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**PROCUREMENT AND INFRASTRUCTURE CLUSTER**  
**ENGINEERING UNIT, ROADS PROVISION DEPARTMENT**  
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Ref No. CSA 3254

10 July 2018

Architecture

by email : [Linda.Danisa@durban.gov.za](mailto:Linda.Danisa@durban.gov.za)

**Attention : Ms. L. Danisa**

**GEOTECHNICAL ASSESSMENT FOR PROPOSED NEW CANESIDE OHS CLINIC  
AT 151 CANEHAVEN ROAD, PHOENIX**

A new, single storey clinic is proposed for the currently undeveloped road-side portion of the Phoenix Parks depot. A geotechnical investigation was carried out during May and June 2018; our observations, conclusions and recommendations for development follow.

## **1. OBSERVATIONS**

A proposed layout was provided by City Architects together with a site survey. The near level site is currently asphalted for staff parking.

Although presently almost level, the northern extent of the study area was originally a small drainage line that has been filled in; the natural drainage has been accommodated in a west-east trending culvert / pipeline just north of this proposed footprint. It is thus inferred that the fill increases in thickness in a wedge to the north to a maximum depth in the order of 3-4m below present ground level.

The region is underlain by Pietermaritzburg Formation shale and the typically active clay soils derived therefrom. The history and source of the fill is unknown but it is very likely locally derived and hence of a generally similar nature to the natural material. Further, it has been in place and under variably loaded depot traffic for many years so has probably undergone consolidation due to its own mass.

## 2. FIELD WORK

After a number of site visits and various delays, a total of three inspection pits were excavated using a TLB; these were designated IP1 – IP3. Approximate locations are indicated on the site plan, Figure 1. Subsoil profiles are recorded below.

### IP 1

<u>DEPTH (m)</u>	<u>DESCRIPTION</u>
0.0 – 0.025	Asphalt
0.025 – 0.05	Crusher Gravel
0.05 – 1.0	Slightly moist, dark yellow-brown and dark brown, firm, fissured, fine gravelly silty CLAY – (Fill)
1.0 – 1.7	Slightly moist, dark brown, firm to stiff, silty CLAY with abundant soft rock shale gravel and small slabs of rock – (Fill)
1.7 – 2.4	Slightly moist, grey and dark yellow-brown mottled red-orange, firm to stiff, very gravelly silty CLAY. Increasing shale fragments with depth; joint surfaces stained red-brown – (Residual Shale).

End of hole.

No seepage evident.

Bulk sample from 0.3m – Foundation Indicator, Mod, CBR (Sample No. 161 & 162)

### IP 2

<u>DEPTH (m)</u>	<u>DESCRIPTION</u>
0.0 – 0.02	Asphalt
0.02 – 0.04	Crusher Gravel
0.04 – 1.0	Slightly moist, dark yellow-brown and dark brown, firm to stiff, fissured, gravelly silty CLAY – (Fill)
1.0 – 1.3	Slightly moist to moist, red-brown, firm to stiff, gravelly silty CLAY – (Fill)
1.3 – 1.7	Moist, dark grey and grey, firm to stiff, very gravelly silty CLAY – (Fill)
1.7 – 2.7	Moist, dark grey stained red-brown, firm to stiff, silty CLAY – (Residual Shale)
2.7 – 3.3	Moist, grey and yellow-brown mottled red-orange, stiff, fissured silty CLAY – (Residual Shale)

End of hole.

Very slight seepage from 2.4m.

Samples from 0.3m & 1.8m – Foundation Indicators (Sample Nos. 163 & 164 respectively)

**IP 3**

<b><u>DEPTH (m)</u></b>	<b><u>DESCRIPTION</u></b>
0.0 – 0.02	Asphalt
0.02 – 0.04	Crusher Gravel
0.04 – 1.4	Slightly moist, dark brown and yellow-brown, firm to stiff, fissured, silty CLAY with abundant siltstone, shale and dolerite cobbles, gravel and some paper – (Fill)
1.4 – 2.1	Moist, dark grey and dark red-brown, firm to stiff, silty CLAY with abundant medium to coarse grain ferricrete nodules – (Fill)
2.1 – 2.8	Moist, grey and dark yellow-orange, stiff, fissured silty CLAY with abundant very soft rock shale gravel and fragments – (Residual Shale)
2.8 – 3.1	Highly weathered, grey and red-brown, very closely bedded, close to medium jointed, very soft rock SHALE – (Pietermaritzburg Formation)
End of hole – slow excavation in soft rock.	
Very slight seepage from about 2.5m.	

Two Dynamic Cone Penetrometer tests, DCP1 & DCP2, were carried out at the approximate positions shown on the site plan, Figure 1. Test results follow as Figures 2 & 3. Depths of 3.65m (soft refusal) to 4.5m (no refusal) were achieved. Subsoils were found to be generally stiff to very stiff, increasing notably from about 3m.

Three materials samples were collected and returned to the Pavement and Geotechnical Engineering Soils Lab for testing to determine, variably, grading, Atterburg Limits, Modified AASHTO density and CBR values. Test results are summarised in Figures 4 – 6.

### **3. LABORATORY TEST RESULTS**

The three samples had materially similar indicator results, being clay contents between 37 & 42%, a grading modulus of 1.2, plasticity indices of 17 to 23, and linear shrinkages of 10 or 10.5%. They were uniformly poor quality with AASHTO Classifications of A-7-6(9), A-6(6) and A-6(5).

One sample was further tested to determine the Modified AASHTO density and CBR values. A Mod density of 1763kg/m<sup>3</sup> was returned with an optimum moisture content of 18.1%. Unsurprisingly, this material classified as worse than G10 (no construction uses, not even general

fill) with a CBR swell of 3.1% (that is, this material has a high potential for heave when over compacted).

The original valley line was clearly backfilled with unsuitable spoil from another project to level the site rather than it being an engineered backfill with view to future development.

#### **4. GEOTECHNICAL ASSESSMENT**

The site is underlain by active clay soils (either fill or natural) to at least 2.8m, inferred to extend to greater than 4.5m in the north. These clays may be moist from as shallow as 1.4m towards the original valley line in the north with slight (winter) seepage evident from about 2.4m depth. While the clays are naturally prone to volume changes with fluctuating soil moisture content, in practice the location in a filled valley line, sealed under asphalt paving, will probably moderate moisture changes and reduce the seasonal swell and shrinkage.

#### **5. RECOMMENDATIONS**

##### **5.1 Earthworks**

The new OHS clinic will be a single storey brick structure on the existing platform. Earthworks are thus expected to be largely limited to foundation and service trenches. Excavation of the upper soil horizon (to at least 2.8m depth) is 'soft' as defined by the SANS1200 and will be easily achieved with a reasonable TLB; manual pick and shovel excavation is theoretically possible but will become increasingly challenging and time consuming as the clay stiffens and moistens with depth.

Given the cohesive nature of the underlying clays, near vertical trench sidewalls will stand unsupported for the medium term during construction. Nonetheless, all trenches deeper than 1.5m must be shored for safety and it remains the contractor's responsibility to monitor the exposed materials regularly (daily, in any depth excavation) as cohesion reduces with drying out and cracking of the clay. All trenches excavated on the site must be backfilled in compacted layers to reduce the potential for settlement over time and formation of depressions where water can pond.

The active clay has a high potential for heave if over compacted. Where replaced in trenches or used on site (not ideal), it should be placed at optimum moisture content  $\pm 2\%$  in  $\leq 200\text{mm}$  loose layers and compacted to no more than 90% of Mod AASHTO density.

After construction, the site should be graded to ensure drainage of surface run-off away from the structure so that water does not pond against the walls or near foundations.

## **5.2 Foundations**

No bearing pressures have been provided, however, the new clinic will be a single storey brick structure so is not expected to be heavily loaded. The majority of the site is sealed under asphalt so seasonal fluctuations in soil moisture after completion of construction will be limited; even then, assuming a worst case of prolonged drought or prolonged leaking services, a number of founding solutions offer themselves in this geotechnical setting of active clay soils and bedrock at in excess of 3m depth.

A suitably stiffened concrete raft designed to accommodate moderately high soil volume changes (up to 10% over a 3m clay depth) - NHBC classification H2-H3 for single storey. This obviates the need for deep excavations into potentially moist clays and shallow seepage. In reality, in this fully paved setting, the probability of the soils every drying out completely then saturating to give that maximum volume change is very small.

Alternatively, the clinic could be supported on footings; again, there are a number of possible permutations. Settlement calculations for the scenario of 0.8m wide reinforced strip footings at 0.6m depth, carrying 100kPa, returned an anticipated consolidation settlement in the order of 9mm; add to that the potential seasonal volume changes due to moisture fluctuations (possibly another 20mm worst case). Deepening the footings does not achieve a great improvement in consolidation settlement but it will reduce the effects of seasonal volume changes. Ideally, in active clays, a founding depth of 1.5m is recommended to place the footings in moisture constant material.

At 1.5m depth, normal strip footings may become uneconomic. Ground beams spanning isolated footings taken into stiff, moisture constant clay at 1.5m below final ground level is an alternative. For a 100kPa load on a 1x1m isolated footing at 1.5m depth, an estimated total consolidation settlement of 6mm can be expected; differential settlement is inferred to be half of total. Worst

case, an additional 5mm could be allowed for seasonal volume changes. The structure should include judiciously placed construction joints to accommodate any differential movement as may occur over time.

If the inferred settlements are considered excessive for this structure or if there is any possibility of extending the clinic to a second storey in the future with the associated increase in load, end bearing, grout injected auger piles socketed into shale bedrock at inferred depths in the order of 6 – 8m depth may be a preferred solution as it will allow the increased loads without new settlement. Piling has the advantage of rapid installation, saving on time costs, compared to the other founding methods.

Ideally, an inert material should be imported for placing under the surface bed, however, if the insitu active clay is used, it should be lightly compacted then spiked and watered for 24 hours prior to casting of the concrete to give the clay time to swell. This will reduce the potential for swell later once the clay is sealed under the floor slab.

No open flower beds should be planted against the new building so as to maintain the paving seal against soil moisture fluctuations. Landscaping and plantings should be limited to pots or sealed, raised beds for a distance of at least 5m from the new structure.

### **5.3 Waste Water Disposal**

Soak pits are not feasible on this site due to the underlying low permeability clay. Formal, off-site sewage disposal is available. Storm water run-off should be collected and diverted into the stream flowing under the site.

### **5.4 Construction Materials**

The insitu materials, at worse than G10, are not even suitable as general fill. All construction materials will have to be imported from a commercial supplier. Insitu clays should be boxed out under the pavement layer works for the driveway and parking areas.

## **6. SUMMARY**

To accommodate the moderately active clay soils, foundations may comprise either a stiffened raft, reinforced strip footings, ground beans carried on isolated footings into moisture constant stiff clay at 1.5m depth, or end-bearing mini-piles to an inferred 6 – 8m depth.

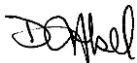
The insitu soils and weathered rock are very poor quality and, strictly speaking, of no construction use at all. However, if used as backfill in trenches or under the surface bed, moisture content and compaction must be strictly controlled to reduce the potential for excessive volume changes or heave.

Low permeability clay soils are not suitable for soakpits. All waste water must be diverted to the relevant formal system available in the area.

P&GE is available for site inspections as excavations progress to assess variations in subsoil conditions and adapt recommendations accordingly.

If there are any further queries, please contact the writer.

**Yours faithfully,**



**D. J. ABEL Pr.Sci.Nat. MSAIEG  
Engineering Geologist**

**FIGURE 1 - SITE PLAN : PROPOSED CANESIDE OHS CLINIC, PHOENIX**



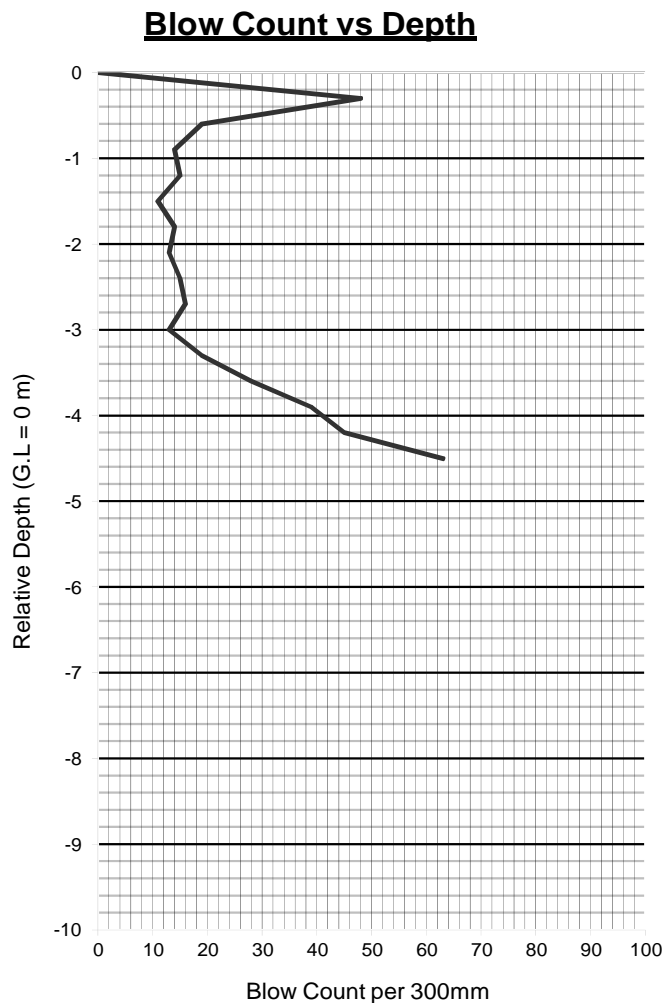


## Dynamic Cone Penetrometer

**Test No. : 1**

**Project :** Proposed New Caneside OHS Clinic  
**Client :** Architecure

Date: 0.00 Remarks: -  
Test Location: 151 Canehaven Drive, Phoenix -  
Date of Test: May 2018 Depth Interval (m) : 0.3

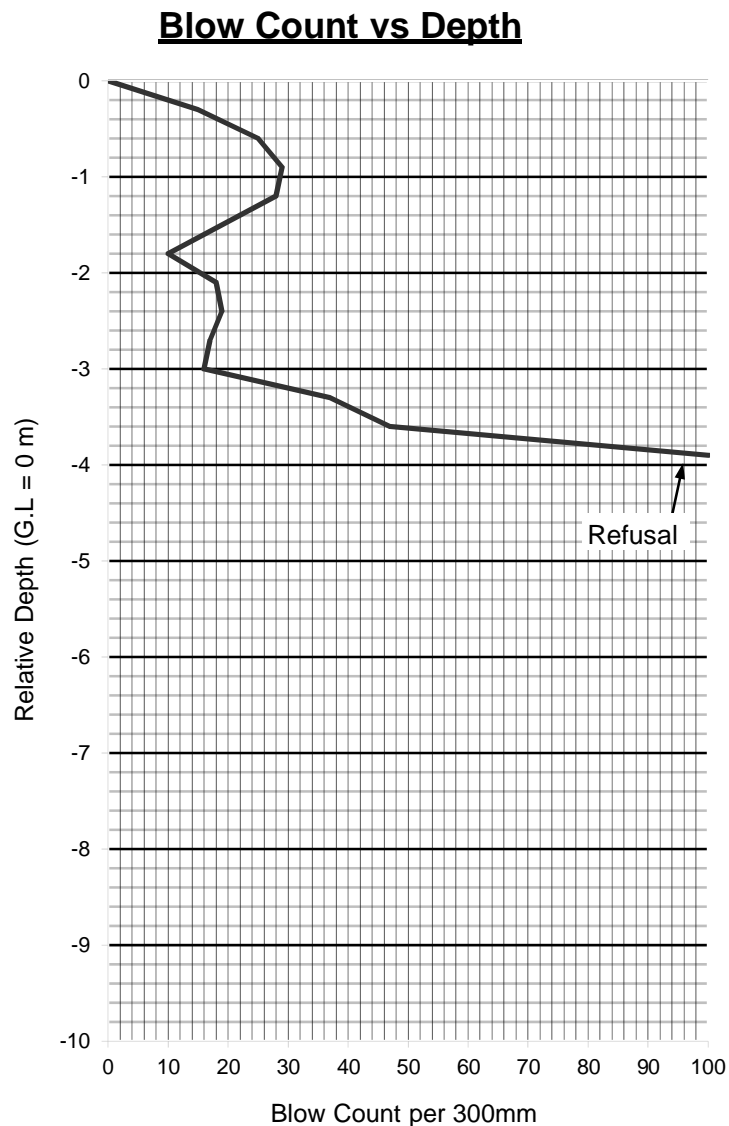
[illegible]

**Reference No. : CSA 2962**

## Dynamic Cone Penetrometer

**Test No. : 2**

<b>Project :</b>	<b>Proposed New Caneside OHS Clinic</b>		
<b>Client :</b>	<b>Architecure</b>		
Date:	0.00	Remarks:	-
Test Location:	151 Canehaven Drive, Phoenix		-
Date of Test:	May 2018	Depth Interval (m) :	0.3

[illegible]

**Reference No. : CSA 2962**

# Roads Provision Department

## Pavement & Geotechnical Engineering

### Soil Classification - TMH 1 Method A1(a), A2, A3, A4, A5

Ref. No. : 0

WO No. : 0

Sampled By : Lab

Project : Caneside OHS Clinic

Contract No. : 0

Date Sampled : 11/06/2018

Source : TP1

Layer :

Results To : D. Abel

Location : On site

Depth (m) : 0.3

Address : 151 Canehaven Drive,

Soil Description : DK BR SANDY LEAN CLAY (CLAYEY GRAVEL)

Sample No. : 162

#### Insitu moisture content :

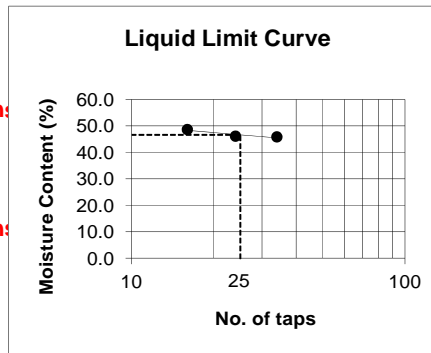
Pan no. :	22
Mass of pan + wet material (g) :	1844.70
Mass of pan + dry material (g) :	1555.90
Mass of pan (g) :	254.70
Moisture content (%) :	22.2

#### Grading :

Sieve Size (mm)	Sieve Size (mm)	% Passing
Old	New	
75.0	75.0	100
63.0	63.0	100
53.0	50.0	100
37.5	37.5	100
26.5	28.0	100
19.0	20.0	100
13.2	14.0	98
4.750	5.000	86
2.000	2.000	69
0.425	0.425	58
0.250	0.250	56
0.150	0.150	54
0.075	0.075	53

#### Atterberg Limits :

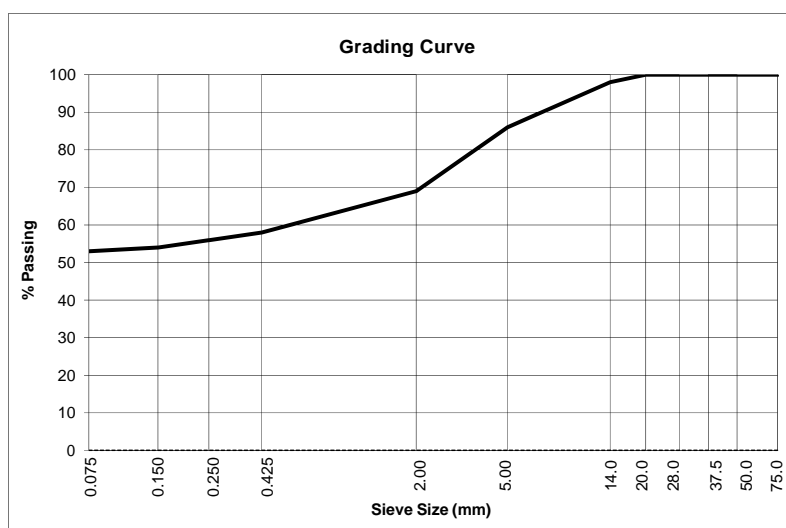
	Bottle number	Mass of bottle (g)	Bottle + wet sample	Bottle + dry sample	Number of taps	Moisture content (%)
Liquid Limit	35	54.99	57.44	56.67	34	45.83
	36	55.08	58.82	57.64	24	46.09
	37	56.68	59.92	58.86	16	48.62
Plastic Limit	39	56.68	60.66	59.87		24.76
	40	55.55	59.60	58.81		24.23



Linear Shrinkage	Measured shrinkage (mm) :	17.0
	No. of liquid limit taps at time of sampling :	16

#### Classification Summary :

Liquid Limit :	47
Plastic Limit :	24
Plasticity Index :	23
Linear Shrinkage :	10.5
Grading Modulus :	1.2
Group Index :	9
Cu :	#####
Cc :	0.0
MOD :	1763
OMC :	18.1
CBR @ 90% M.AASHTO :	2.0
CBR @ 93% M.AASHTO :	3.0
CBR @ 95% M.AASHTO :	4.0
CBR @ 98% M.AASHTO :	7.0
CBR @ 100% M.AASHTO :	9.0
% Swell @ 100% M.AASHTO :	3.1



Unified Classification : CL Sandy lean clay

AASHTO Classification : A-7-6 (9)

Remarks :

TRH14 Classification : Worse than G10

Signed :  
Materials Tester : Z.M. Luthuli  
Tested By : R.C. Guma

FIGURE 4

# Roads Provision Department

## Pavement & Geotechnical Engineering

### Soil Classification - TMH 1 Method A1(a), A2, A3, A4, A5

Ref. No. : 0

WO No. : 0

Sampled By : Lab

Project : Caneside OHS Clinic

Contract No. : 0

Date Sampled : 11/06/2018

Source : On site

Layer :

Results To : D. Abel

Location : TP2

Depth (m) : 1.0

Address : 151 Canehaven Drive,

Soil Description : DK BR CLAYEY SAND (CLAYEY GRAVEL)

Sample No. : 163

#### Insitu moisture content :

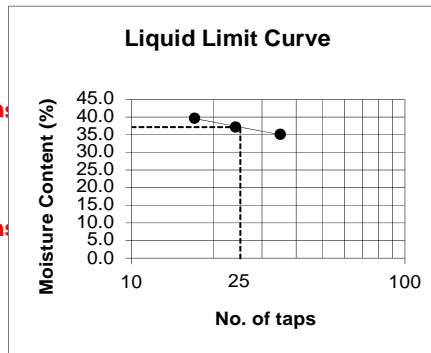
Pan no. :	25
Mass of pan + wet material (g) :	2236.10
Mass of pan + dry material (g) :	1939.80
Mass of pan (g) :	254.10
Moisture content (%) :	17.6

#### Grading :

Sieve Size (mm)	Sieve Size (mm)	% Passing
Old	New	
75.0	75.0	100
63.0	63.0	100
53.0	50.0	100
37.5	37.5	100
26.5	28.0	100
19.0	20.0	100
13.2	14.0	98
4.750	5.000	87
2.000	2.000	73
0.425	0.425	59
0.250	0.250	55
0.150	0.150	52
0.075	0.075	48

#### Atterberg Limits :

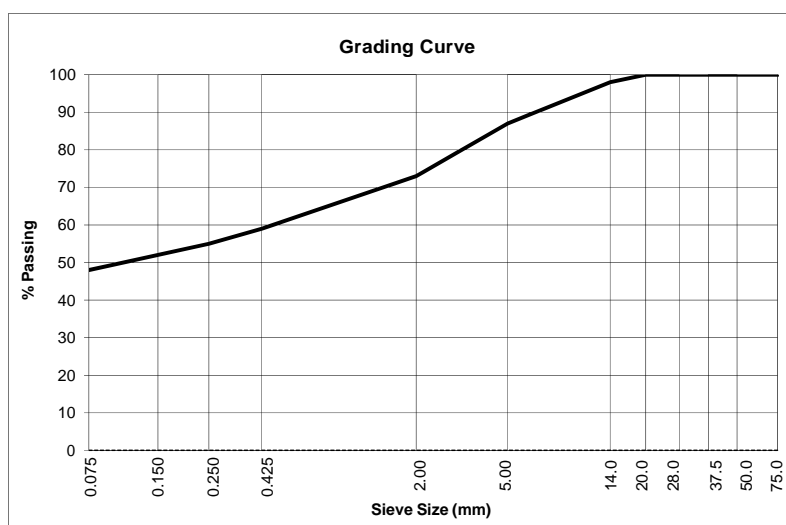
	Bottle number	Mass of bottle (g)	Bottle + wet sample	Bottle + dry sample	Number of taps	Moisture content (%)
Liquid Limit	26	55.38	58.65	57.80	35	35.12
	27	54.95	58.16	57.29	24	37.18
	28	55.36	58.00	57.25	17	39.68
Plastic Limit	29	54.86	58.58	57.95		20.39
	30	55.00	58.57	57.97		20.20



Linear Shrinkage	Measured shrinkage (mm) :	16.0
	No. of liquid limit taps at time of sampling :	17

#### Classification Summary :

Liquid Limit :	37
Plastic Limit :	20
Plasticity Index :	17
Linear Shrinkage :	10.0
Grading Modulus :	1.2
Group Index :	5
Cu :	4583.1
Cc :	0.2
MOD :	-
OMC :	-
CBR @ 90% M.AASHTO :	-
CBR @ 93% M.AASHTO :	-
CBR @ 95% M.AASHTO :	-
CBR @ 98% M.AASHTO :	-
CBR @ 100% M.AASHTO :	-
% Swell @ 100% M.AASHTO :	-



Unified Classification : SC Clayey sand

AASHTO Classification : A-6 (5)

TRH14 Classification : (G8/9/10 or worse)

Remarks :

Signed :  
Materials Tester : Z.M. Luthuli  
Tested By : R.C. Guma

FIGURE 5

# Roads Provision Department

Pavement & Geotechnical Engineering  
Soil Classification - TMH 1 Method A1(a), A2, A3, A4, A5

Ref. No. : 0

WO No. : 0

Sampled By : Lab

Project : Caneside OHS Clinic

Contract No. : 0

Date Sampled :

Source :

Layer :

Results To : D. Abel

Location :

Depth (m) : 1.8

Address : 151 Canehaven Drive,

Soil Description : DK BR CLAYEY SAND (CLAYEY GRAVEL)

Sample No. : 164

## Insitu moisture content :

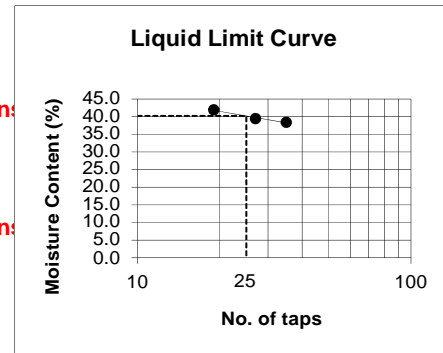
Pan no. : 26  
Mass of pan + wet material (g) : 2136.00  
Mass of pan + dry material (g) : 1798.90  
Mass of pan (g) : 254.00  
Moisture content (%) : 21.8

## Grading :

Sieve Size (mm)	Sieve Size (mm)	% Passing
Old	New	
75.0	75.0	100
63.0	63.0	100
53.0	50.0	100
37.5	37.5	100
26.5	28.0	100
19.0	20.0	100
13.2	14.0	98
4.750	5.000	88
2.000	2.000	74
0.425	0.425	59
0.250	0.250	55
0.150	0.150	52
0.075	0.075	49

## Atterberg Limits :

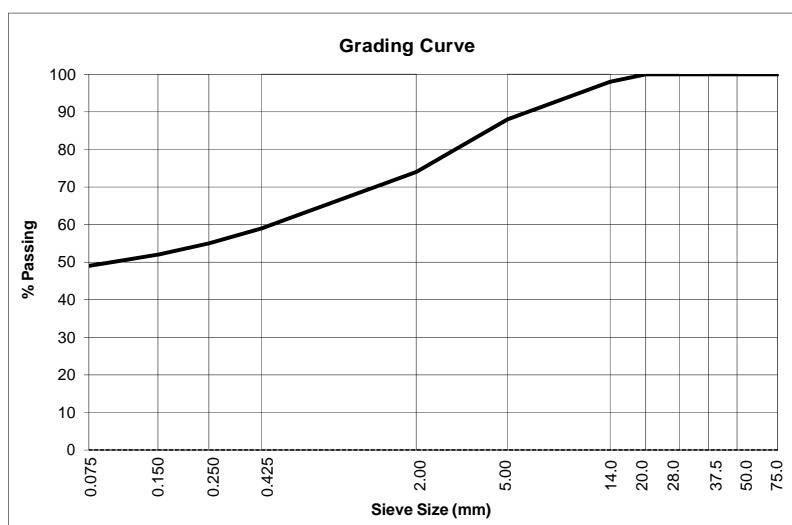
	Bottle number	Mass of bottle (g)	Bottle + wet sample	Bottle + dry sample	Number of taps	Moisture content (%)
Liquid Limit	32	52.26	55.54	54.63	35	38.40
	33	52.29	55.33	54.47	27	39.45
	34	52.35	56.04	54.95	19	41.92
Plastic Limit	35	52.65	55.82	55.32		18.73
	36	54.92	58.16	57.65		18.68



Linear Shrinkage Measured shrinkage (mm) : 16.0  
No. of liquid limit taps at time of sampling : 19

## Classification Summary :

Liquid Limit : 40  
Plastic Limit : 19  
Plasticity Index : 21  
Linear Shrinkage : 10.0  
Grading Modulus : 1.2  
Group Index : 7  
Cu : 51470.7  
Cc : 0.2  
MOD : -  
OMC : -  
CBR @ 90% M.AASHTO : -  
CBR @ 93% M.AASHTO : -  
CBR @ 95% M.AASHTO : -  
CBR @ 98% M.AASHTO : -  
CBR @ 100% M.AASHTO : -  
% Swell @ 100% M.AASHTO : -



Unified Classification : SC Clayey sand

AASHTO Classification : A-6 (7)

TRH14 Classification : (G8/9/10 or worse)

Remarks :

Signed :  
Materials Tester : Z.M. Luthuli  
Tested By : R.C. Guma

FIGURE 6