
 Plasticity Index : 13
 Linear Shrinkage (%) : 7.5
 PI of Whole Sample : 11
 P.R.A. Classification : A-6(4)
 Unified Soil Classification : SC
 Activity : 1.15
 Heave Classification : LOW
 Grading Modulus : 0.68
 Percentage (<0.002) : 10.0
 Moisture Content (%) : 11.5

| Material Description : Brown Clayey Silty Sand | | | | | |
|--|----------|----------|----------|------------|----------------|
| | Clay (%) | Silt (%) | Sand (%) | Gravel (%) | Classification |
| Jennings | 13.8 | 21.7 | 61.5 | 3.0 | SILTY SAND |
| Astm | 13.8 | 34.4 | 51.0 | 0.8 | SILTY SAND |
| British Standard | 9.6 | 28.9 | 58.6 | 3.0 | SILTY SAND |



PARTICLE SIZE DISTRIBUTION



| Sieve Size (mm) | % Pass | JENN CLAY | SILT | SAND | GRAVEL |
|-----------------|--------|-----------|------|------|--------|
| 0.0015 | 9 | | | | |
| 0.0020 | 10 | | | | |
| 0.0036 | 12 | | | | |
| 0.0050 | 14 | | | | |
| 0.0060 | 15 | | | | |
| 0.0075 | 17 | | | | |
| 0.0100 | 20 | | | | |
| 0.0150 | 23 | | | | |
| 0.0200 | 25 | | | | |
| 0.0260 | 27 | | | | |
| 0.0400 | 33 | | | | |
| 0.0500 | 36 | | | | |
| 0.0600 | 38 | | | | |
| 0.0750 | 48 | | | | |
| 0.1500 | 58 | | | | |
| 0.2500 | 73 | | | | |
| 0.4250 | 87 | | | | |
| 2.0000 | 97 | | | | |
| 4.7500 | 99 | | | | |
| 13.200 | 100 | | | | |
| 19.000 | 100 | | | | |
| 26.500 | 100 | | | | |
| 37.500 | 100 | | | | |
| 53.000 | 100 | | | | |
| 63.000 | 100 | | | | |
| 75.000 | 100 | | | | |

Remarks :



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Email: sunild@matrolab.co.za

TEST RESULTS

JOHAN LOURENS

Project : Manovani Development

Attention: Mr Johan Lourens

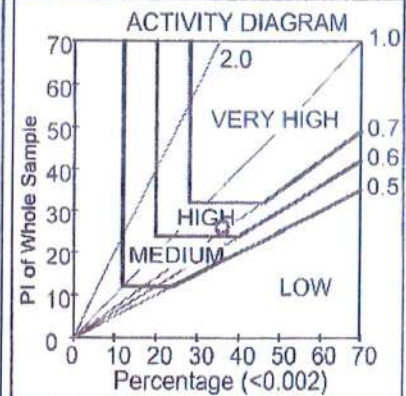
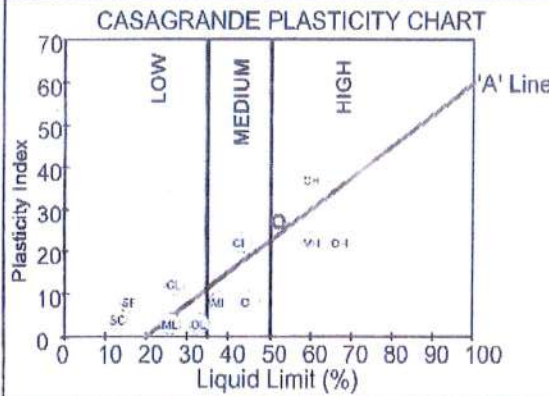
Your Ref :
Our Ref : PL/50016
Date Reported : 27.10.2008

FOUNDATION INDICATOR (ASTM: D422)

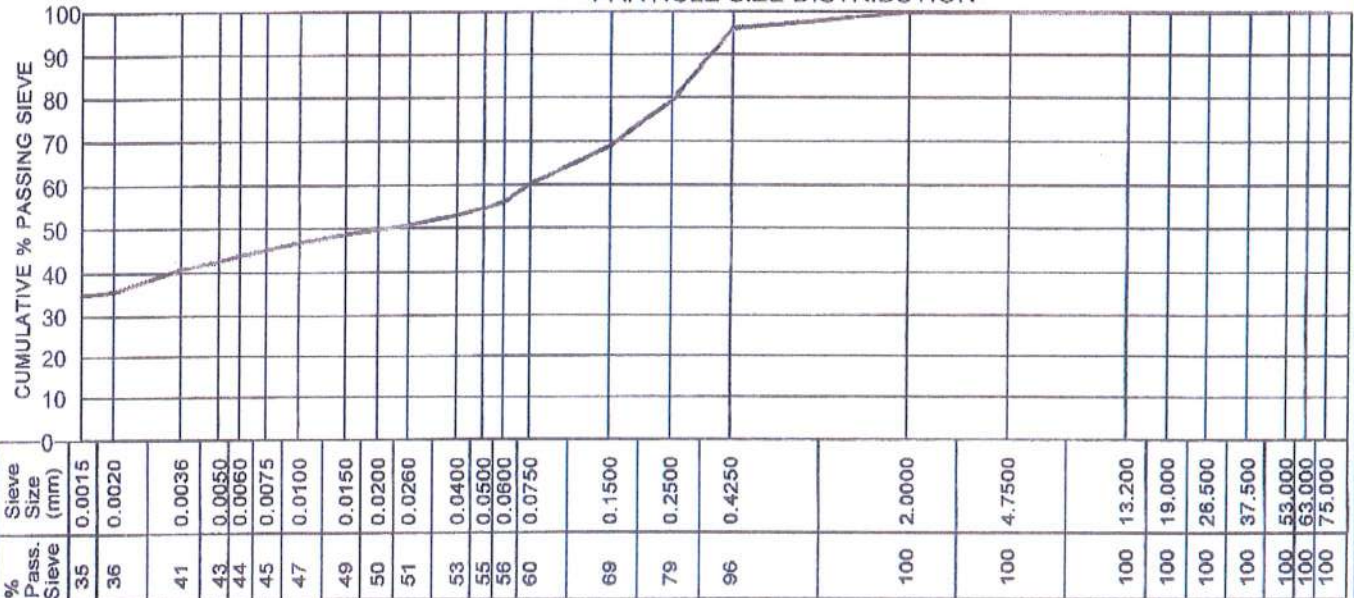
Sample No. : A83995
Hole No. : M3-A3
Depth (mm) : 2200-3000
Liquid Limit (%) : 52
Plasticity Index : 27
Linear Shrinkage (%) : 13.0
PI of Whole Sample : 26
P.R.A. Classification : A-7-6(13)
Unified Soil Classification: CH
Activity : 0.73
Heave Classification : HIGH
Grading Modulus : 0.44
Percentage (<0.002) : 36.0
Moisture Content (%) : 17.6

Material Description : Dark Red Brown Silty Sandy Clay

| | Clay (%) | Silt (%) | Sand (%) | Gravel (%) | Classification |
|------------------|----------|----------|----------|------------|----------------|
| Jennings | 42.7 | 11.9 | 45.2 | 0.1 | SANDY CLAY |
| Astm | 42.7 | 17.7 | 39.6 | 0.0 | SANDY CLAY |
| British Standard | 35.8 | 20.5 | 43.6 | 0.1 | SANDY CLAY |



PARTICLE SIZE DISTRIBUTION



| JENN CLAY | | SILT | | | SAND | | | GRAVEL | | |
|-----------|-----------|-------------|-------------|-----------|-------------|-------------|-------------|---------------|---------------|--|
| ASTM CLAY | | SILT | | | FINE SAND | MEDIUM SAND | COARSE SAND | GRAVEL | | |
| BS CLAY | FINE SILT | MEDIUM SILT | COARSE SILT | FINE SAND | MEDIUM SAND | COARSE SAND | FINE GRAVEL | MEDIUM GRAVEL | COARSE GRAVEL | |
| | | | | | | | | | | |

Remarks :



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Fax: (012) 800 3043
Email: sunlid@matrolab.co.za

TEST RESULTS

JOHAN LOURENS

Attention: Mr Johan Lourens

Project: Manovani Development

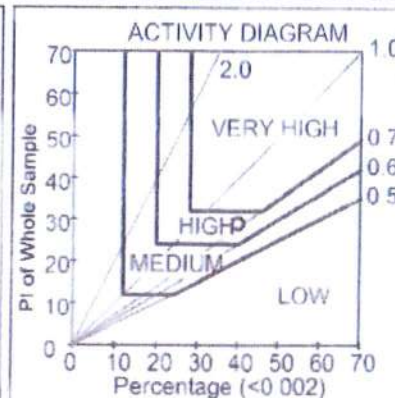
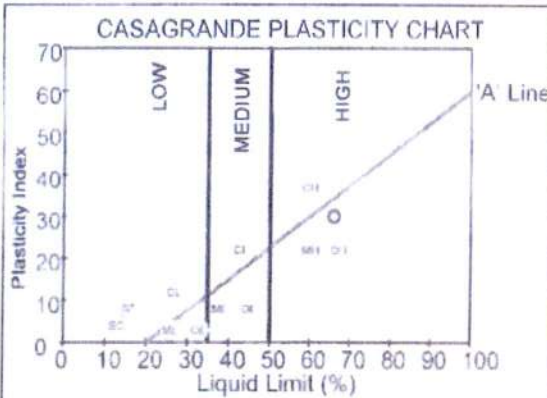
Your Ref
Our Ref: PL/50016
Date Reported: 27.10.2008

FOUNDATION INDICATOR (ASTM: D422)

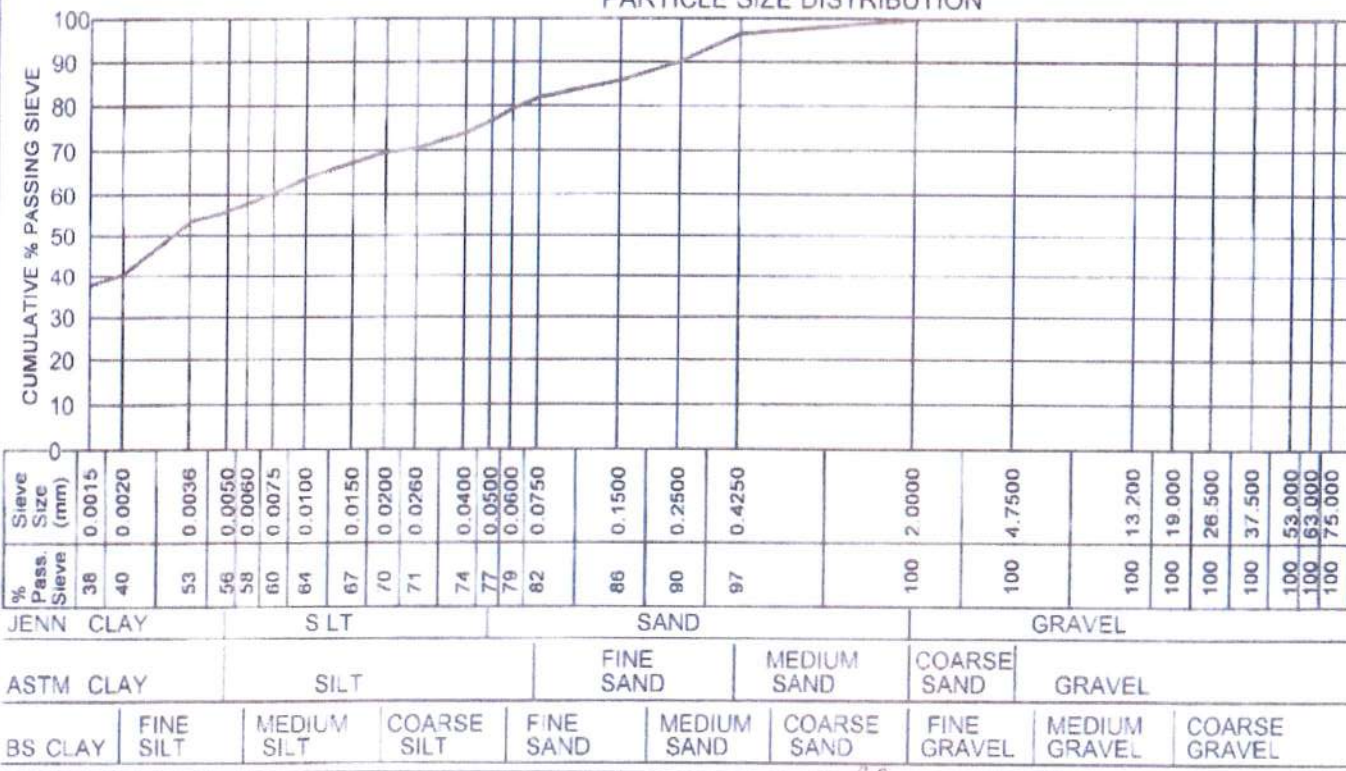
Sample No.: A83996
Hole No.: M4-A3
Depth (mm): 3000-5600
Liquid Limit (%): 66
Plasticity Index: 30
Linear Shrinkage (%): 14.5
PI of Whole Sample: 29
P R A Classification: A-7-5(20)
Unified Soil Classification: OH
Activity: 0.72
Heave Classification: HIGH
Grading Modulus: 0.22
Percentage (<0.002): 40.0
Moisture Content (%): 28.1

Material Description: Red Brown Sandy Silty Clay

| | Clay (%) | Silt (%) | Sand (%) | Gravel (%) | Classification |
|------------------|----------|----------|----------|------------|----------------|
| Jennings | 56.1 | 20.6 | 23.1 | 0.2 | CLAY |
| Astm | 56.1 | 25.8 | 18.1 | 0.0 | CLAY |
| British Standard | 40.5 | 39.0 | 20.4 | 0.2 | SILTY CLAY |



PARTICLE SIZE DISTRIBUTION



Remarks:



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TEST RESULTS

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Attention: Mr Johan Lourens

Project : Manovani Development

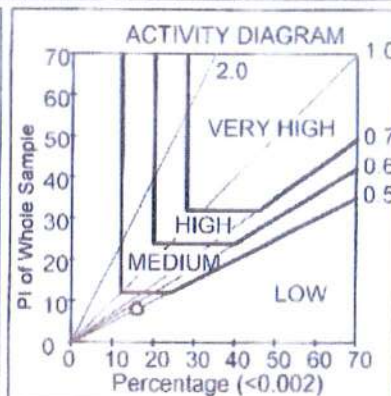
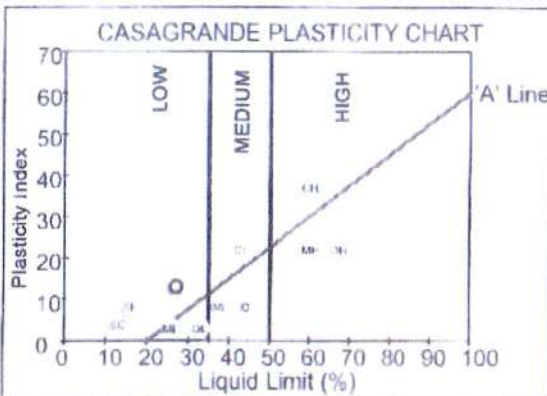
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Our Ref : PL/50016
Date Reported : 27.10.2008

FOUNDATION INDICATOR (ASTM: D422)

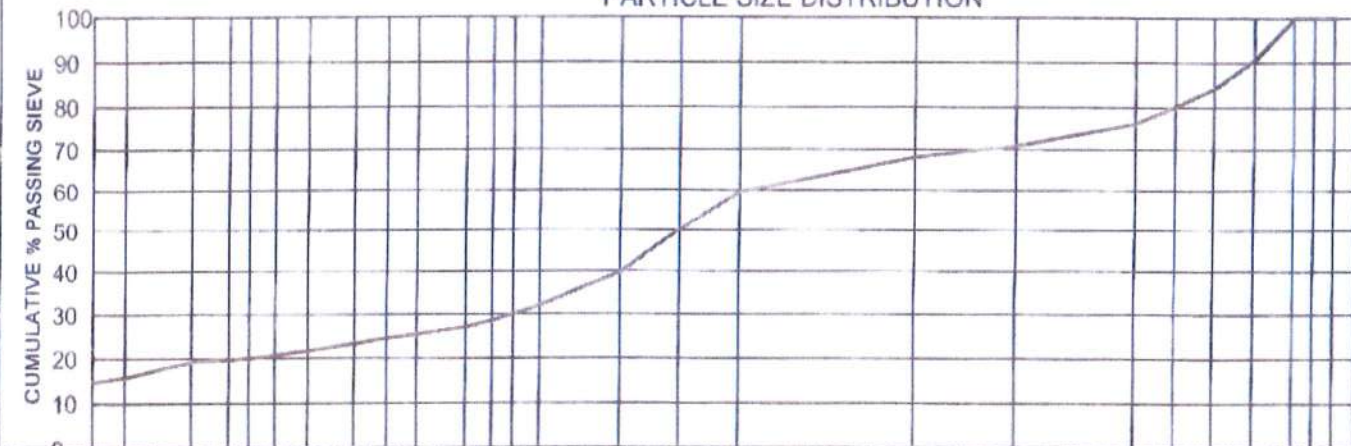
Sample No. : A83997
Hole No. : M9-A2
Depth (mm) : 0-1400
Liquid Limit (%) : 27
Plasticity Index : 13
Linear Shrinkage (%) : 6.0
PI of Whole Sample : 8
P.R.A. Classification : A-2-6(1)
Unified Soil Classification: SC
Activity : 0.51
Heave Classification : LOW
Grading Modulus : 1.40
Percentage (<0.002) : 16.0
Moisture Content (%) : 17.2

Material Description : Brown Silty Clayey Gravelly Sand

| | Clay (%) | Silt (%) | Sand (%) | Gravel (%) | Classification |
|------------------|----------|----------|----------|------------|----------------|
| Jennings | 19.7 | 8.8 | 39.6 | 31.9 | CLAYEY SAND |
| Astm | 19.7 | 12.3 | 38.9 | 29.1 | CLAYEY SAND |
| British Standard | 15.6 | 14.4 | 38.1 | 31.9 | CLAYEY SAND |



PARTICLE SIZE DISTRIBUTION



| Sieve Size (mm) | 0.0015 | 0.0020 | 0.0036 | 0.0050 | 0.0060 | 0.0075 | 0.0100 | 0.0150 | 0.0200 | 0.0260 | 0.0400 | 0.0500 | 0.0600 | 0.0750 | 0.1500 | 0.2500 | 0.4250 | 2.0000 | 4.7500 | 13.200 | 19.000 | 26.500 | 37.500 | 53.000 | 63.000 | 75.000 | |
|-----------------|-----------|--------|-------------|--------|-------------|--------|-----------|--------|-------------|--------|-------------|--------|-------------|--------|---------------|--------|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-----|
| % Pass. Sieve | 15 | 16 | 19 | 20 | 20 | 21 | 22 | 23 | 25 | 25 | 27 | 28 | 30 | 32 | 40 | 50 | 60 | 68 | 71 | 76 | 80 | 84 | 91 | 100 | 100 | 100 | 100 |
| JENN CLAY | | | | | | | SILT | | | | | | | | SAND | | | | | | | | | | GRAVEL | | |
| ASTM CLAY | | | | | | | SILT | | | | FINE SAND | | MEDIUM SAND | | COARSE SAND | | | | | | | | | | GRAVEL | | |
| BS CLAY | FINE SILT | | MEDIUM SILT | | COARSE SILT | | FINE SAND | | MEDIUM SAND | | COARSE SAND | | FINE GRAVEL | | MEDIUM GRAVEL | | COARSE GRAVEL | | | | | | | | | | |

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TEST RESULTS

JOHAN LOURENS

Attention: Mr Johan Lourens

Project : Manovani Development

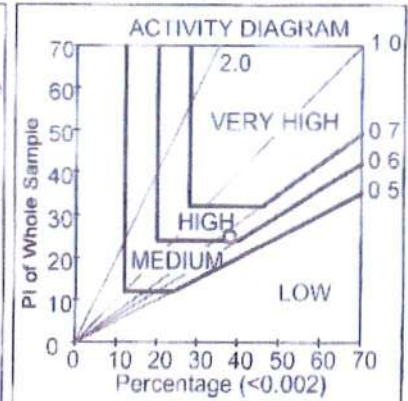
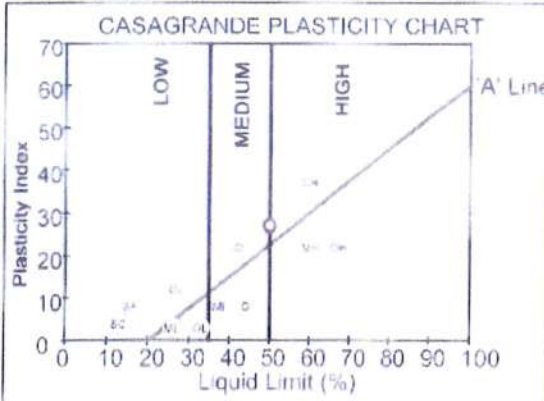
Your Ref
Our Ref : PL/50016
Date Reported : 27 10 2008

FOUNDATION INDICATOR (ASTM: D422)

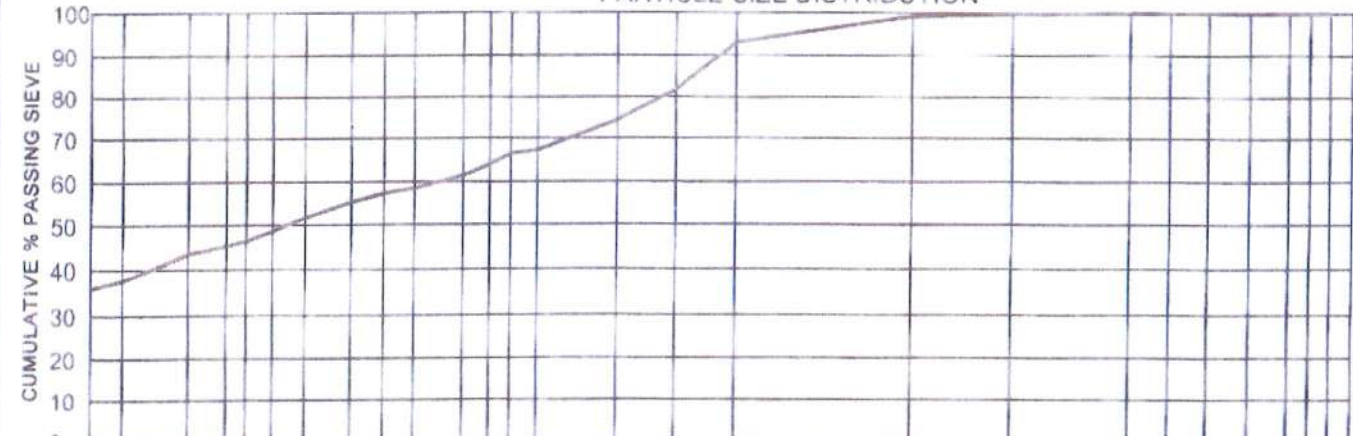
Sample No. : A83998
Hole No. : M10-A2
Depth (mm) : 1400-3700
Liquid Limit (%) : 50
Plasticity Index : 27
Linear Shrinkage (%) : 13.0
PI of Whole Sample : 25
P.R.A. Classification : A 7.6(15)
Unified Soil Classifier : CH
Activity : 0.66
Heave Classification : HIGH
Grading Modulus : 0.41
Percentage (<0.002) : 38.0
Moisture Content (%) : 19.1

Material Description : Brown Silty Sandy Clay

| | Clay (%) | Silt (%) | Sand (%) | Gravel (%) | Classification |
|------------------|----------|----------|----------|------------|----------------|
| Jennings | 45.1 | 18.9 | 35.2 | 0.8 | SANDY CLAY |
| Astm | 45.1 | 22.0 | 32.5 | 0.3 | SANDY CLAY |
| British Standard | 37.7 | 28.8 | 32.7 | 0.8 | SANDY CLAY |



PARTICLE SIZE DISTRIBUTION



| Sieve Size (mm) | % Pass, Sieve | Classification |
|-----------------|---------------|----------------|
| 0.0015 | 36 | JENN CLAY |
| 0.0020 | 38 | JENN CLAY |
| 0.0036 | 43 | JENN CLAY |
| 0.0050 | 45 | JENN CLAY |
| 0.0060 | 46 | JENN CLAY |
| 0.0075 | 49 | JENN CLAY |
| 0.0100 | 52 | JENN CLAY |
| 0.0150 | 55 | JENN CLAY |
| 0.0200 | 58 | JENN CLAY |
| 0.0260 | 59 | JENN CLAY |
| 0.0400 | 62 | JENN CLAY |
| 0.0500 | 64 | JENN CLAY |
| 0.0600 | 67 | JENN CLAY |
| 0.0750 | 67 | JENN CLAY |
| 0.1500 | 74 | JENN CLAY |
| 0.2500 | 82 | JENN CLAY |
| 0.4250 | 93 | JENN CLAY |
| 2.0000 | 99 | JENN CLAY |
| 4.7500 | 100 | JENN CLAY |
| 13.200 | 100 | JENN CLAY |
| 19.000 | 100 | JENN CLAY |
| 26.500 | 100 | JENN CLAY |
| 37.500 | 100 | JENN CLAY |
| 53.000 | 100 | JENN CLAY |
| 63.000 | 100 | JENN CLAY |
| 75.000 | 100 | JENN CLAY |

| ASTM | Clay | Silt | Fine Sand | Medium Sand | Coarse Sand | Gravel |
|------|------|------|-----------|-------------|-------------|--------|
| ASTM | CLAY | SILT | FINE SAND | MEDIUM SAND | COARSE SAND | GRAVEL |

| BS | Clay | Fine Silt | Medium Silt | Coarse Silt | Fine Sand | Medium Sand | Coarse Sand | Fine Gravel | Medium Gravel | Coarse Gravel |
|----|------|-----------|-------------|-------------|-----------|-------------|-------------|-------------|---------------|---------------|
| BS | CLAY | FINE SILT | MEDIUM SILT | COARSE SILT | FINE SAND | MEDIUM SAND | COARSE SAND | FINE GRAVEL | MEDIUM GRAVEL | COARSE GRAVEL |

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TEST RESULTS

JOHAN LOURENS

Project : Manovan Development

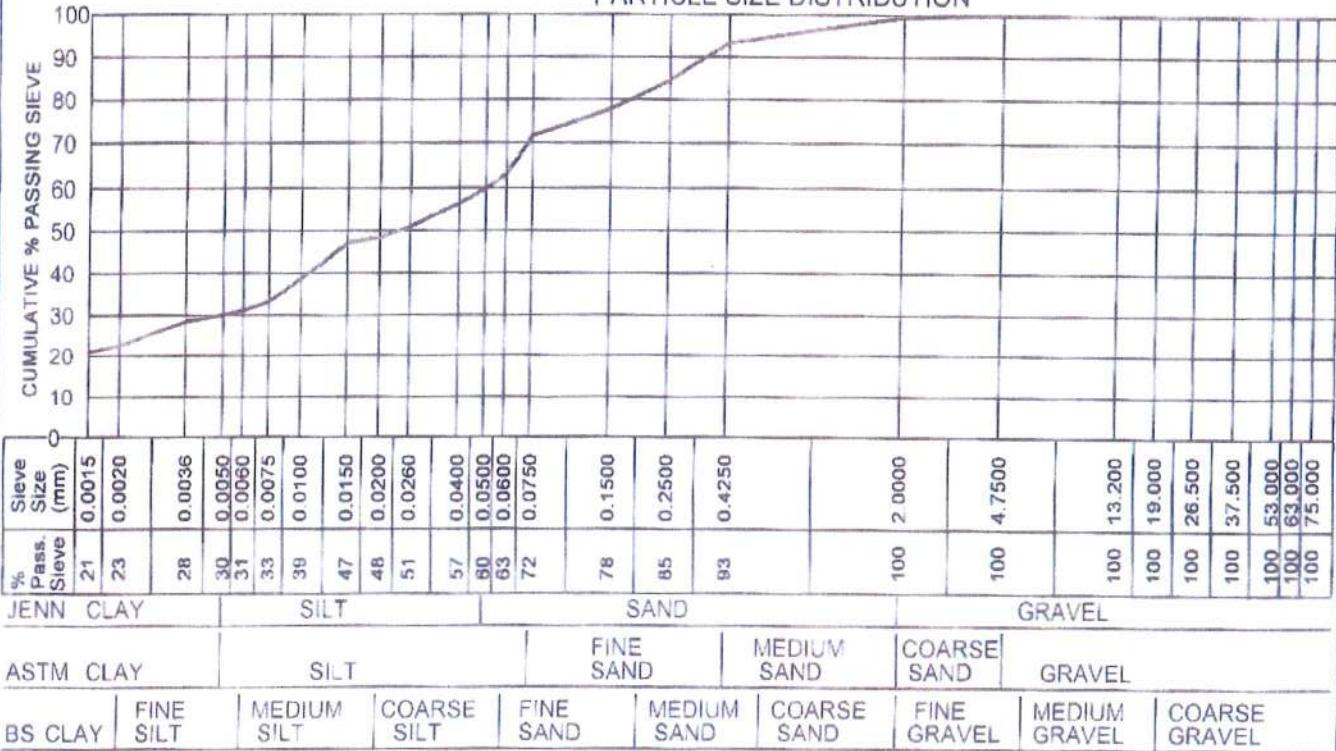
Attention: Mr Johan Lourens

Your Ref :
Our Ref : PL/50016
Date Reported : 27.10.2008

FOUNDATION INDICATOR (ASTM: D422)

| | | | | | | | |
|-------------------------------|-----------|---|----------|----------|------------|----------------|-------------|
| Sample No. : | A83999 | Material Description : Red Brown Sandy Clayey Silt | | | | | |
| Hole No. : | M11-A2 | Clay (%) | Silt (%) | Sand (%) | Gravel (%) | Classification | |
| Depth (mm) : | 3700-6600 | Jennings | 30.1 | 29.9 | 39.6 | 0.4 | SANDY CLAY |
| Liquid Limit (%) : | 48 | Astm | 30.1 | 41.5 | 28.4 | 0.0 | SILTY CLAY |
| Plasticity Index : | 25 | British Standard | 22.6 | 40.7 | 36.3 | 0.4 | CLAYEY SILT |
| Linear Shrinkage (%) : | 12.0 | <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>CASAGRANDE PLASTICITY CHART</p> </div> <div style="text-align: center;"> <p>ACTIVITY DIAGRAM</p> </div> </div> | | | | | |
| PI of Whole Sample : | 23 | | | | | | |
| P.R.A. Classification : | A-7-6(15) | | | | | | |
| Unified Soil Classification : | CL | | | | | | |
| Activity : | 1.02 | | | | | | |
| Heave Classification : | MEDIUM | | | | | | |
| Grading Modulus : | 0.35 | | | | | | |
| Percentage (<0.002) : | 23.0 | | | | | | |
| Moisture Content (%) : | 28.3 | | | | | | |

PARTICLE SIZE DISTRIBUTION



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TEST RESULTS

JOHAN LOURENS

Attention: Mr Johan Lourens

Project : Manovani Development

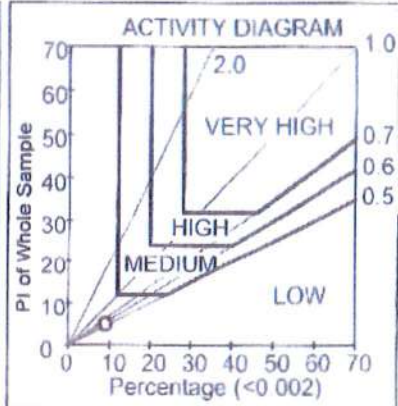
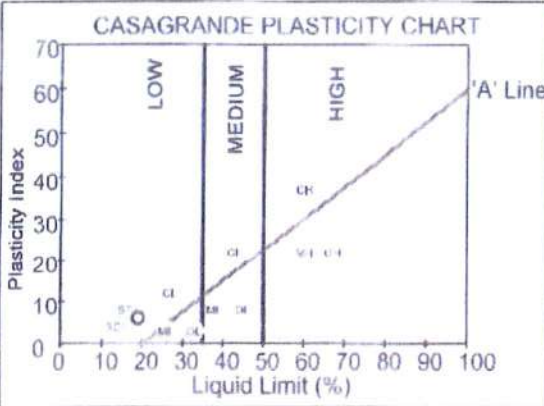
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Date Reported : 27.10.2008

FOUNDATION INDICATOR (ASTM: D422)

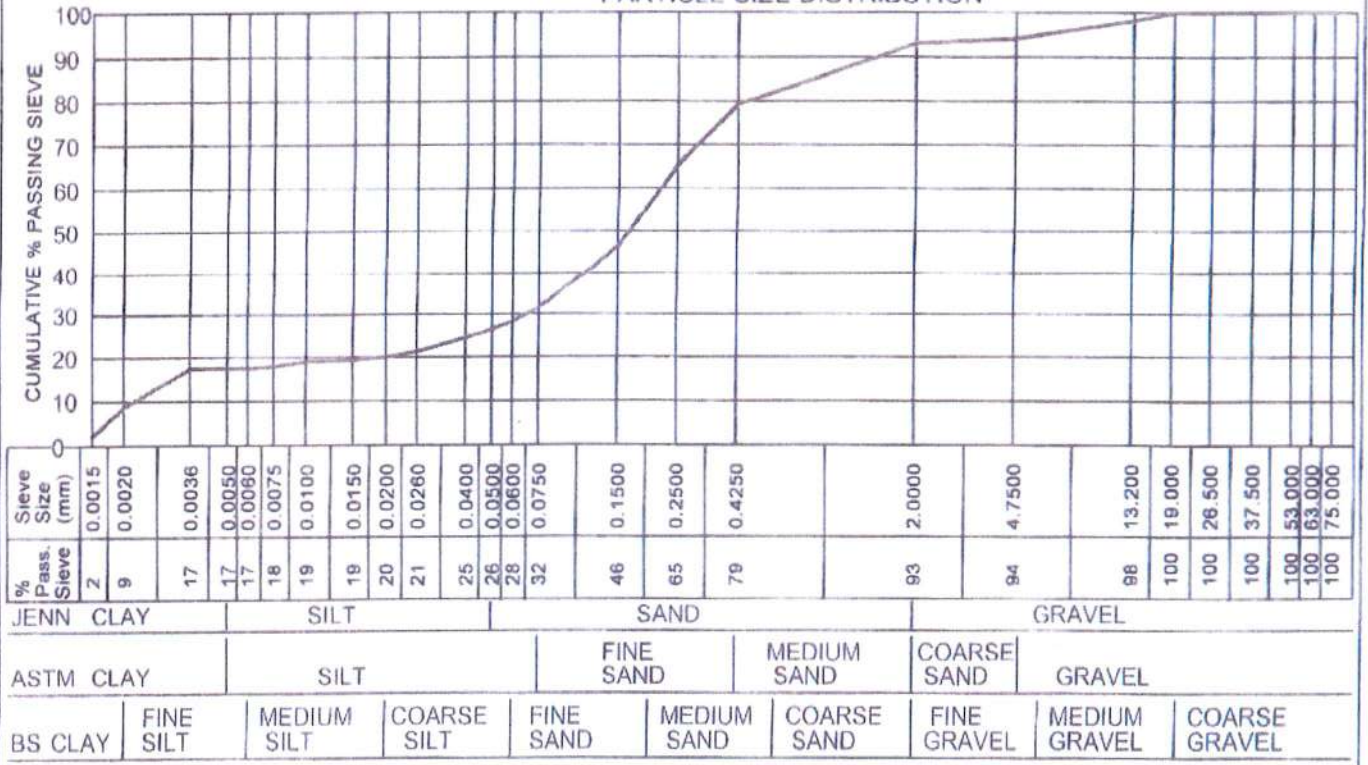
Sample No : A84000
Hole No. : M12-A1
Depth (mm) : 0-1600
Liquid Limit (%) : 19
Plasticity Index : 6
Linear Shrinkage (%) : 3.0
PI of Whole Sample : 5
P.R.A. Classification : A-2-4(0)
Unified Soil Classification: SM-SC
Activity : 0.58
Heave Classification : LOW
Grading Modulus : 0.96
Percentage (<0.002) : 9.0
Moisture Content (%) : 8.6

Material Description: Brown Orange Silty Clayey Sand

| | Clay (%) | Silt (%) | Sand (%) | Gravel (%) | Classification |
|------------------|----------|----------|----------|------------|----------------|
| Jennings | 17.4 | 9.0 | 66.7 | 6.9 | SILTY SAND |
| Astm | 17.4 | 14.1 | 62.6 | 5.9 | SILTY SAND |
| British Standard | 8.6 | 19.7 | 64.8 | 6.9 | SILTY SAND |



PARTICLE SIZE DISTRIBUTION



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TEST RESULTS

JOHAN LOURENS
Attention: Mr Johan Lourens

Project : Manovani Development

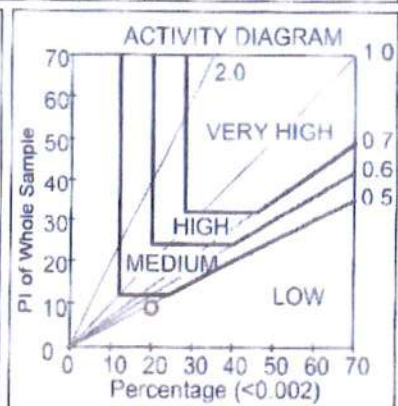
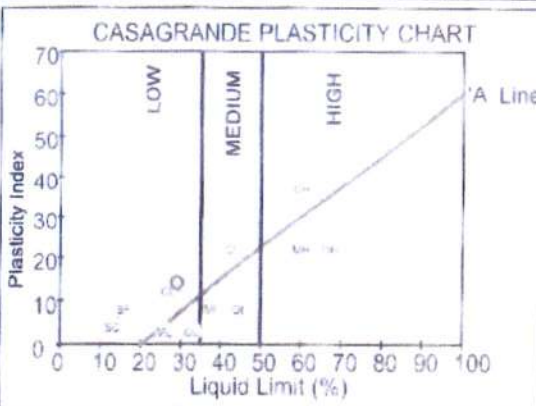
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Our Ref : PL/50016
Date Reported : 27,10 2008

FOUNDATION INDICATOR (ASTM: D422)

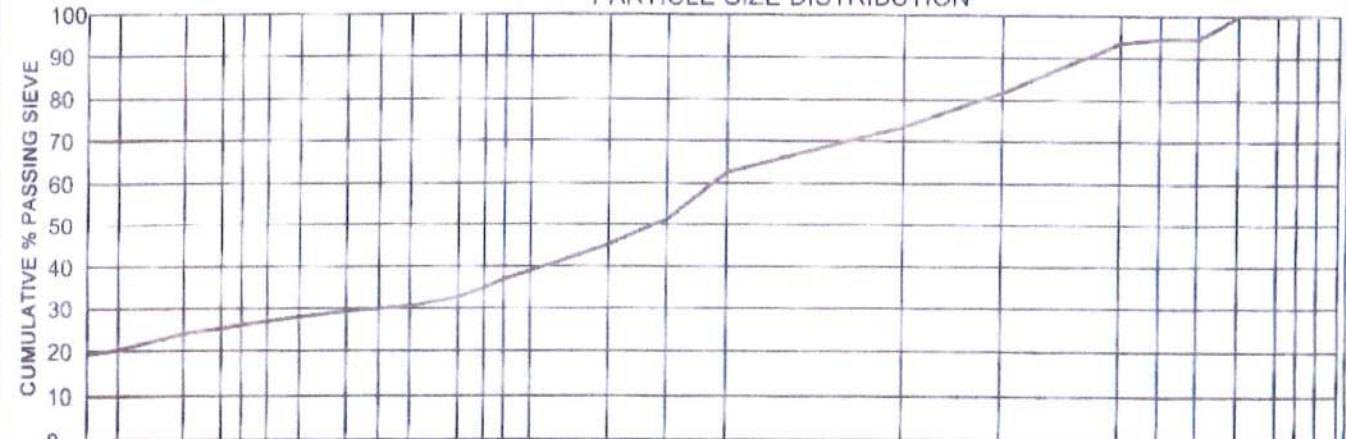
Sample No. : A84001
Hole No. : M13-A7
Depth (mm) : 1900-2500
Liquid Limit (%) : 29
Plasticity Index : 14
Linear Shrinkage (%) : 7.0
PI of Whole Sample : 9
P.R.A. Classification : A-5(2)
Unified Soil Classification: SC
Activity : 0.44
Heave Classification : LOW
Grading Modulus : 1.25
Percentage (<0.002) : 20.0
Moisture Content (%) : 10.0

Material Description : Red Brown Silty Gravelly Clayey Sand

| | Clay (%) | Silt (%) | Sand (%) | Gravel (%) | Classification |
|------------------|----------|----------|----------|------------|----------------|
| Jennings | 25.3 | 9.6 | 38.5 | 26.6 | SANDY CLAY |
| Astm | 25.3 | 13.7 | 42.8 | 18.2 | SANDY CLAY |
| British Standard | 20.3 | 16.8 | 36.3 | 26.6 | CLAYEY SAND |



PARTICLE SIZE DISTRIBUTION



| Sieve Size (mm) | 0.0015 | 0.0020 | 0.0036 | 0.0050 | 0.0060 | 0.0075 | 0.0100 | 0.0150 | 0.0200 | 0.0260 | 0.0400 | 0.0500 | 0.0600 | 0.0750 | 0.1500 | 0.2500 | 0.4250 | 2.0000 | 4.7500 | 13.200 | 19.000 | 26.500 | 37.500 | 53.000 | 63.000 | 75.000 | | |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|--|
| % Pass. Sieve | 19 | 20 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 33 | 35 | 37 | 39 | 45 | 51 | 63 | 73 | 82 | 93 | 94 | 94 | 100 | 100 | 100 | 100 | | |
| JENN CLAY | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ASTM CLAY | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BS CLAY | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

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TEST RESULTS

JOHAN LOURENS
Attention: Mr Johan Lourens

Project : Manovani Development

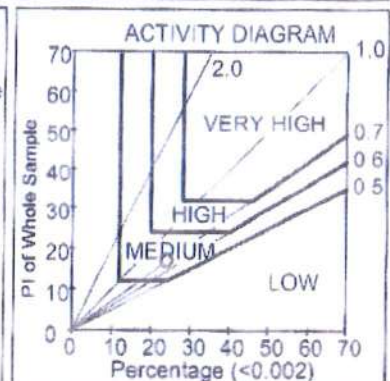
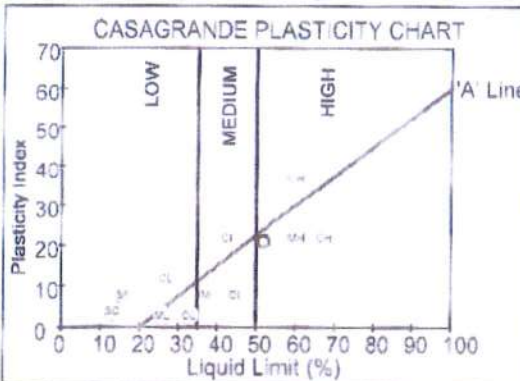
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FOUNDATION INDICATOR (ASTM: D422)

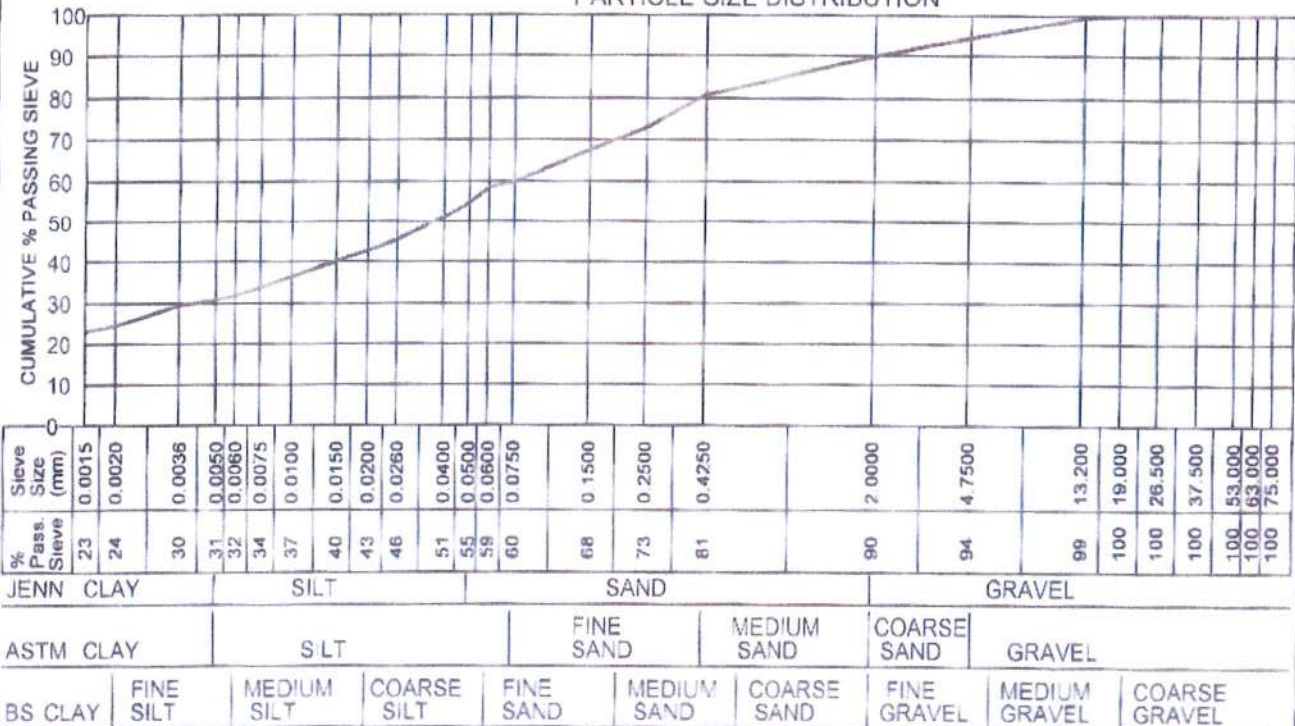
Sample No. : A84002
Hole No. : M14-A7
Depth (mm) : 2500-5500
Liquid Limit (%) : 52
Plasticity Index : 21
Linear Shrinkage (%) : 11.0
PI of Whole Sample : 17
P.R.A. Classification : A-7-5(11)
Unified Soil Classification : OH
Activity : 0.69
Heave Classification : MEDIUM
Grading Modulus : 0.69
Percentage (<0.002) : 24.0
Moisture Content (%) : 18.7

Material Description : Dark Olive Yellow Silty Clayey Sand

| | Clay (%) | Silt (%) | Sand (%) | Gravel (%) | Classification |
|------------------|----------|----------|----------|------------|----------------|
| Jennings | 30.9 | 24.0 | 35.0 | 10.1 | SANDY CLAY |
| Astm | 30.9 | 29.0 | 34.5 | 5.6 | SANDY CLAY |
| British Standard | 24.5 | 34.1 | 31.3 | 10.1 | CLAYEY SILT |



PARTICLE SIZE DISTRIBUTION



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TEST RESULTS

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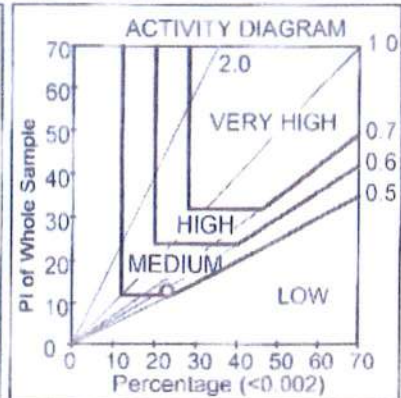
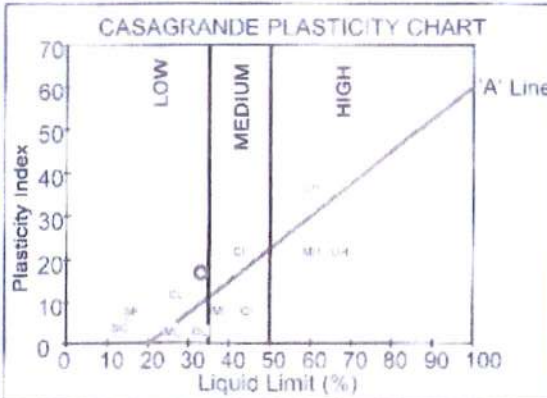
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Our Ref : PL/50016
Date Reported : 27.10.2008

FOUNDATION INDICATOR (ASTM: D422)

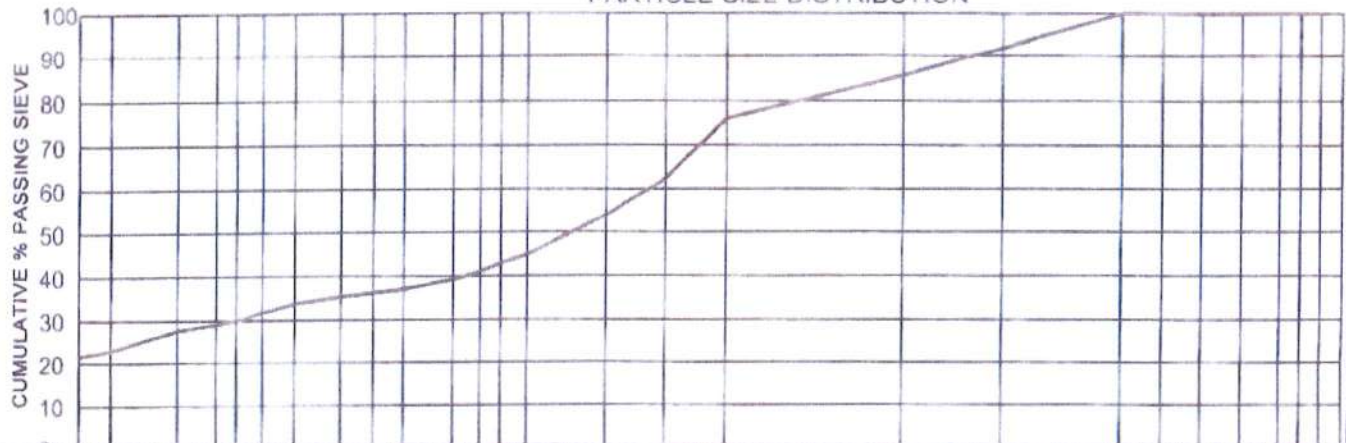
Sample No. : A84003
Hole No. : M16-A5
Depth (mm) : 1600-3700
Liquid Limit (%) : 33
Plasticity Index : 17
Linear Shrinkage (%) : 9.0
PI of Whole Sample : 13
P.R.A. Classification : A-6(4)
Unified Soil Classifier : SC
Activity : 0.56
Heave Classification : MEDIUM
Grading Modulus : 0.93
Percentage (<0.002) : 23.0
Moisture Content (%) : 14.8

Material Description : Red Brown Silty Clayey Sand

| | Clay (%) | Silt (%) | Sand (%) | Gravel (%) | Classification |
|------------------|----------|----------|----------|------------|----------------|
| Jennings | 29.1 | 12.1 | 44.5 | 14.3 | SANDY CLAY |
| Astm | 29.1 | 15.7 | 47.0 | 8.1 | SANDY CLAY |
| British Standard | 23.1 | 20.1 | 42.5 | 14.3 | CLAYEY SAND |



PARTICLE SIZE DISTRIBUTION



| Sieve Size (mm) | 22 | 23 | 28 | 29 | 30 | 32 | 34 | 35 | 36 | 37 | 39 | 41 | 43 | 45 | 54 | 62 | 76 | 2.0000 | 4.7500 | 13.200 | 19.000 | 26.500 | 37.500 | 53.000 | 63.000 | 75.000 |
|-----------------|-----------|----|-------------|----|-------------|----|-----------|----|-------------|----|-------------|----|-------------|----|---------------|----|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| % Pass. Sieve | 22 | 23 | 28 | 29 | 30 | 32 | 34 | 35 | 36 | 37 | 39 | 41 | 43 | 45 | 54 | 62 | 76 | 86 | 92 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| JENN CLAY | | | | | | | SILT | | | | SAND | | | | GRAVEL | | | | | | | | | | | |
| ASTM CLAY | | | | | | | SILT | | | | FINE SAND | | MEDIUM SAND | | COARSE SAND | | GRAVEL | | | | | | | | | |
| BS CLAY | FINE SILT | | MEDIUM SILT | | COARSE SILT | | FINE SAND | | MEDIUM SAND | | COARSE SAND | | FINE GRAVEL | | MEDIUM GRAVEL | | COARSE GRAVEL | | | | | | | | | |

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TEST RESULTS

JOHAN LOURENS

Attention: Mr Johan Lourens

Project : Manovani Development

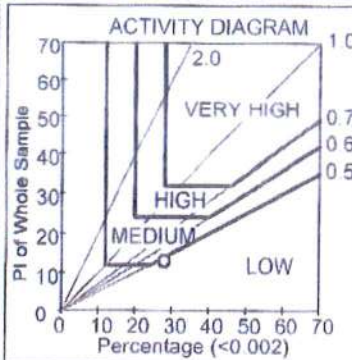
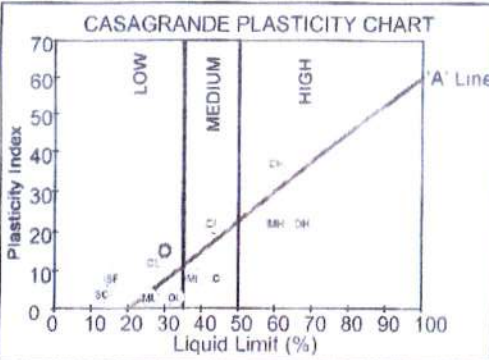
Your Ref :
Our Ref : PL/50016
Date Reported : 27 10 2008

FOUNDATION INDICATOR (ASTM: D422)

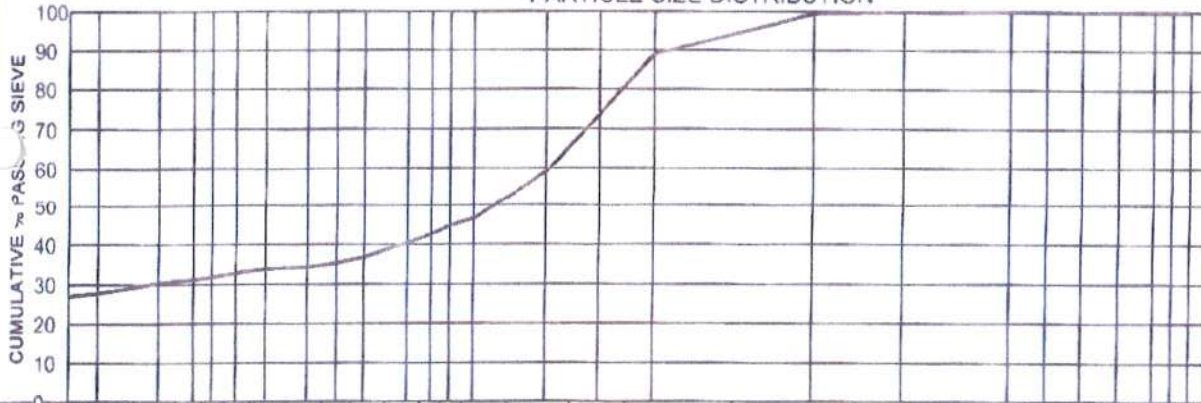
Sample No : A84004
Hole No. : M17-A4
Depth (mm) : 0-1800
Liquid Limit (%) : 30
Plasticity Index : 15
Linear Shrinkage (%) : 8.0
PI of Whole Sample : 13
P.R.A. Classification : A-6(4)
Unified Soil Classifier : SC
Activity : 0.47
Heave Classification : LOW
Grading Modulus : 0.65
Percentage (<0.002) : 28.0
Moisture Content (%) : 7.9

Material Description : Red Brown Silty Clayey Sand

| | Clay (%) | Silt (%) | Sand (%) | Gravel (%) | Classification |
|------------------|----------|----------|----------|------------|----------------|
| Jennings | 31.3 | 11.4 | 56.9 | 0.4 | SANDY CLAY |
| Astm | 31.3 | 15.2 | 53.4 | 0.1 | SANDY CLAY |
| British Standard | 27.7 | 17.1 | 54.7 | 0.4 | CLAYEY SAND |



PARTICLE SIZE DISTRIBUTION



| Sieve Size (mm) | 0.0015 | 0.0020 | 0.0036 | 0.0050 | 0.0060 | 0.0075 | 0.0100 | 0.0150 | 0.0200 | 0.0260 | 0.0400 | 0.0500 | 0.0600 | 0.0750 | 0.1500 | 0.2500 | 0.4250 | 2.0000 | 4.7500 | 13.200 | 19.000 | 26.500 | 37.500 | 53.000 | 63.000 | 75.000 |
|-----------------|-----------|--------|-------------|--------|-------------|--------|-----------|--------|--------|-------------|--------|-------------|-------------|--------|-------------|--------|---------------|--------|---------------|--------|--------|--------|--------|--------|--------|--------|
| % Pass. Sieve | 27 | 28 | 30 | 31 | 32 | 33 | 34 | 34 | 35 | 37 | 40 | 43 | 45 | 46 | 59 | 74 | 89 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| JENN CLAY | | | SILT | | | | SAND | | | | | | | | | | GRAVEL | | | | | | | | | |
| ASTM CLAY | | | SILT | | | | FINE SAND | | | | | MEDIUM SAND | | | COARSE SAND | | GRAVEL | | | | | | | | | |
| BS CLAY | FINE SILT | | MEDIUM SILT | | COARSE SILT | | FINE SAND | | | MEDIUM SAND | | | COARSE SAND | | FINE GRAVEL | | MEDIUM GRAVEL | | COARSE GRAVEL | | | | | | | |

Remarks :



MATROLAB GROUP (PTY.) LTD.

- CIVIL ENGINEERING SERVICES -

Reg No.: 2003/029180/07 - VAT. Reg.No.: 4040210587

a SANAS Accredited Testing Laboratory, No. T0025



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TEST RESULTS

JOHAN LOURENS

Attention: Mr Johan Lourens

Project : Manovani Development

Your Ref :
Our Ref : PL/50016
Date Reported : 23.10.2008

SIEVE ANALYSIS, ATTERBERG LIMITS, CBR, UCS(TMH1:A1-A5,A7,A8)

| SAMPLE NO. | A83993 | A83994 | A83997 | A83400 |
|-----------------|-------------------------------|---------------------------|---------------------------|-----------------------------------|
| HOLE NO. | A3 | A3 | A2 | A1 |
| ROAD NO. | | | | |
| DEPTH (mm) | 0-800 | 800-2200 | 0-1400 | 0-1600 |
| CHAINAGE | M1 | M2 | M9 | M12 |
| LAYER TYPE | | | | |
| STABILISED WITH | Natural | Natural | natural | Natural |
| SUPPLIER | | | | |
| CURING METHOD | | | | |
| DESCRIPTION | Red Brown Gravelly Sandy Clay | Brown Gravelly Sandy Clay | Brown Gravelly Sandy Clay | Brown Orange Gravelly Clayey Sand |

SIEVE ANALYSIS (% PASSING)

| Sieve Size | A83993 | A83994 | A83997 | A83400 |
|------------|--------|--------|--------|--------|
| 75 mm | | | | |
| 63 mm | | | | |
| 53 mm | | | 100 | |
| 37.5 mm | | | 91 | |
| 26.5 mm | | | 84 | |
| 19.0 mm | | | 80 | 100 |
| 13.2 mm | | 100 | 76 | 98 |
| 4.75 mm | 100 | 99 | 71 | 94 |
| 2.0 mm | 99 | 97 | 68 | 93 |
| 0.425 mm | 88 | 87 | 60 | 79 |
| 0.075 mm | 49 | 48 | 32 | 31 |

SOIL MORTAR

| Material | A83993 | A83994 | A83997 | A83400 |
|-------------------------------|--------|--------|--------|--------|
| COARSE SAND <2.000mm >0.425mm | 11 | 10 | 12 | 15 |
| FINE SAND <0.425mm >0.075mm | 39 | 40 | 41 | 52 |
| MATERIAL <0.075mm | 50 | 50 | 47 | 33 |

CONSTANTS

| Property | A83993 | A83994 | A83997 | A83400 |
|-------------------------------|---------|--------|----------|----------|
| GRADING MODULUS | 0.64 | 0.68 | 1.40 | 0.97 |
| PRA CLASSIFICATION | A-6(5) | A-6(4) | A-2-6(1) | A-2-4(0) |
| COLTO CLASSIFICATION | --- | --- | --- | G8 |
| TRH Class. (INSITU {93% 90%}) | G10 G10 | G9 G10 | - - | C8 G8 |
| LIQUID LIMIT (%) | 32 | 27 | 27 | 19 |
| PLASTICITY INDEX (0.425mm) | 16 | 13 | 13 | 6 |
| LINEAR SHRINKAGE (%) | 8.5 | 7.5 | 6.0 | 3.0 |

MOD AASHTO

| Property | A83993 | A83994 | A83997 | A83400 |
|--|--------|--------|--------|--------|
| MAXIMUM DRY DENSITY (kg/m ³) | 1948 | 2070 | 2022 | 2075 |
| OPTIMUM MOISTURE CONTENT (%) | 6.8 | 8.9 | 10.4 | 7.4 |
| MOULDING MOISTURE (%) | 7.0 | 9.1 | 10.4 | 7.2 |

| TYPE OF TEST | CBR | CBR | CBR | CBR |
|---------------------------|-----|-----|-----|-----|
| CBR-UCS @ 100% MOD AASHTO | 44 | 31 | 17 | 30 |
| CBR-UCS @ 98% MOD AASHTO | 16 | 23 | 15 | 21 |
| CBR-UCS @ 97% MOD AASHTO | 10 | 20 | 14 | 18 |
| CBR-UCS @ 95% MOD AASHTO | 4.2 | 15 | 12 | 15 |
| CBR-UCS @ 93% MOD AASHTO | 3.7 | 8.4 | 6.2 | 14 |
| CBR-UCS @ 90% MOD AASHTO | 3.0 | 3.4 | 1.7 | 12 |

CBR-UCS @ % MOD AASHTO derived from calculation.

| % SWELL AT [MOD][NRB][PROC] | 1.14 | 1.80 | 2.54 | 1.40 | 1.68 | 2.31 | 1.69 | 2.16 | 2.47 | 0.57 | 1.23 | 1.63 |
|-----------------------------|------|------|------|------|------|------|------|------|------|------|------|------|
|-----------------------------|------|------|------|------|------|------|------|------|------|------|------|------|

Remarks :

FORM: A1

Program ver 3.0 (23.07.2008)

Technical Signatory : S.E. Breiting

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