GEOTECHNICAL REPORT

GEOTECHNICAL SITE INVESTIGATION FOR THE PROPOSED NEW DEVELOPMENT OF ERF 12403, KNYSNA

27 JANUARY 2015

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Ref No: 2014\Marike Vreken Town Planners\Report\Geotechnical Report 27.1.2015 Rev 0

Report review history:

Revision No	Date	Prepared by:	Reviewed by:
0	27.1.2015	I.Paton Pr.Sci.Nat	D McDonald
			

Authors qualifications and affiliations:

Iain Paton is a professional engineering geologist with 15 years' experience in the mining, energy and construction industries and is registered with the South African Council for Natural and Scientific Professions (Pr Sci Nat # 400236/07), the South African Institute of Engineering and Environmental Geologists (SAIEG), the Geotechnical Division of the South African Institute of Civil Engineering (SAICE) and the Institute of Municipal Engineering of South Africa (IMESA).

Declaration of independence:

The author of this report is independent professional consultant with no vested interest in the project, other than remuneration for work associated with the compilation of this report.

General limitations:

1. The investigation has been conducted in accordance with generally accepted engineering practice, and the opinions and conclusions expressed in the report are made in good faith based on the information at hand at the time of the investigation.
2. The contents of this report are valid as of the date of preparation. However, changes in the condition of the site can occur over time as a result or either natural processes or human activity. In addition, advancements in the practice of geotechnical engineering and changes in applicable practice codes may affect the validity of this report. Consequently, this report should not be relied upon after an eclipsed period of one year without a review by this firm for verification of validity. This warranty is in lieu of all other warranties, either expressed or implied.
3. Unless otherwise stated, the investigation did not include any specialist studies, including but not limited to the evaluation or assessment of any potential environmental hazards or groundwater contamination that may be present.
4. The investigation is conducted within the constraints of the budget and time and therefore limited information was available. Although the confidence in the information is reasonably high, some variation in the geotechnical conditions should be expected during and after construction. The nature and extent of variations across the site may not become evident until construction. If variations then become apparent this could affect the proposed project, and it may be necessary to re-evaluate recommendations in this report. Therefore, it is recommend that Outeniqua Geotechnical Services is retained to provide specialist geotechnical engineering services during construction in order to observe compliance with the design concepts, specifications and recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated prior to the start of construction. Any significant deviation from the expected geotechnical conditions should be brought to the author's attention for further investigation.
5. The assessment and interpretation of the geotechnical information and the design of structures and services and the management of risk is the responsibility of the appointed engineer.

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1. Introduction

1.1 Background information

A new mixed-use development is proposed on Erf 12403 Knysna, consisting of residential, commercial and retail spaces (see locality map in **Figure 1**). A preliminary geotechnical site investigation was carried out on the site in 2005 by Siyakhula Lab. Amongst other findings, this initial investigation encountered a sawdust dump on the site and, following several other specialist investigations, a follow-up geotechnical investigation was commissioned by the developers (this report) to determine the present geotechnical conditions and the extent and expected volumes of sawdust presently on the site.

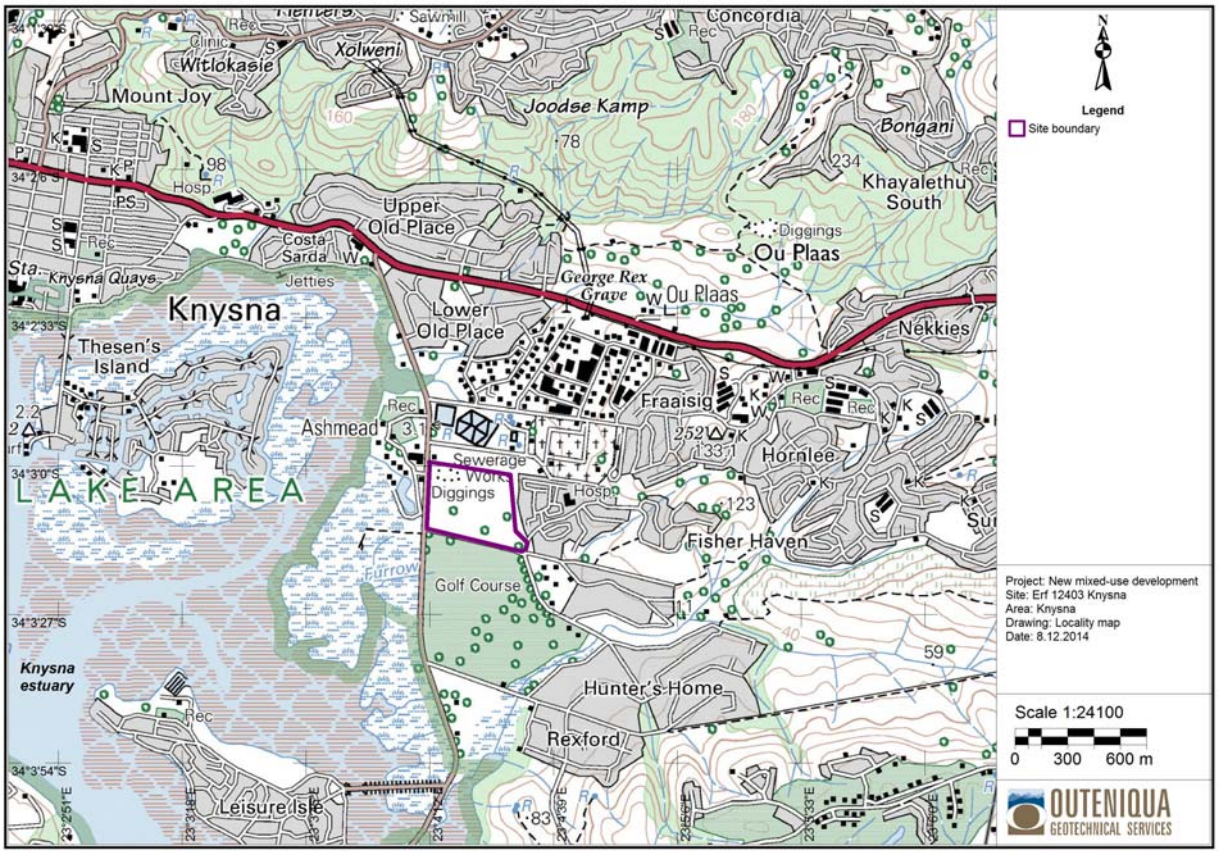


Figure 1: Locality map

1.2 Terms of reference

The scope of works is to conduct a geotechnical site investigation for the proposed development, with special focus on the presence of a possible sawdust dump.

The proposed methodology is as follows:

- Review all available information on the geology and geotechnical nature of the site;
- Conduct a subsurface investigation, consisting of 17 test pits (using a TLB), insitu penetration tests and laboratory tests;
- Delineate any uncontrolled fill and estimate the volume thereof;

- Compile a concise report providing all relevant information gained from the investigation and recommendations for the design of the proposed civil infrastructure and structures.

1.3 Information available

The following reports were available for perusal:

- Preliminary Geotechnical Report by Siyakhula Lab, dated 18 October 2005;
- "Potential impact of sawdust dump on a natural wetland, Knysna" by Allanson Associates, dated 13 July 1995;
- "George Rex Development: Groundwater Assessment" by WSP, dated September 2006.

The following maps and plans were available for reference purposes and are reproduced in the report:

- Digital raster geological map of the area;
- Digital aerial photo imagery from Google Earth and the Directorate of Surveys & Mapping;
- Digital topo-cadastral data sets obtained from the Directorate of Surveys & Mapping.

1.4 Site description

The site is located along George Rex Drive in Knysna which is a causeway that was constructed many decades along the edge of the Knysna estuary (see **Figure 2**). The site is 19.5Ha in extent and is characterised by fairly flat terrain (<1:100) which drains very slowly in a south and westerly direction into the Knysna estuary. Surface ponding of rainwater was noted in many areas which restricted access across site with machinery. Approximately 7Ha of the site consists of a permanent marsh/wetland and the central portion of the site is usually dry and covered by grass and scattered alien trees. The site is vacant with the exception of one derelict small house (see **Figure 3**).

Figure 2: Aerial photo of site

Figure 3: View across site towards the south (note small dwelling in centre)

2. Methods of investigation

2.1 Preliminary studies

A desk study of available information was conducted prior to the subsurface investigation. This exercise included a review of maps, plans and existing reports on the

geotechnical and physical nature of the site. A site walkover survey was also undertaken to validate the available data and collect additional information pertaining surface processes, topography and site accessibility.

2.2 Subsurface investigation

The subsurface nature of the site was investigated using the following methods:

- Seventeen test pits were excavated in a semi-random pattern across the site with a TLB/Backhoe to an approximate depth of 2m. The test pits were logged, photographed and sampled according to standard methods. Refer to **Appendix 2** for details.
- Laboratory tests were conducted on selected soil samples taken from test pits. Refer to **Appendix 3** for details.
- Dynamic Cone Penetrometer (DCP) tests were conducted from natural ground level (NGL) at all test pit positions. Refer to **Appendix 4**.

3. Results of the investigation

3.1 Geology

The site is underlain by alluvial and estuarine deposits of Quaternary age (see **Figure 4**). These deposits are associated with the Knysna estuary and are typically unconsolidated sandy soils with variable amounts of silt and clay and occasional marine invertebrate shells. These Quaternary deposits overlie conglomerate, sandstone and siltstone of the Uitenhage Group and/or quartzitic sandstone of the Table Mountain Group at unknown depths, but which are exposed on the hills surrounding the Knysna Basin.

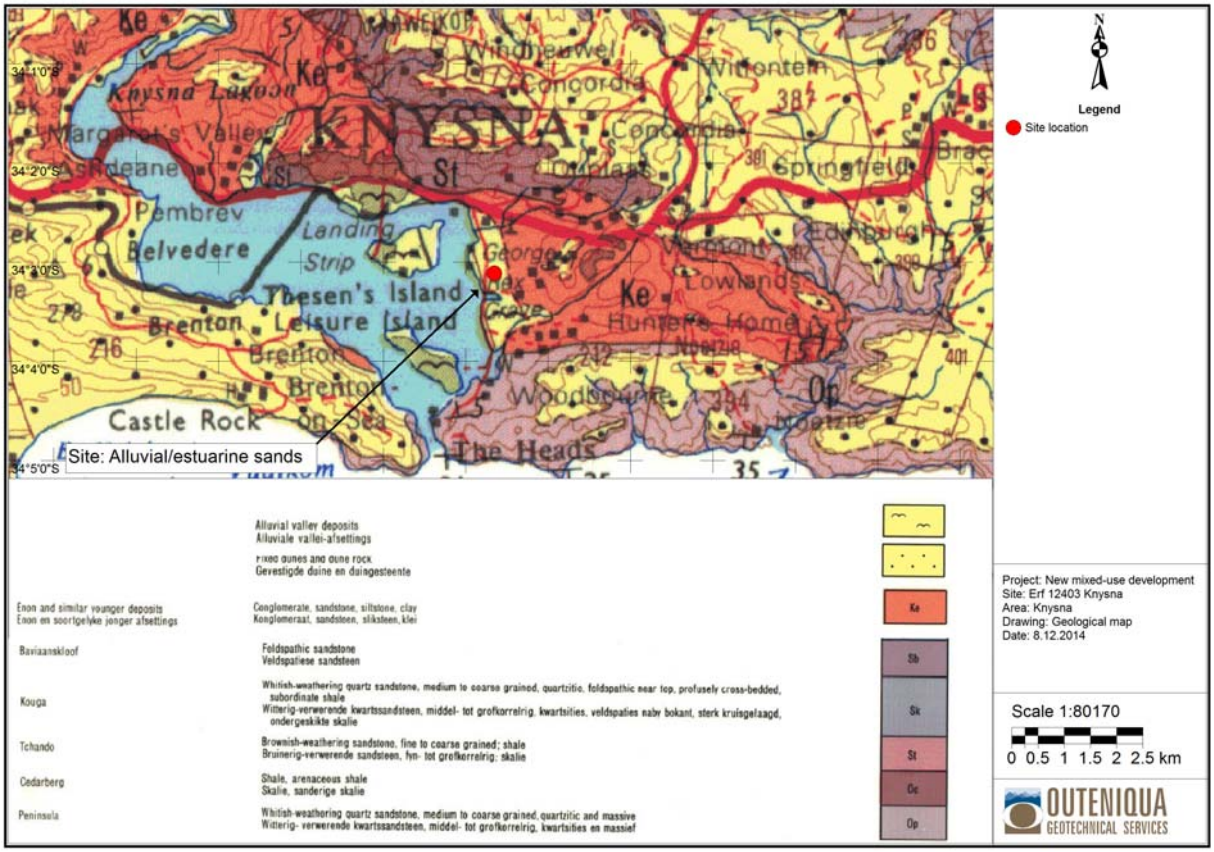


Figure 4: Geological map

3.2 Geotechnical data

3.2.1 Soil types

The typical insitu soil profile encountered in the test pits is recorded as follows:

- 0-400mm: Moist to very moist, dark brown, loose, intact, CLAYEY SILTY FINE SAND, transported colluvium (topsoil – organic rich);
- 400-1000mm: Moist, light brown mottled light red orange, loose-medium dense, intact, slightly SILTY FINE SAND, transported fine alluvium;
- 1000-1500mm: Very moist, light-dark grey, medium dense, intact, SAND, transported (estuarine/alluvium);
- >1500mm: Wet, dark grey, medium dense, intact, SAND, transported (estuarine – some shells present).

DCP tests indicate variable levels of consistency but there is a general trend of improvement with depth, although one or two results indicate loose soil with low bearing capacity down to 1.4m. The water table can also negatively affect the DCP results and this should be taken into consideration when analyzing the results. Nevertheless, compaction of the founding medium will definitely be required to reduce settlement.

There is a small isolated heap of superficial sawdust on the site, as indicated on the geotechnical map (**Figure 5**) at TP8. The estimated area of the heap is 400m^2 and the average thickness is estimated at 500mm, therefore the insitu volume (excluding bulking) is estimated at 200m^3. This material is unsuitable for engineering purposes and should ideally be removed or spread very thinly (<100mm thick) out across the site.

Environmental input is recommended.

There is also a heap of fill material indicated on the geotechnical map at TP11 which appears to be a mix of soil & sawdust. This heap is estimated to be 2400m^2 with an average thickness of 1m, therefore the insitu volume (excluding bulking) is estimated at 2400m^3. It is estimated that 50% of this fill can be selected out for general fill purposes during construction, but will require further testing.

There is a large heap of imported fill soil indicated on the geotechnical map near TP17 which appears to be mainly soil (possibly imported from excavations at the Knysna Mall in about 2003). This heap is estimated to be 9400m^2 with an average thickness of 2m, therefore the insitu volume (excluding bulking) is estimated at 18800m^3. It is estimated that 80% of this fill can be selected out for general fill purposes during construction. Large blocks of concrete may have to be crushed or used as rock fill.

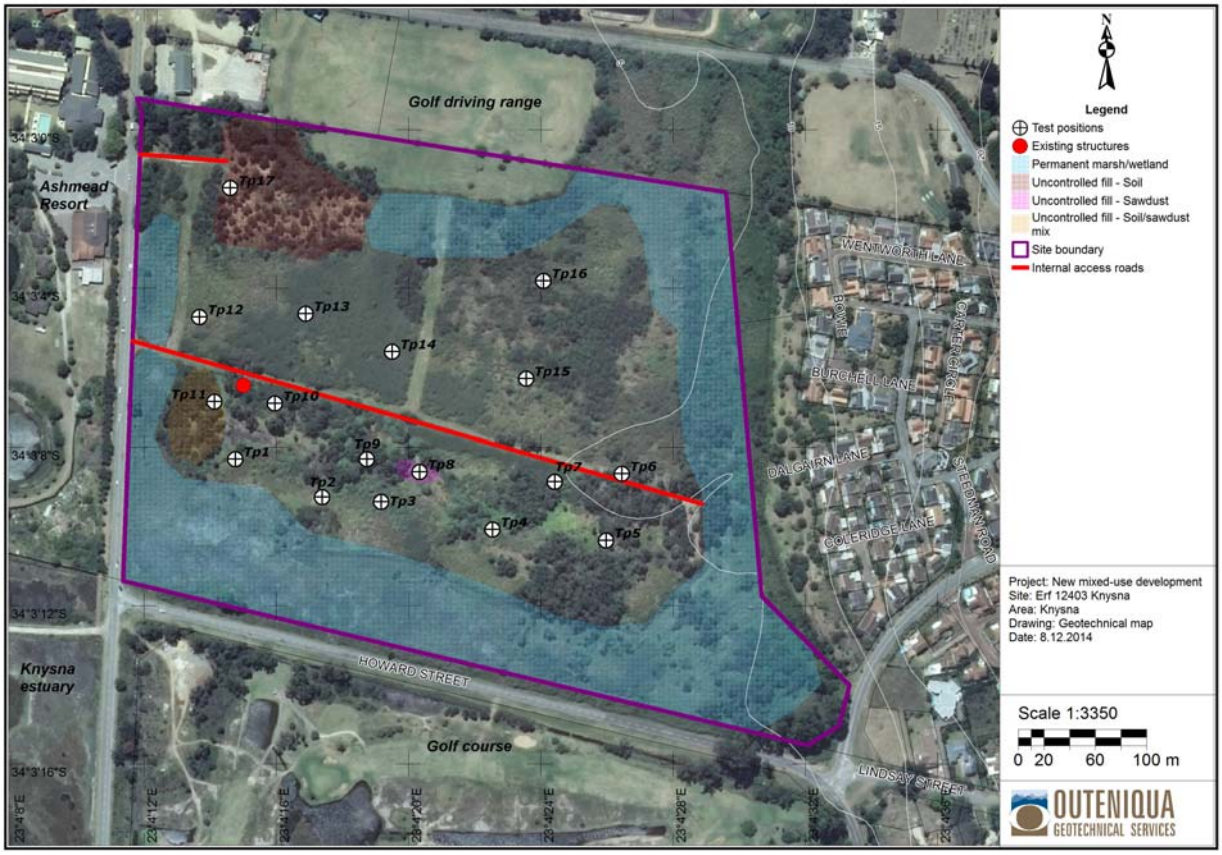


Figure 5: Geotechnical map

3.2.2 Groundwater

The permanent (fluctuating) water table was encountered at a depth range of 1.4m-2.0m below natural ground level (NGL). The water table level measurements in test pits indicate slight variations across the site with an average depth of 1.6m below ground surface, as indicated in **Table 1**. The sidewalls of the test pits caved in due to the saturated sand which has no cohesion.

Table 1: Water table levels recorded in test pits (in meters)

Test position	Water table depth
TP1	1.8
TP2	1.6
TP3	1.5
TP4	1.5
TP5	1.1
TP6	1.5
TP7	1.8
TP8	1.6
TP9	1.5
TP10	1.6
TP11	2.0
TP12	1.8
TP13	1.6
TP14	1.4
TP15	1.5
TP16	1.6
TP17	-
AVE	**1.6**

3.2.3 Laboratory test results on soil

Samples of soil types were collected from test pits for Foundation Indicator tests to classify the soils in terms of grading, Atterberg limits, moisture content and potential expansivity. The results are summarised in **Table 2**.

Table 2: Summary of results of Foundation Indicator tests

Test Pit No	***Sample Depth (mm)***	***Atterberg Limits***			***Clay***	***Silt***	***Sand***	***Gravel***	***MC****	***USC****	***PE******
		PI	***LL***	***LS***							
TP2	250-800	4	17	2	25	64	10	1	19.3	CL-ML	LOW
TP4	300-1500	NP	NP	0	13	28	59	0	22.3	SM	LOW
TP7	400-1400	NP	NP	0	14	50	36	0	16.9	ML	LOW
TP9	0-400	5	27	3	18	37	45	0	39.9	ML	LOW

*Moisture Content **Universal Soil Classification ***Potential Expansivity

The tests indicate that the soils are generally not too problematic but are fine grained and can be classified according to the USC system under the following categories:

CL-ML – Clayey silts of low plasticity;
SM – Silty sands with non-plastic fines;
ML – Silts or silty fine sands of low plasticity.

The soils generally display low potential expansiveness and the predicted heave is negligible.

A representative sample of surficial soil was collected at TP14 for Mod. AASHTO density, CBR and Indicator tests to determine the subgrade potential for road-building purposes. A representative sample was also taken at TP17 of the fill stockpile to determine the suitability of this material for selected filling purposes. A summary of the results is shown in **Table 3**.

Table 3: Summary of Mod/CBR/Indicator test results

Test Pit No	Sample Depth (mm)	CBR at					Swell (%)	PI (%)	GM	MDD/ OMC	TRH14 Class
		100 %	98%	95%	93%	90%					
TP14	0-300	28	23	17	12	6	0.91	SP	0.86	1852/11.6	G10
TP17	0-2100	8	7	6	5	4	1.09	NP	1.52	2116/9.1	G10

The tests indicate that the roadbed quality is marginal (borderline G10/G9) and will tend to become saturated, soft and muddy in wet periods. The fill from the stockpile is also marginal quality with an unusually low CBR value. Further tests may prove better material further into the stockpile as visually it appears promising as a source of fill material.

4. Recommendations

4.1 Earthworks and Foundations

The soil types are potentially compressible under load (estimated S1 category) and will require good compaction to safely carry even single storey masonry structures. The recommended foundation system is reinforced shallow strip foundations or light rafts on insitu sands, compacted to minimum 95% Mod. AASHTO density, with bearing pressures limited to 100kPa. Foundations with heavier loads (e.g. triple storey buildings or bridges) may involve piling or engineered soil rafts and specialist geotechnical input is recommended. It is recommended that initial compaction of the entire site is undertaken during earthworks phase with a heavy padfoot roller to prove soft spots and improve the density of the upper soil layers.

Structural filling material under floor slabs should be imported G7 and compacted to a minimum of 95% of the Mod AASHTO density, or as directed by the engineer. Floor slabs should be lightly reinforced.

The following additional recommendations are provided:

- Strip all organic and foreign material (rubbish and rubble) over footprint areas.
- No structures should be placed on uncontrolled fill.

- Uncontrolled fill should be carted to spoil or recompacted as directed by the engineer.
- Localised depressions requiring filling should be filled with suitable local or imported material and compacted to the same degree and level as the surrounding density.
- Do not try to compact saturated soil. Rather rip and dry or remove and replace.
- Foundation trenches should be inspected by the engineer to approve founding conditions, such as soil types, density and moisture levels.
- Due to the low-lying nature of the site, it is recommended that floor levels should be raised to prevent flooding and damp problems associated with a shallow water table.

4.2 Roads and services

The *in situ* roadbed is a marginal quality (borderline G9-10) and allowance should be made in the design for a selected layer. The following recommendations are provided for the preparation of the subgrade:

- Cut roadbed to line and level;
- Proof roll (minimum 5 passes with a 10ton roller) to identify soft areas;
- Scarify and compact to 93% of Mod. AASHTO density, or remove soft or wet soil and reinstate with imported G7 quality material, or suitably drier *in situ* soil;
- Compact roadbed to a minimum depth of 150 mm to 93% of Mod. AASHTO density. Recommended moisture content during rolling is optimum moisture content (OMC) minus 2-3%.

The road layerworks recommendations are provided in **Table 4** as a guide for the design of internal, lightly trafficked roads.

Pipe bedding and backfill materials for buried pipes should consist of free-draining, non-cohesive granular material graded between 0.6 and 19mm. Pipe cradle material should be selected and placed in accordance with SABS1200LB.

Table 4: Road layerworks recommendations

Layer	***Material***	***Thickness***	***Required Compaction***
Roadbed	*In situ* soil G9/10	150mm	93% Mod AASHTO
Selected Subgrade	Imported G7	150mm	93% Mod AASHTO
Subbase	Imported G5	150mm	95% Mod AASHTO
Base	Imported G4/2	150mm	98% Mod AASHTO
Seal	Cape Seal	13/19mm	TBD by engineer
OR			
Roadbed	*In situ* soil G9/10	150mm	93% Mod AASHTO
Selected Subgrade	Imported G7	150mm	93% Mod AASHTO
Subbase	Imported G5	150mm	95% Mod AASHTO
Bedding	Clean bedding sand	20mm	100% Mod AASHTO
Paving	Interlocking concrete pavers	60/80mm	-

5. Site drainage

The soil has a medium to low permeability and persistent rainfall will tend to pond on surface (see **Figure 6**). Effective storm water systems will therefore be required to accommodate flood events recurring every 10 years. A well-planned road layout can significantly reduce stormwater system costs. Raised barrier kerbs, mountable or semi-mountable kerbs or open side drains (swales) along roads are recommended in order to evacuate storm water. Regularly spaced inlets are recommended to prevent storm water from overtopping kerbs and flowing into adjacent properties. Subsoil drains along roads are not deemed necessary.

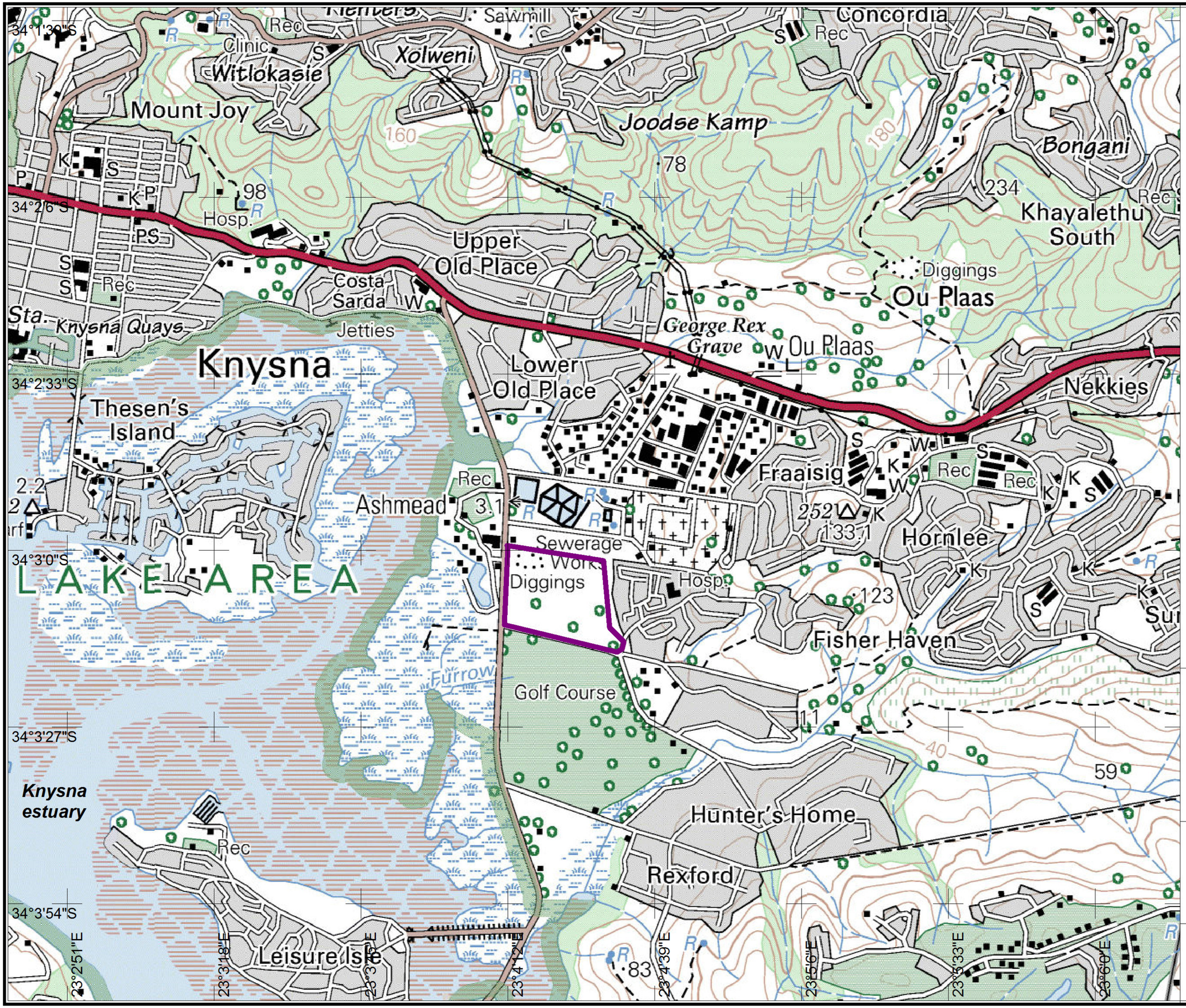
Figure 6: Photo of standing water on site after rains

6. Conclusions

The site investigation indicates that the geology and geotechnical nature of the site is generally considered suitable for the proposed development and that no insurmountable geotechnical constraints are expected to impact on the project feasibility. Recommendations based on the findings of the investigation are provided for consideration by the design engineers.

Appendix 1

Maps



N

Legend

Site boundary

Project: New mixed-use development
Site: Erf 12403 Knysna
Area: Knysna
Drawing: Locality map
Date: 8.12.2014

Scale 1:24100

0 300 600 m

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N

Legend

Site boundary

Project: New mixed-use development
Site: Erf 12403 Knysna
Area: Knysna
Drawing: Aerial photo map
Date: 8.12.2014

Scale 1:10020

0 60 180 300 m

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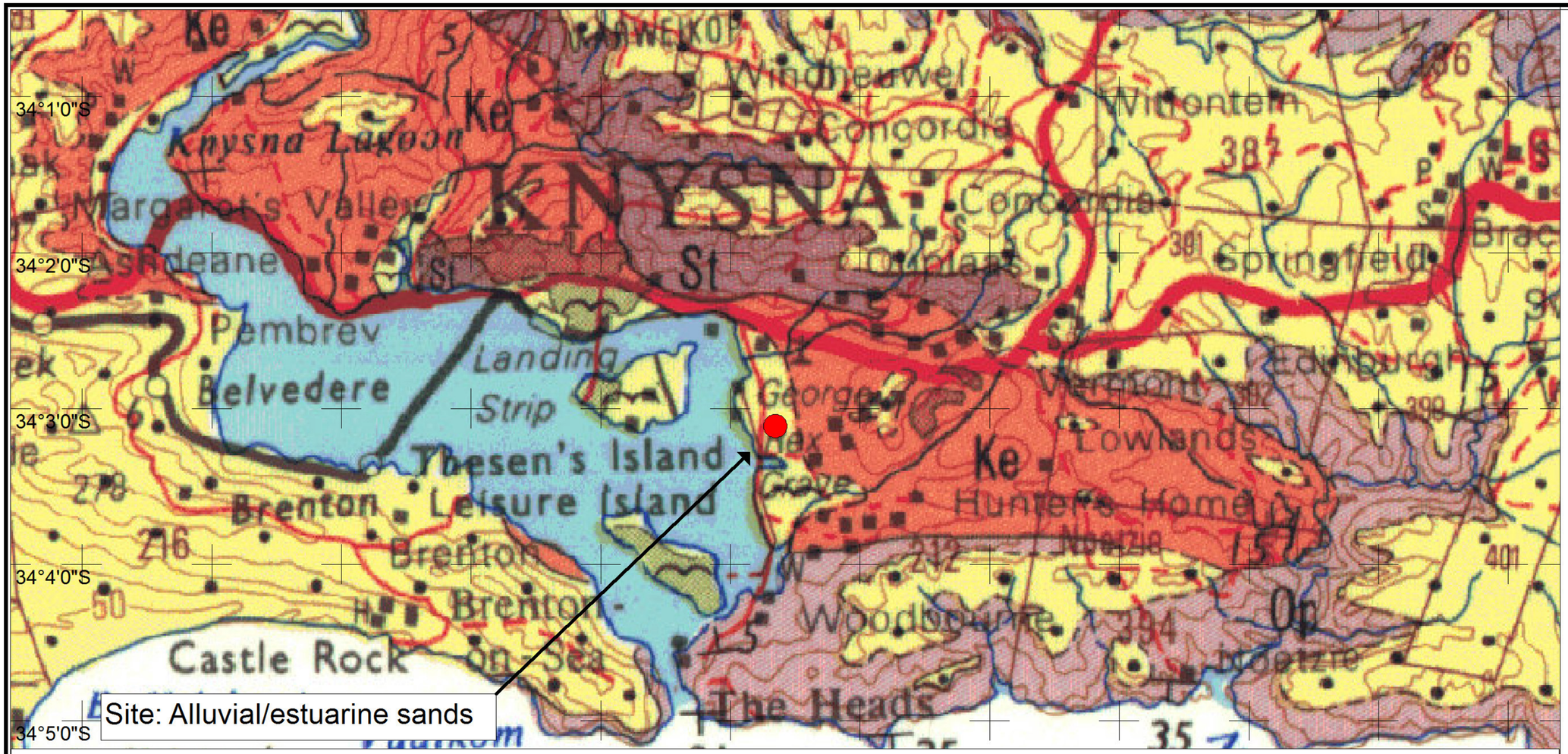

	Alluvial valley deposits Alluviale vallei-afsettings	
	Fixed dunes and dune rock Gevestigde duine en duingesteente	
Enon and similar younger deposits Enon en soortgelyke jonger afsettings	Conglomerate, sandstone, siltstone, clay Konglomeraat, sandsteen, sliksteen, klei	Ke
Baviaanskloof	Feldspathic sandstone Veldspatiese sandsteen	Sb
Kouga	Whitish-weathering quartz sandstone, medium to coarse grained, quartzitic, feldspathic near top, profusely cross-bedded, subordinate shale Witterig-verwerende kwartssandsteen, middel- tot grofkorrelrig, kwartsities, veldspaties naby bokant, sterk kruisgelaagd, ondergeskikte skalie	Sk
Tchando	Brownish-weathering sandstone, fine to coarse grained; shale Bruinerig-verwerende sandsteen, fyn- tot grofkorrelrig; skalie	St
Cedarberg	Shale, arenaceous shale Skalie, sanderige skalie	Oc
Peninsula	Whitish-weathering quartz sandstone, medium to coarse grained, quartzitic and massive Witterig- verwerende kwartssandsteen, middel- tot grofkorrelrig, kwartsities en massief	Op

N

Legend

Site location

Project: New mixed-use development
Site: Erf 12403 Knysna
Area: Knysna
Drawing: Geological map
Date: 8.12.2014

Scale 1:80170

0 0.5 1 1.5 2 2.5 km

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N

Legend

- Test positions
- Existing structures
- Permanent marsh/wetland
- Uncontrolled fill - Soil
- Uncontrolled fill - Sawdust
- Uncontrolled fill - Soil/sawdust mix
- Site boundary
- Internal access roads

Project: New mixed-use development
Site: Erf 12403 Knysna
Area: Knysna
Drawing: Geotechnical map
Date: 8.12.2014

Scale 1:3350

0 20 60 100 m

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Appendix 2

Test pit profiles

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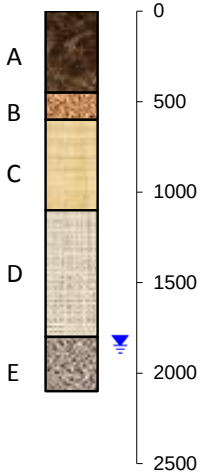
Geotechnical Soil Profile

Client:	Marike Vreken Town Planners
Project:	Erf 12403, George Rex Drive
Area:	Knysna
Date:	24.11.14
Excavator:	TLB

TP 1

Datum: NGL | Co-ords: 23 Y-006534 X3769465

Key to symbols: ● Sample taken | Groundwater



(0 to 450)	Moist, dark red brown, loose, intact, **SAWDUST**, imported (Fill)
(450 to 600)	Moist, dark brown, medium dense, intact, **SILTY SAND**, transported (Topsoil)
(600 to 1100)	Moist, light brown, medium dense, intact, **SAND**, transported.
(1100 to 1800)	Very moist, dark grey, medium dense, intact, **SLIGHTLY SILTY SAND**, transported (Estuarine - some bivalve shells present)
(1800 to 2100)	Wet, dark grey, medium dense, intact, **SLIGHTLY SILTY SAND**, transported (Estuarine - some bivalve shells present)

Water table @ 1800mm

Dynamic Cone Penetrometer (DCP)

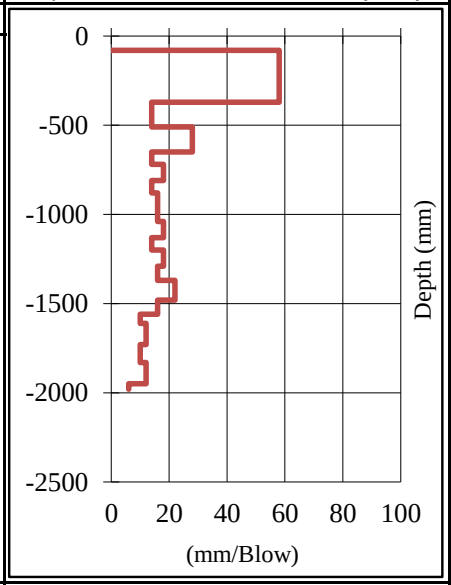
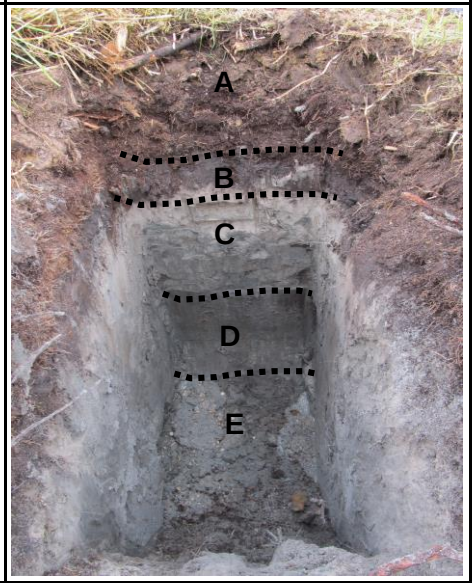


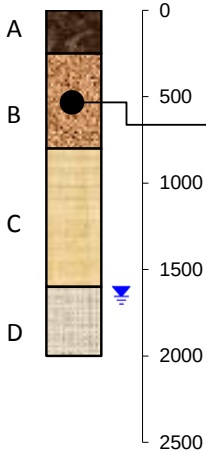
Photo of Test Pit



TP 2

Datum: NGL | Co-ords: 23 Y-006602 X3769495

Key to symbols: ● Sample taken | Groundwater



(0 to 250)	Very moist, dark brown, loose, intact, **CLAYEY SILTY SAND**, transported (Organic topsoil)
(250 to 800)	Moist, light grey, medium dense, intact, **GRAVELY SANDY CLEYEY SILT**, transported.
	Foundation Indicator
(800 to 1600)	Very moist, dark grey, medium dense, intact, **SLILGHTLY SILTY SAND**.
(1600 to 2000)	Wet, dark grey, medium dense, intact, **SLIGHTLY SILTY SAND**.

Sidewalls collapse
Water table @ 1600mm

Dynamic Cone Penetrometer (DCP)

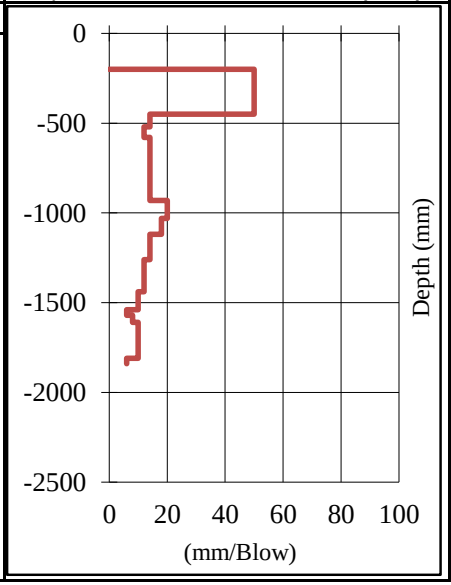
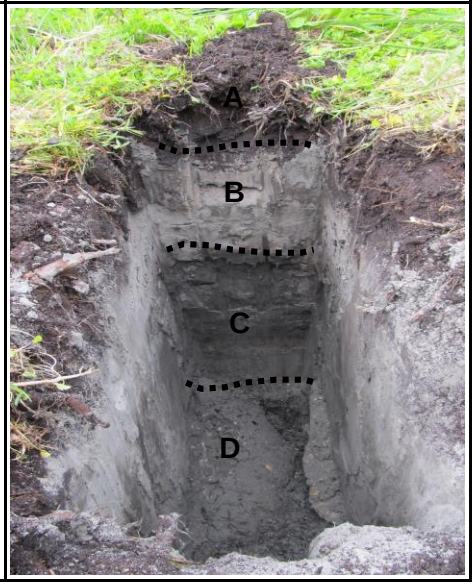


Photo of Test Pit



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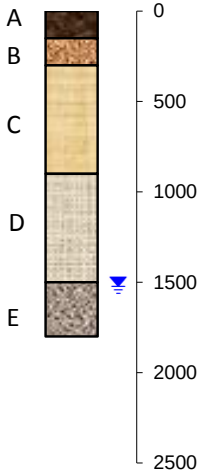
Geotechnical Soil Profile

Client:	Marike Vreken Town Planners
Project:	Erf 12403, George Rex Drive
Area:	Knysna
Date:	24.11.14
Excavator:	TLB

TP 3

Datum: NGL | Co-ords: 23 Y-006647 X3769499

Key to symbols: ● Sample taken | ▼ Groundwater



(0 to 150) Very moist, dark red brown, loose, intact, sawdust, imported.

(150 to 300) Very moist, dark brown, loose, intact, **CLAYEY SILTY SAND**, transported.

(300 to 900) Very moist, light brown, medium dense, intact, **SAND**, transported.

(900 to 1500) Very moist, dark grey, medium dense, intact, **SAND**, transported.

(1500 to 1800) Wet, dark grey, medium dense, intact, **SAND**, transported.

Sidewalls collapse

Water table @ 1500mm

Dynamic Cone Penetrometer (DCP)

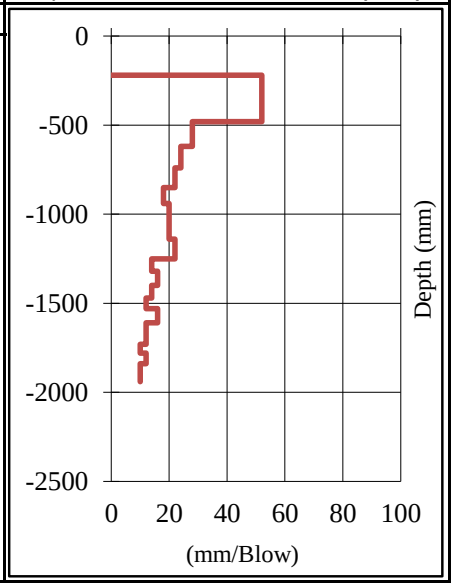
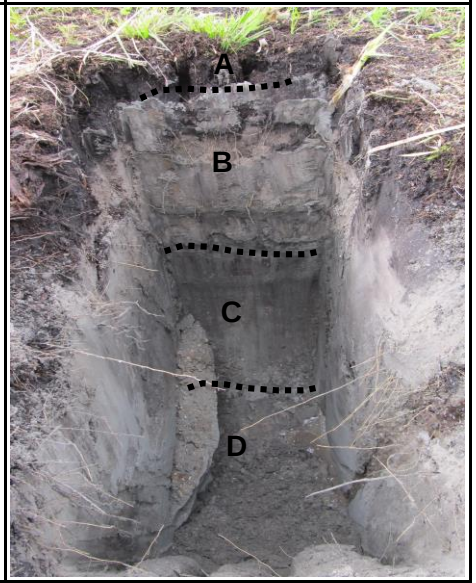


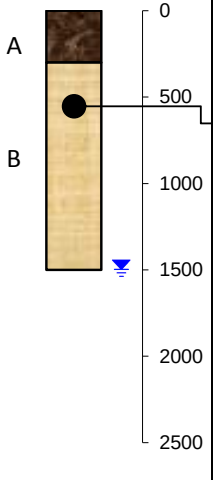
Photo of Test Pit



TP 4

Datum: NGL | Co-ords: 23 Y-006733 X3769521

Key to symbols: ● Sample taken | ▼ Groundwater



(0 to 300) Very moist, dark brown, loose, intact, **CLAYEY SILTY SAND**, transported (Topsoil)

(300 to 1500) Very moist, light brown mottled light grey, medium dense, intact, **CLAYEY SILTY SAND**, transported.

Foundation Indicator

Sidewalls collapse - test pit stopped

Water table @ 1500mm

Dynamic Cone Penetrometer (DCP)

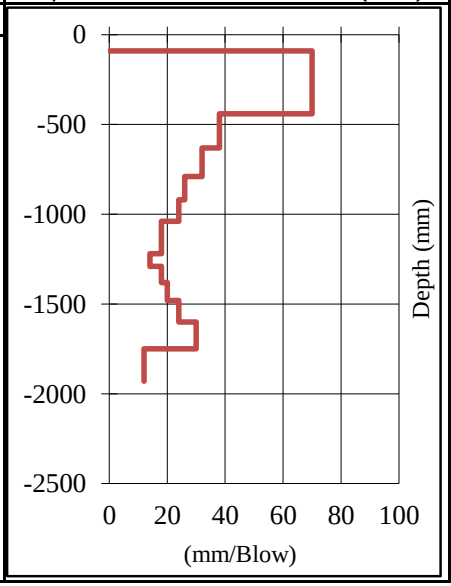
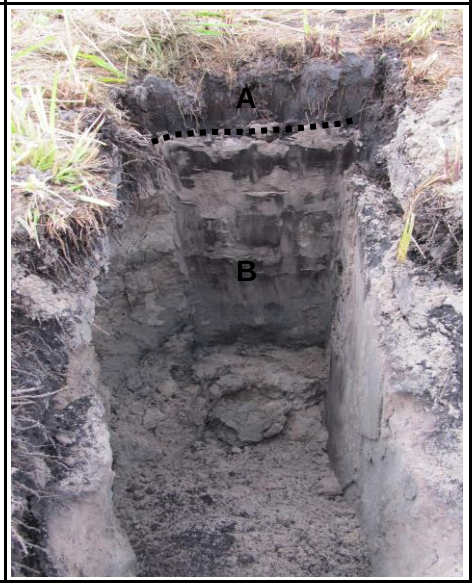


Photo of Test Pit



OUTENIQUA GEOTECHNICAL SERVICES

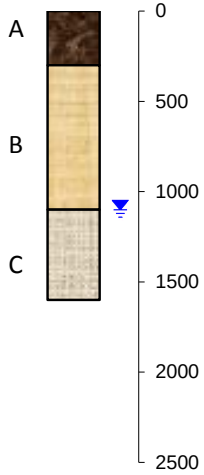
Geotechnical Soil Profile

Client:	Marike Vreken Town Planners
Project:	Erf 12403, George Rex Drive
Area:	Knysna
Date:	24.11.14
Excavator:	TLB

TP 5

Datum: NGL | Co-ords: 23 Y-006822 X3769529

Key to symbols: ● Sample taken | Groundwater



(0 to 300) Moist, dark brown, loose, intact, **CLAYEY SILTY SAND**, transported (Topsoil)

(300 to 1100) Very moist, light brown, medium dense, intact, **SAND**, transported.

(1100 to 1600) Wet, light brown, medium dense, intact, **SAND**, transported.

Sidewalls collapse
Seepage @ 1100mm

Dynamic Cone Penetrometer (DCP)

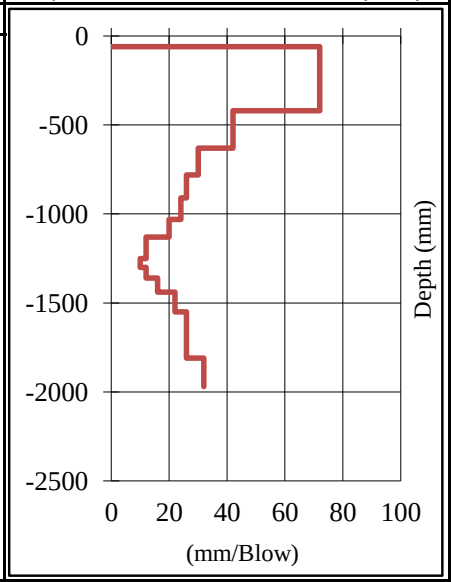
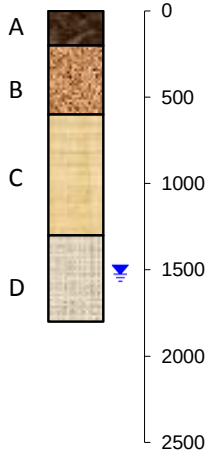


Photo of Test Pit

TP 6

Datum: NGL | Co-ords: 23 Y-006834 X3769477

Key to symbols: ● Sample taken | Groundwater



(0 to 200) Moist, light to dark brown, medium dense, intact, **GRAVELLY SILTY SAND**, imported (Fill, road)

(200 to 600) Moist, dark brown to black, medium dense, intact, **SILTY SAND**, transported (Topsoil)

(600 to 1300) Moist, light brown, medium dense, intact, **SAND**, transported.

(1300 to 1800) Very moist, dark grey, medium dense, intact, **SAND**, transported.

Sidewalls collapse
Water table @ 1500mm

Dynamic Cone Penetrometer (DCP)

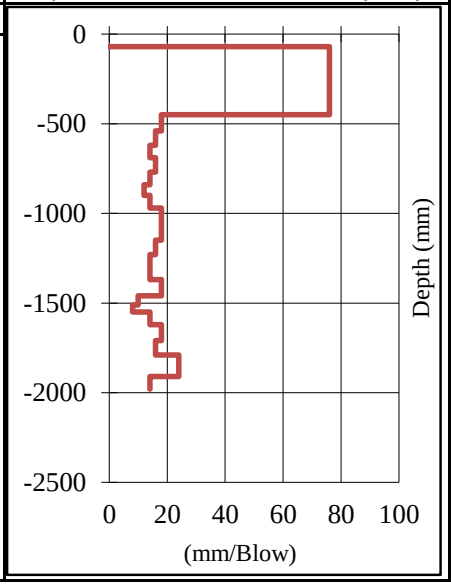
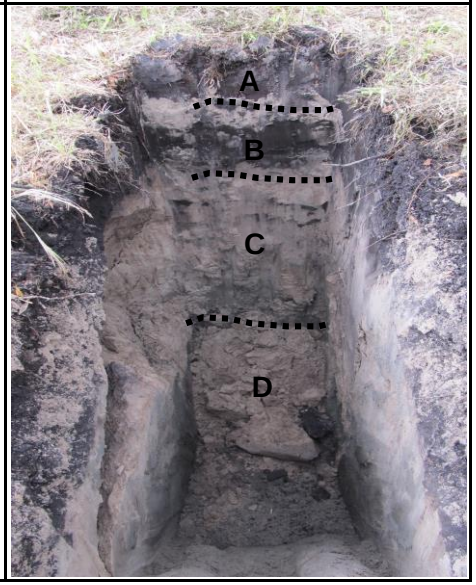


Photo of Test Pit



OUTENIQUA GEOTECHNICAL SERVICES

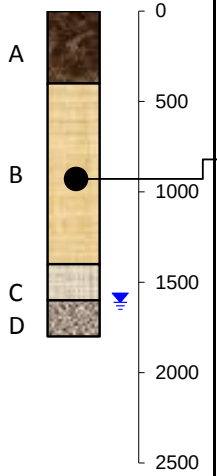
Geotechnical Soil Profile

Client:	Marike Vreken Town Planners
Project:	Erf 12403, George Rex Drive
Area:	Knysna
Date:	24.11.14
Excavator:	TLB

TP 7

Datum: NGL | Co-ords: 23 Y-006782 X3769483

Key to symbols: ● Sample taken | Groundwater



(0 to 400) Moist, dark brown to black, medium dense, intact, **CLAYEY SILTY SAND**, transported (Topsoil)

(400 to 1400) Very moist, light brown, medium dense, intact, **CLAYEY SANDY SILT**, transported.

Foundation Indicator

(1400 to 1600) Very moist, dark grey, medium dense, intact, **SAND**, transported.

(1600 to 1800) Wet, dark grey, medium dense, intact, **SAND**, transported.

Sidewalls collapse

Water table @ 1800mm

Dynamic Cone Penetrometer (DCP)

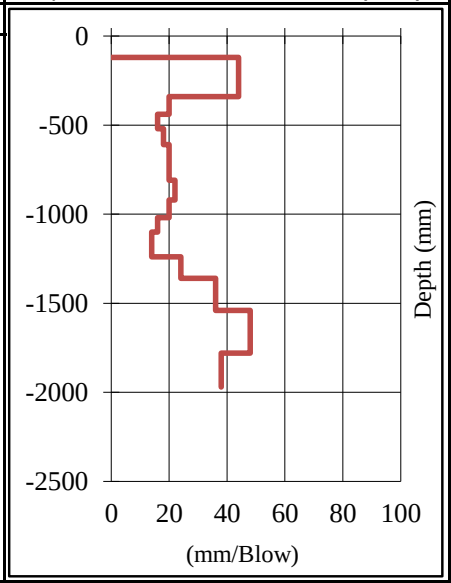
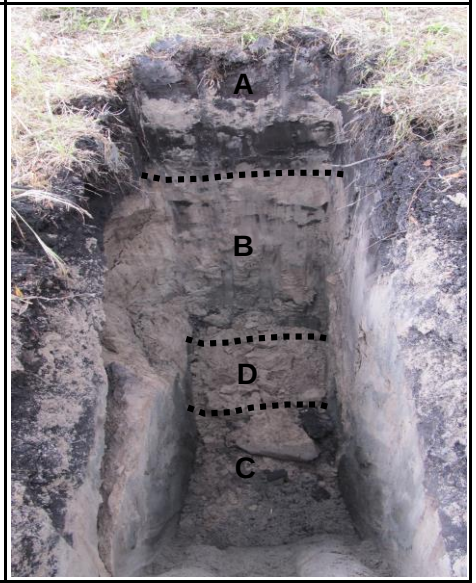


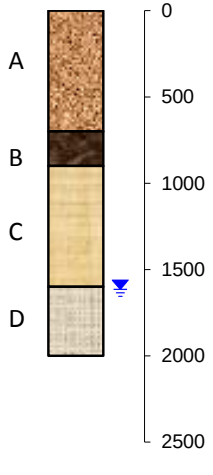
Photo of Test Pit



TP 8

Datum: NGL | Co-ords: 23 Y-006677 X3769475

Key to symbols: ● Sample taken | Groundwater



(0 to 700) Moist, dark red brown, loose, intact, **SAWDUST**, imported (Fill)

(700 to 900) Moist, dark brown, loose, intact, **SILTY SAND**, transported (Topsoil)

(900 to 1600) Very moist, light brown, medium dense, intact, **SAND,** transported.

(1600 to 2000) Wet, dark grey, medium dense, intact, **SAND**, transported.

Sidewalls collapse

Water table @ 1600mm

Dynamic Cone Penetrometer (DCP)

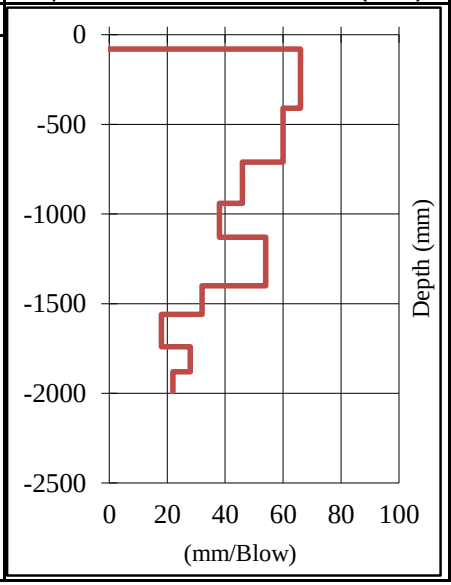
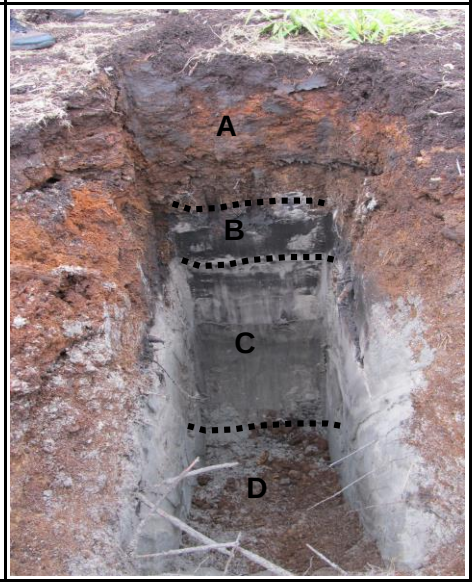


Photo of Test Pit



Geotechnical Soil Profile

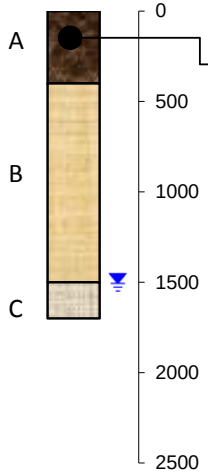
OUTENIQUA GEOTECHNICAL SERVICES

Client:	Marike Vreken Town Planners
Project:	Erf 12403, George Rex Drive
Area:	Knysna
Date:	24.11.14
Excavator:	TLB

TP 9

Datum: NGL | Co-ords: 23 Y-006636 X3769466

Key to symbols: ● Sample taken | Groundwater



(0 to 400) Moist, dark brown, loose, intact, **CLAYEY SILY SAND**, transported (Organic topsoil)

Foundation Indicator

(400 to 1500) Very moist, light brown, medium dense, intact, **SAND**, transported.

(1500 to 1700) Wet, dark grey, medium dense, intact, **SAND**, transported.

Sidewalls collapse

Water table @ 1500mm

Dynamic Cone Penetrometer (DCP)

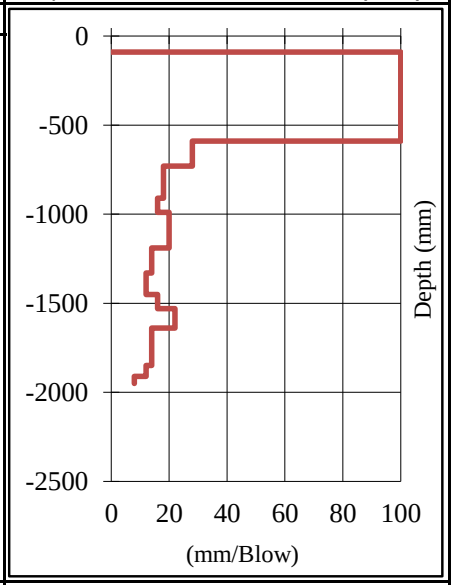
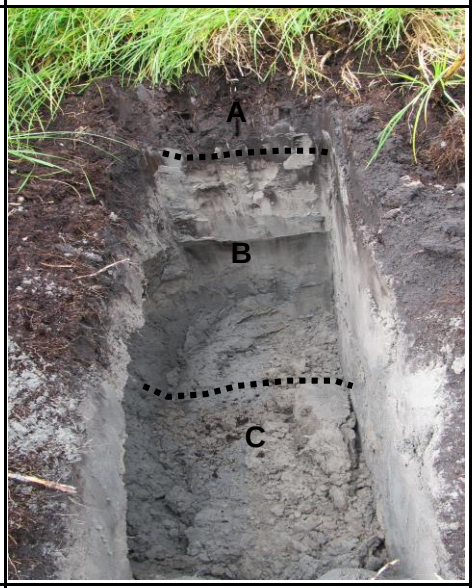


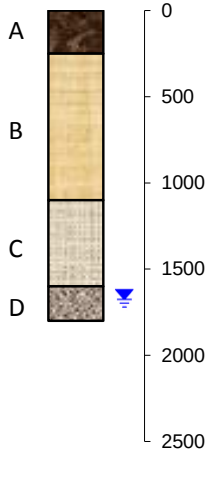
Photo of Test Pit



TP 10

Datum: NGL | Co-ords: 23 Y-006565 X3769423

Key to symbols: ● Sample taken | Groundwater



(0 to 250) Moist, dark brown, loose, intact, **SILTY SAND**, transported (Topsoil)

(250 to 1100) Very moist, light brown, loose to medium dense, intact, **SAND,** transported.

(1100 to 1600) Very moist, dark grey, medium dense, intact, **SAND**, transported.

(1600 to 1800) Wet, dark grey, medium dense, intact, **SAND**, transported.

Sidewalls collapse

Water table @ 1600mm

Dynamic Cone Penetrometer (DCP)

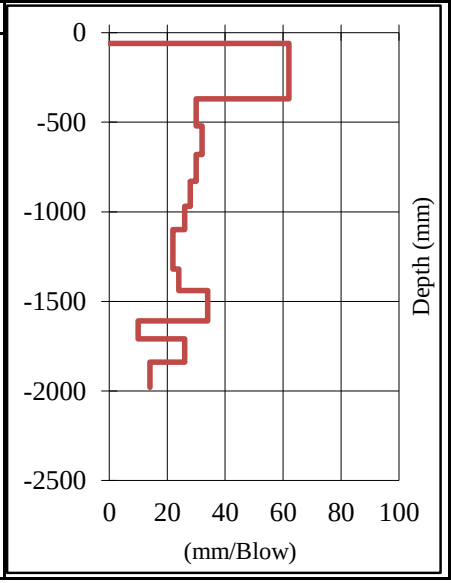
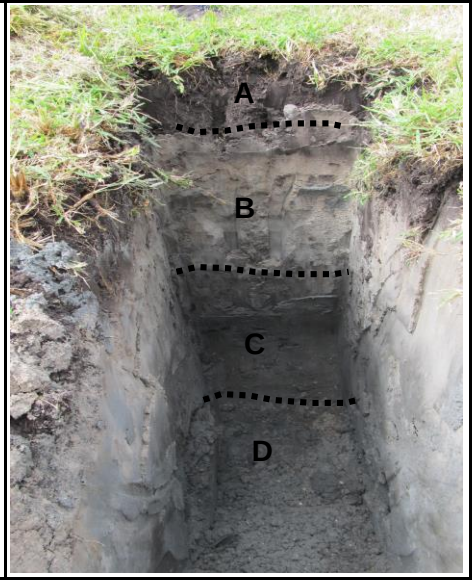


Photo of Test Pit



OUTENIQUA GEOTECHNICAL SERVICES

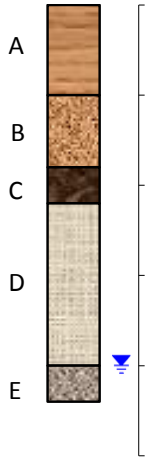
Geotechnical Soil Profile

Client:	Marike Vreken Town Planners
Project:	Erf 12403, George Rex Drive
Area:	Knysna
Date:	24.11.14
Excavator:	TLB

TP 11

Datum: NGL | Co-ords: 23 Y-006518 X3769421

Key to symbols: ● Sample taken | Groundwater



(0 to 500)	Slightly moist, light red brown, medium dense, intact, **GRAVELLY SILTY SAND**, imported (Fill soil)
(500 to 900)	Moist, dark red brown, loose, intact, **SAWDUST**, imported (Fill)
(900 to 1100)	Moist, dark brown, medium dense, intact, **SILTY SAND**, transported (Topsoil)
(1100 to 2000)	Very moist, dark grey, medium dense, intact, **SAND**, transported.
(2000 to 2200)	Wet, dark grey, medium dense, intact, **SAND**, transported.

Sidewalls collapse
Water table @ 2000mm

Dynamic Cone Penetrometer (DCP)

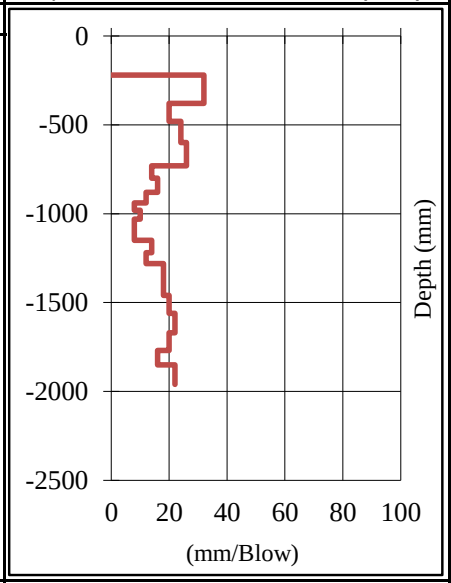
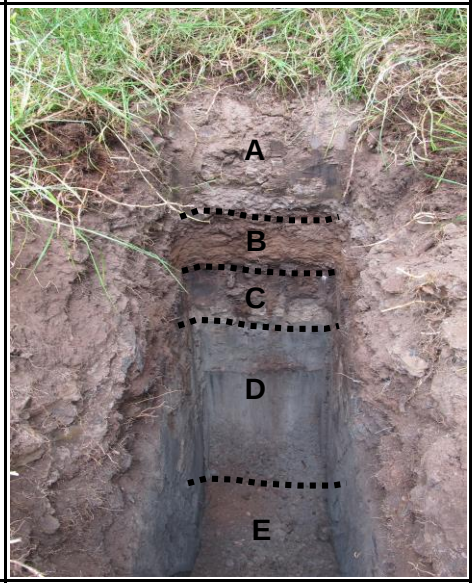


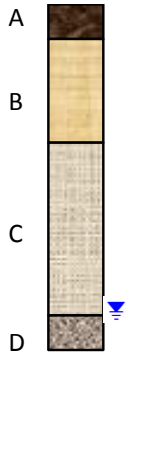
Photo of Test Pit



TP 12

Datum: NGL | Co-ords: 23 Y-006506 X3769355

Key to symbols: ● Sample taken | Groundwater



(0 to 200)	Moist, dark brown to black, loose, intact, **SILTY SAND**, transported (Topsoil)
(200 to 800)	Very moist, light brown, loose to medium dense, intact, **SAND**, transported.
(800 to 1800)	Very moist, dark grey, medium dense, intact, **SAND**, transported (Shells)
(1800 to 2000)	Wet, dark grey, medium dense, intact, **SAND**, transported.

Sidewalls collapse
Water table @ 1800mm

Dynamic Cone Penetrometer (DCP)

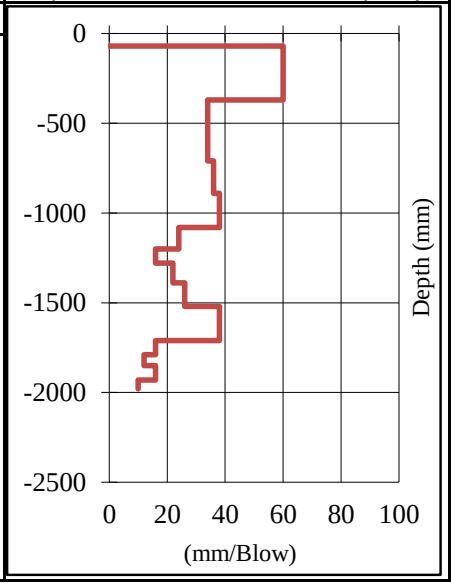
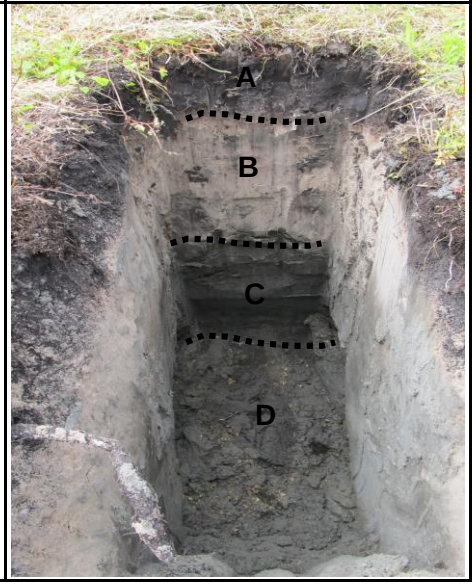


Photo of Test Pit



OUTENIQUA GEOTECHNICAL SERVICES

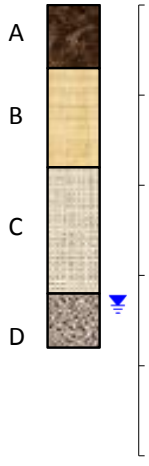
Geotechnical Soil Profile

Client:	Marike Vreken Town Planners
Project:	Erf 12403, George Rex Drive
Area:	Knysna
Date:	24.11.14
Excavator:	TLB

TP 13

Datum: NGL | Co-ords: 23 Y-006589 X3769353

Key to symbols: ● Sample taken | ▼ Groundwater



(0 to 350) Moist, dark brown to black, loose, intact, **SILTY SAND**, transported (Topsoil)

(350 to 900) Moist, light brown, loose to medium dense, intact, **SAND**, transported.

(900 to 1600) Very moist, dark grey, medium dense, intact, **SAND**, transported.

(1600 to 1900) Wet, dark grey, medium dense, intact, **SAND**, transported.

Sidewalls collapse
Water table @ 1600mm

Dynamic Cone Penetrometer (DCP)

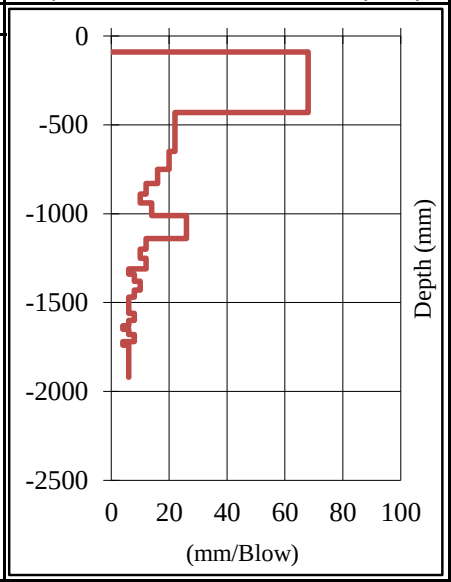
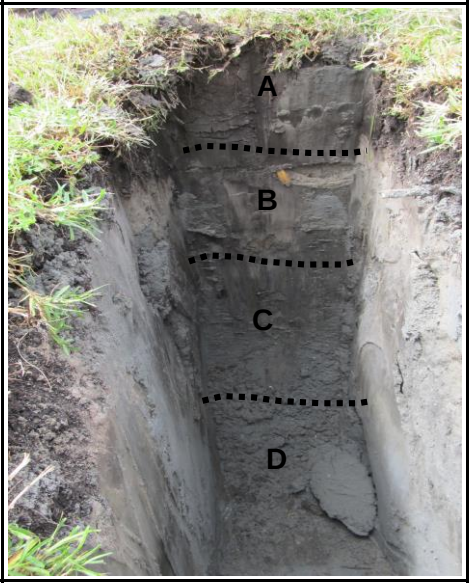


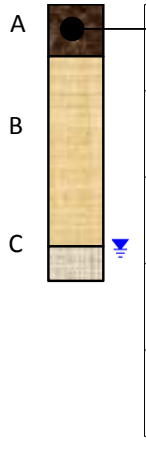
Photo of Test Pit



TP 14

Datum: NGL | Co-ords: 23 Y-006656 X3769382

Key to symbols: ● Sample taken | ▼ Groundwater



(0 to 300) Moist, dark brown to black, loose, intact, **SILTY SAND**, transported.
MOD/CBR/Indicator

(300 to 1400) Very moist, light brown, medium dense, intact, **SAND**, imported.

(1400 to 1600) Wet, dark grey, medium dense, intact, **SAND**, transported.

Sidewalls collapse - test pit stopped
Water table @ 1400mm

Dynamic Cone Penetrometer (DCP)

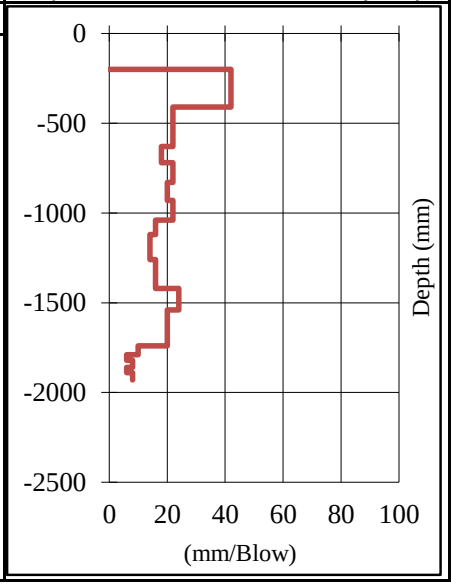
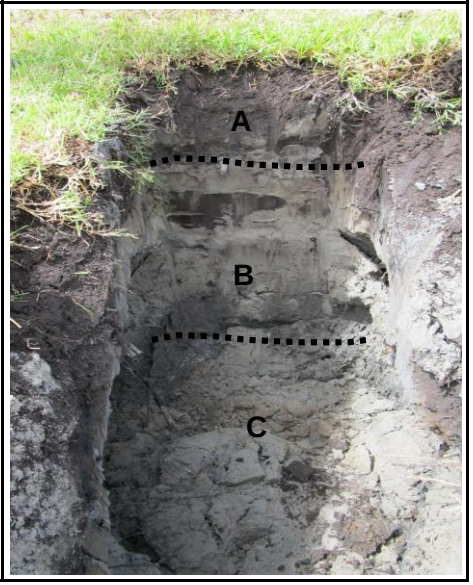


Photo of Test Pit



OUTENIQUA GEOTECHNICAL SERVICES

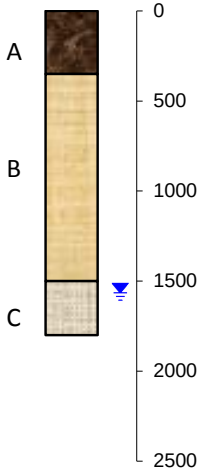
Geotechnical Soil Profile

Client:	Marike Vreken Town Planners
Project:	Erf 12403, George Rex Drive
Area:	Knysna
Date:	24.11.14
Excavator:	TLB

TP 15

Datum: NGL | Co-ords: 23 Y-006760 X3769404

Key to symbols: ● Sample taken | Groundwater



(0 to 350)	Moist, dark brown to black, loose, intact, **SILTY SAND**, transported.
(350 to 1500)	Very moist, light brown, medium dense, intact, **SAND**, imported.
(1500 to 1800)	Wet, dark grey, medium dense, intact, **SAND**, transported.

Sidewalls collapse
Water table @ 1500mm

Dynamic Cone Penetrometer (DCP)

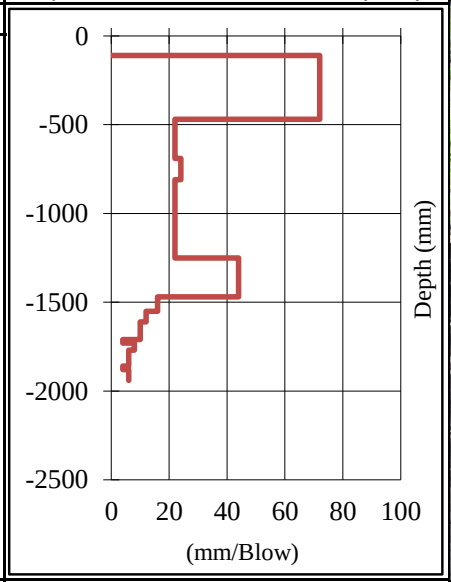
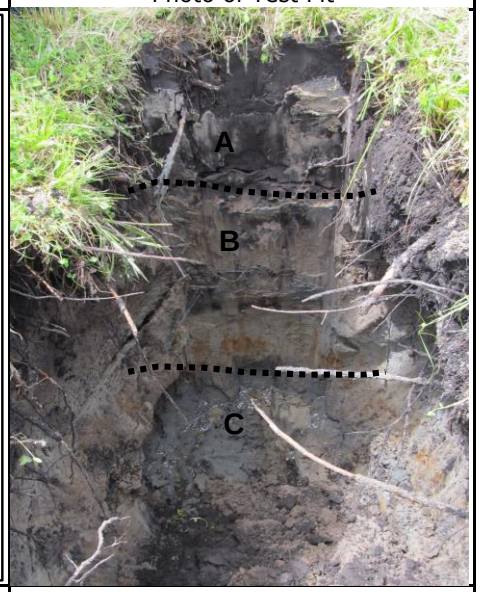


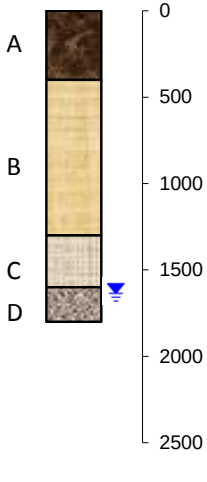
Photo of Test Pit



TP 16

Datum: NGL | Co-ords: 23 Y-006773 X3769328

Key to symbols: ● Sample taken | Groundwater



(0 to 400)	Very moist, dark brown to black, loose, intact, **SILTY SAND**, transported (Topsoil)
(400 to 1300)	Moist, light brown, loose, intact, **SAND**, transported.
(1300 to 1600)	Very moist, dark grey, loose-medium dense, intact, **SAND**, transported.
(1600 to 1800)	Wet, dark grey, medium dense, intact, **SAND**, transported.

Sidewalls collapse
Water table @ 1600mm

Dynamic Cone Penetrometer (DCP)

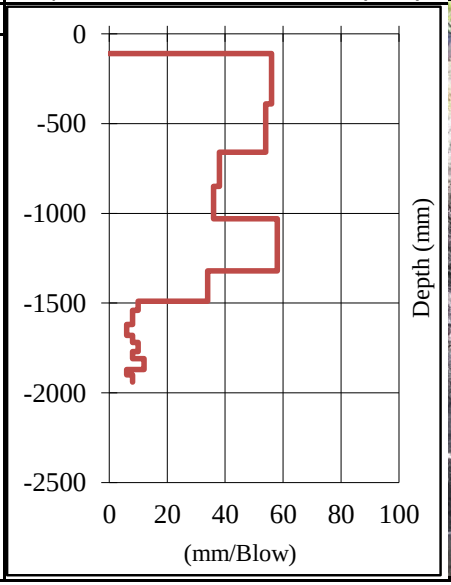
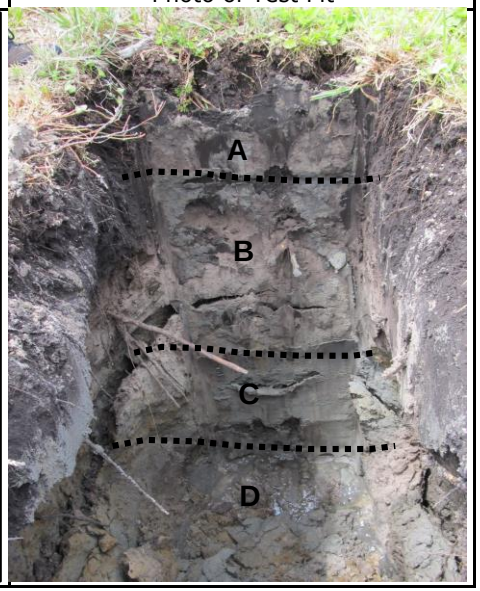


Photo of Test Pit



OUTENIQUA GEOTECHNICAL SERVICES

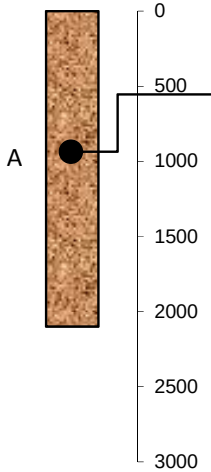
Geotechnical Soil Profile

Client:	Marike Vreken Town Planners
Project:	Erf 12403, George Rex Drive
Area:	Knysna
Date:	24.11.14
Excavator:	TLB

TP 17

Datum: NGL | Co-ords: 23 Y-006530 X3769255

Key to symbols: Sample taken | Groundwater



(0 to 2100) Slightly moist, light to dark red orange, medium dense, voided, **GRAVELLY CLAYEY SILTY SAND**, imported (Fill - possibly from Knysna Mall site)

MOD / CBR / Indicator

Profile taken of slot into fill heap

Dynamic Cone Penetrometer (DCP)

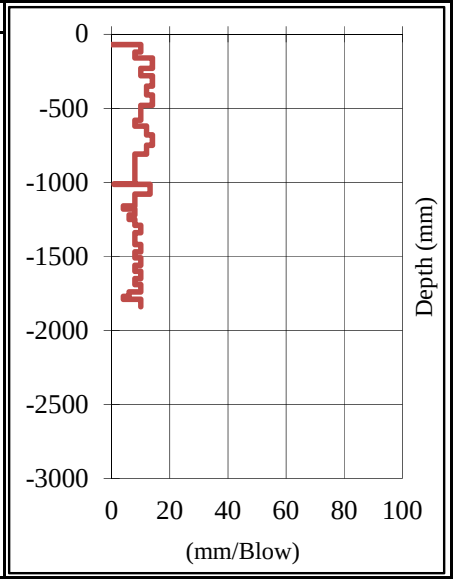


Photo of Test Pit

Appendix 3

Lab test data

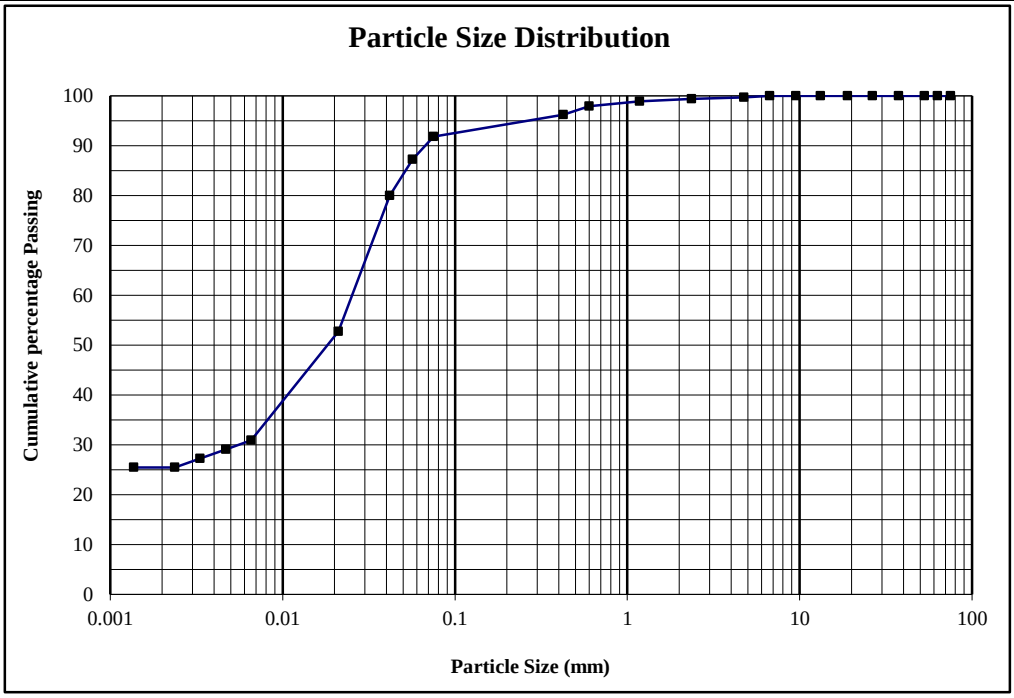
OUTENIQUA LAB (Pty) Ltd
Materials Testing Laboratory
Registration No. 95/07742/07
6 Mirrorball Street, George : PO Box 3186, George Industria, 6536
Tel: 044 8743274 : Fax: 044 8745779 : e-mail: llewelyn@outeniqualab.co.za

Customer :	Marike Vreken Town Planners	Project :	Erf 12403 - George Rex Drive - Knysna
	PO Box 479	Date Received :	09/12/14
	Knysna	Date Reported :	12/01/15
	6570	Req. Number :	3880/14
Attention :	Andries Fourie	No. of Pages :	1/5

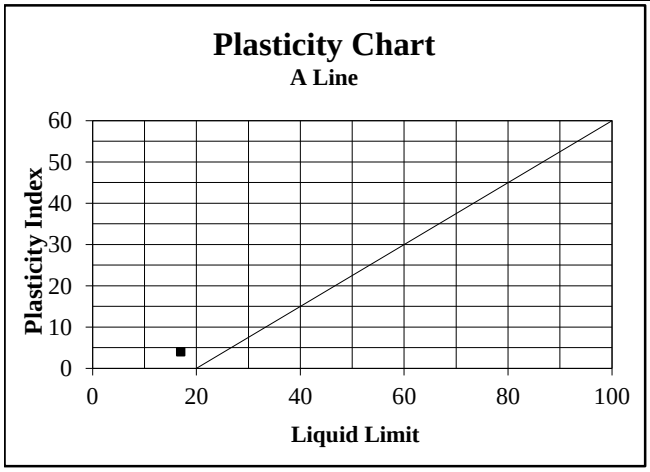
TEST REPORT
FOUNDATION INDICATOR - (TMH 1 Method A1(a),A2,A3,A4,A5) & (ASTM Method D422)

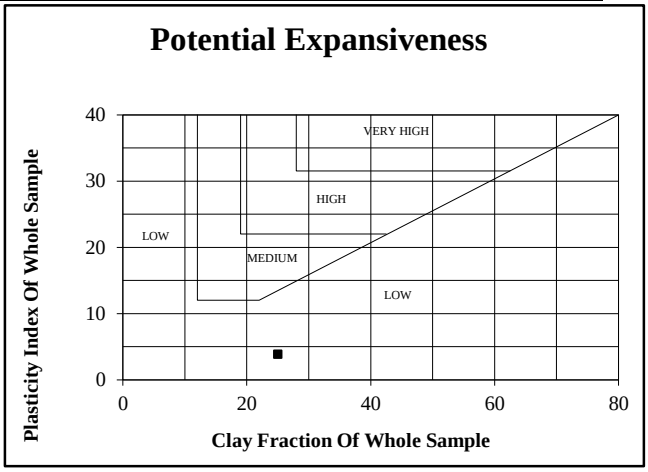
Material Description:	Light Grey Yellow Clayey Silt	Sample Number:	58674			
Position:	TP2	Liquid Limit	17	Linear Shrinkage	2	
Depth:	250-800	Plasticity Index	4	Insitu M/C%	19.3	

Sieve Size(mm)	% Passing
75.0	100
63.0	100
53.0	100
37.5	100
26.5	100
19.0	100
13.2	100
9.5	100
6.7	100
4.75	100
2.36	99
1.18	99
0.600	98
0.425	96
0.075	92
0.0568	87
0.0418	80
0.0210	53
0.0066	31
0.0047	29
0.0033	27
0.0024	25
0.0014	25



% Clay	25	% Silt	64	% Sand	10	% Gravel	1
Unified Soil Classification	CL-ML			PRA Soil Classification		A-4	





Notes:

- **Specimens delivered to Outeniqua Lab in good order.**

L Heathcote (Director)
For Outeniqua Lab (Pty) Ltd.

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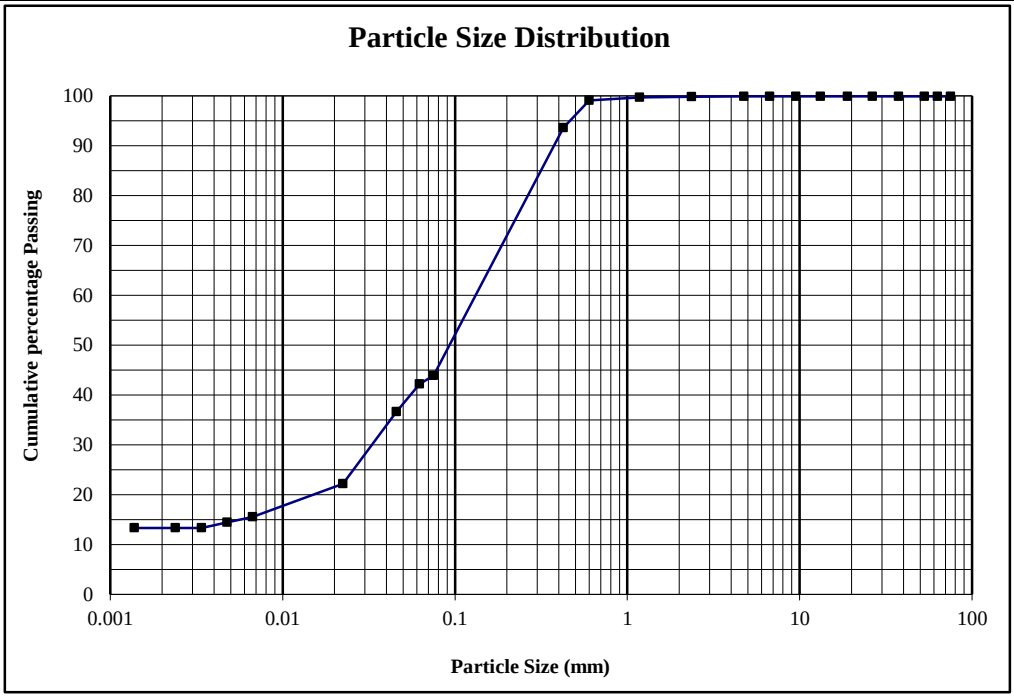
Customer :	Marike Vreken Town Planners	Project :	Erf 12403 - George Rex Drive - Knysna
	PO Box 479	Date Received :	09/12/14
	Knysna	Date Reported :	12/01/15
	6570	Req. Number :	3880/14
Attention :	Andries Fourie	No. of Pages :	2/5

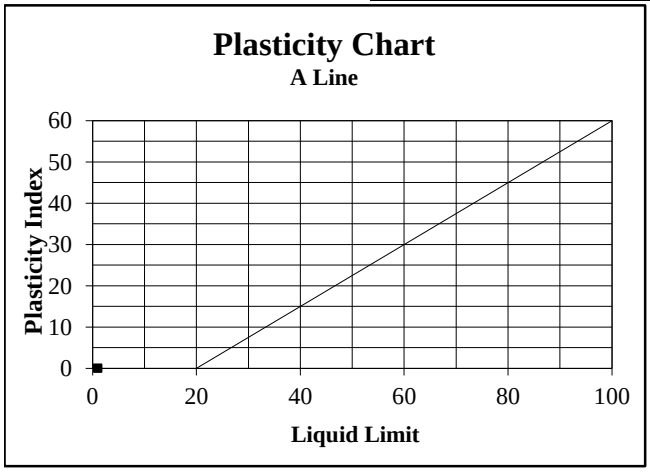
TEST REPORT
FOUNDATION INDICATOR - (TMH 1 Method A1(a),A2,A3,A4,A5) & (ASTM Method D422)

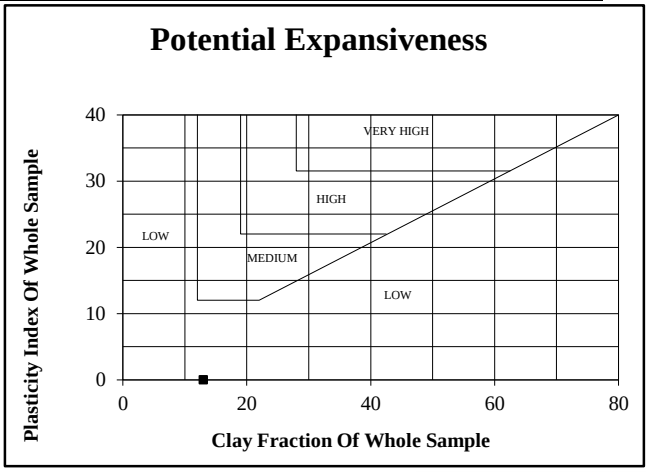
Material Description:	Light Brown-Light Grey Silty Sand	Sample Number:	58675		
Position:	TP4	Liquid Limit	NP	Linear Shrinkage	0
Depth:	300-1500	Plasticity Index	NP	Insitu M/C%	22.3

Sieve Size(mm)	% Passing
75.0	100
63.0	100
53.0	100
37.5	100
26.5	100
19.0	100
13.2	100
9.5	100
6.7	100
4.75	100
2.36	100
1.18	100
0.600	99
0.425	94
0.075	44
0.0623	42
0.0458	37
0.0223	22
0.0067	16
0.0048	14
0.0034	13
0.0024	13
0.0014	13



% Clay	13	% Silt	28	% Sand	59	% Gravel	0
Unified Soil Classification		SM		PRA Soil Classification		A-4	





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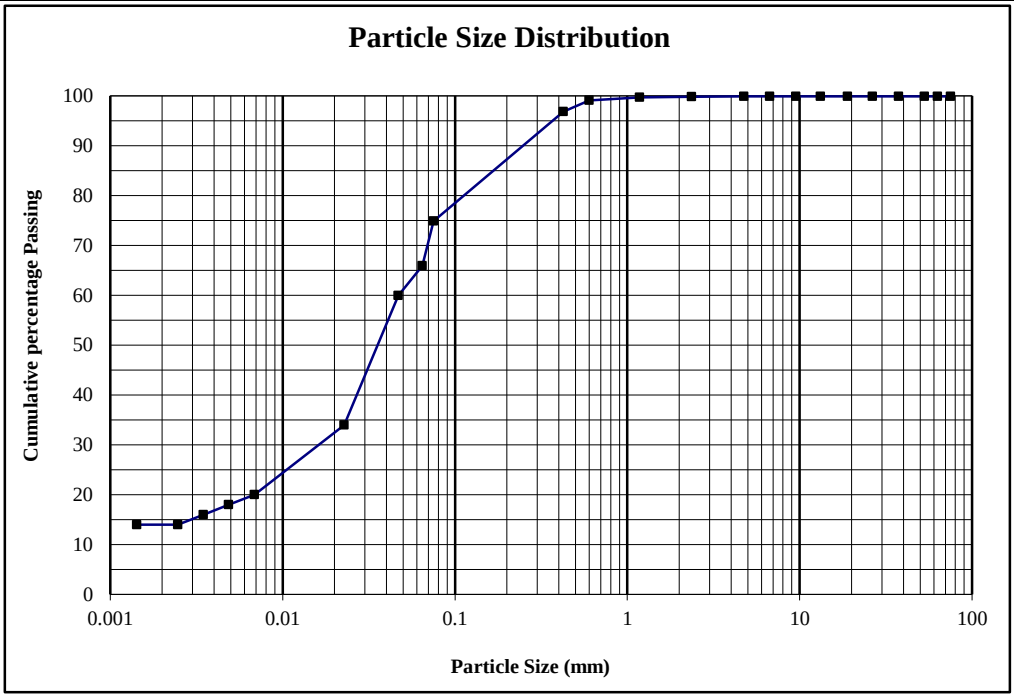
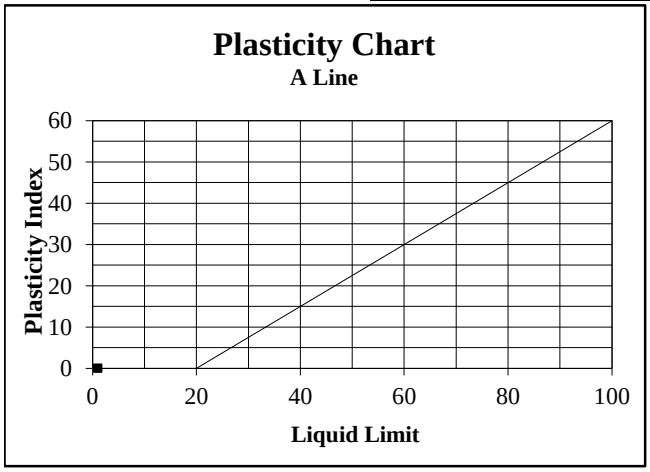
TEST REPORT
FOUNDATION INDICATOR - (TMH 1 Method A1(a),A2,A3,A4,A5) & (ASTM Method D422)

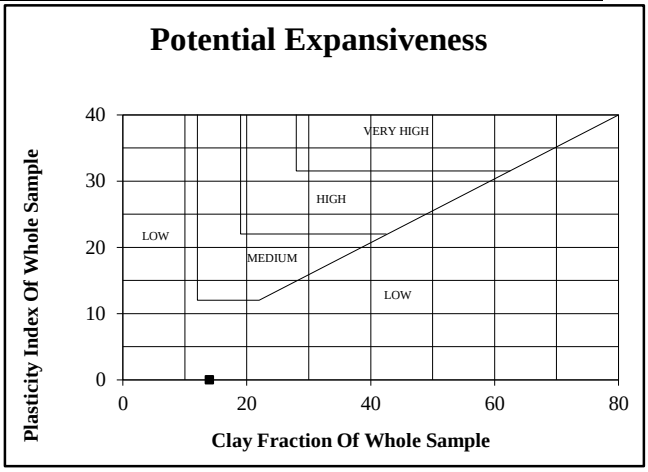
Material Description:	Light Brown Sandy Silt	Sample Number:	58676		
Position:	TP7	Liquid Limit	NP	Linear Shrinkage	0
Depth:	400-1400	Plasticity Index	NP	Insitu M/C%	16.9

Sieve Size(mm)	% Passing
75.0	100
63.0	100
53.0	100
37.5	100
26.5	100
19.0	100
13.2	100
9.5	100
6.7	100
4.75	100
2.36	100
1.18	100
0.600	99
0.425	97
0.075	75
0.0647	66
0.0468	60
0.0228	34
0.0069	20
0.0049	18
0.0035	16
0.0025	14
0.0014	14



% Clay	14	% Silt	50	% Sand	36	% Gravel	0
Unified Soil Classification		ML		PRA Soil Classification		A-4	





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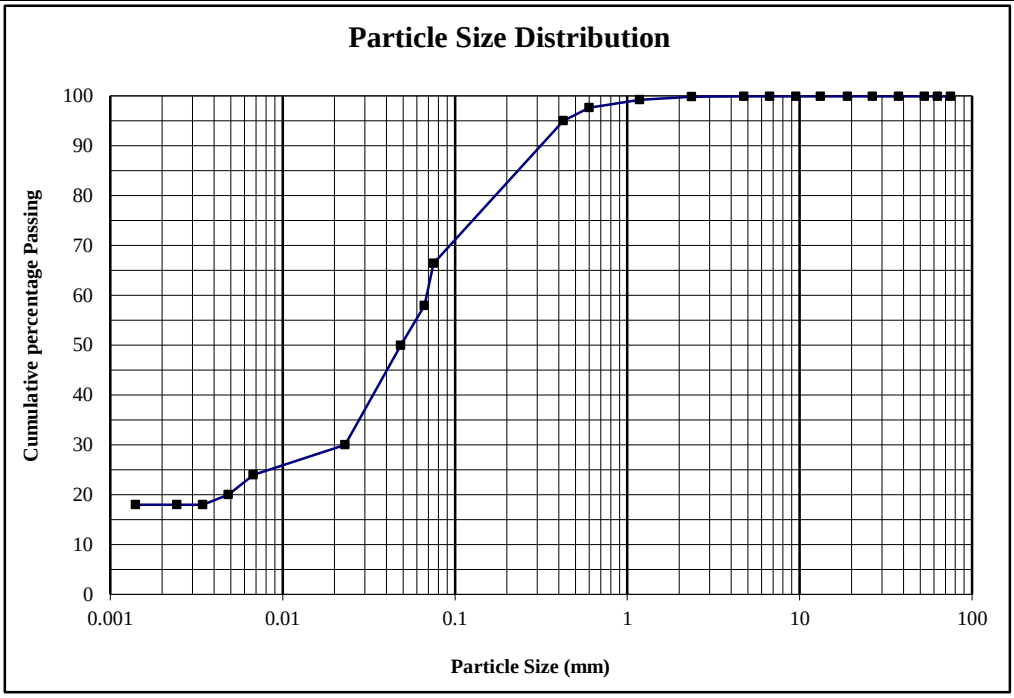
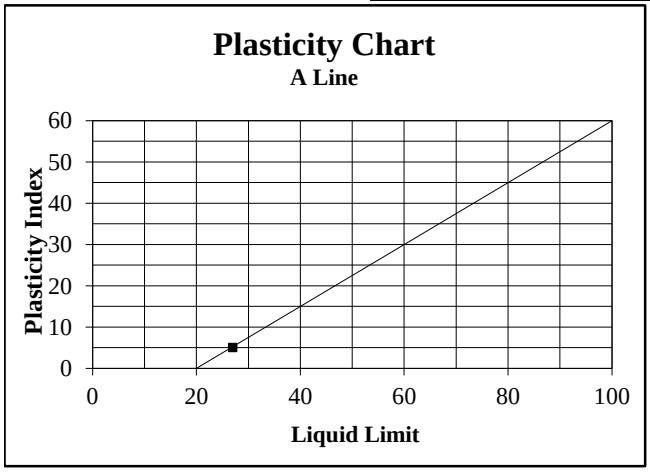
TEST REPORT
FOUNDATION INDICATOR - (TMH 1 Method A1(a),A2,A3,A4,A5) & (ASTM Method D422)

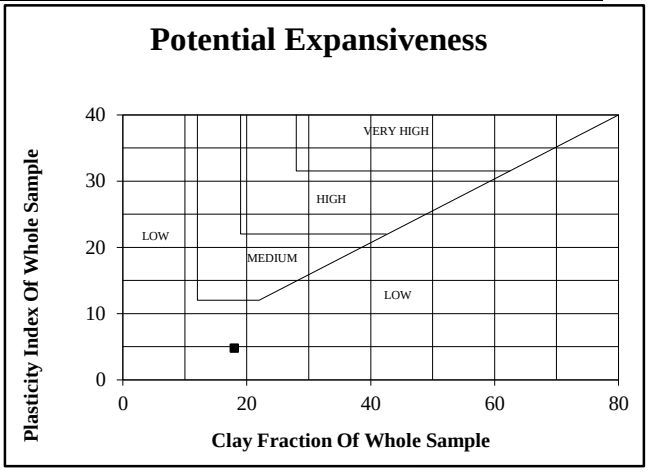
Material Description:	Dark Brown Clayey Silty Sand	Sample Number:	58677		
Position:	TP9	Liquid Limit	27	Linear Shrinkage	3
Depth:	0-400	Plasticity Index	5	Insitu M/C%	39.9

Sieve Size(mm)	% Passing
75.0	100
63.0	100
53.0	100
37.5	100
26.5	100
19.0	100
13.2	100
9.5	100
6.7	100
4.75	100
2.36	100
1.18	99
0.600	98
0.425	95
0.075	66
0.0665	58
0.0484	50
0.0230	30
0.0068	24
0.0049	20
0.0034	18
0.0024	18
0.0014	18



% Clay	18	% Silt	37	% Sand	45	% Gravel	0
Unified Soil Classification		ML		PRA Soil Classification		A-4	





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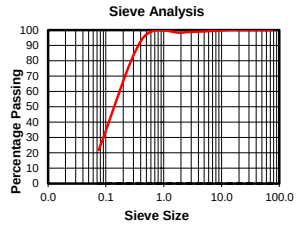
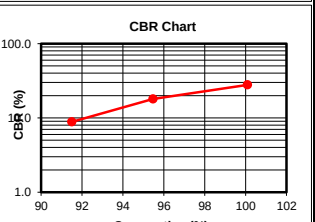
Attention :	Andries Fourie	No. of Pages :	5/5

TEST REPORT
CALIFORNIA BEARING RATIO - (TMH 1 Method A1(a),A2,A3,A4,A5,A7,A8)

Material Indicators								
Sample Position (SV)		TP14	Spec. G10 - TRH 14	Opinion	TP17	Spec. G10 - TRH 14	Opinion
Depth (mm)		0-300			0-2100		
Sample No		58678			58679		
Materials Description	Source	Trial Pit			Trial Pit		
	Colour	Dark Brown Black			Dark Red Orange		
	Soil Type	Silty Sand			Gravelley Clayey Silty Sand		
	Classification	In-Situ			In-Situ		
Max. Stone size in hole (mm)							
Percentage Passing	75.0 mm	100			100		
	63.0 mm	100			100		
	53.0 mm	100			100		
	37.5 mm	100			85		
	26.5 mm	100			83		
	19.0 mm	100			80		
	13.2 mm	100			79		
	4.75 mm	99			73		
	2.00 mm	98			69		
	0.425 mm	94			57		
	0.075 mm	21.9			22.6		
Soil Mortar & Constants							
Grading Modulus		0.86			1.52		
Coarse Sand <2.0 >0.425		4.2			16.5		
Med. <0.250 >0.150		73.6			50.6		
Silt <0.075		22.3			32.9		
Liquid Limit (%)		SP			NP		
Plasticity Index (%)		SP			NP		
Linear Shrinkage (%)		0.5			0.0		
CBR / Density Relationship							
MOD	Max Dry Density (kg/m^3)	1852			2116		
	Opt Moisture Content (%)	11.6			9.1		
	Mould Moisture Con. (%)	11.3			9.4		
	@100% Mod AASHTO	100.1			100.0		
	Swell (%)	0.91	≤1.5	✓	1.09	≤1.5	✓
NRB	100% NRB	95.5			95.5		
	Swell (%)	1.06			1.25		
Proc	100% Proctor	91.5			91.9		
	Swell (%)	1.13			1.37		
CBR	@ 100% Mod AASHTO	28			8		
	@ 98% Mod AASHTO	23			7		
	@ 95% Mod AASHTO	17			6		
	@ 93% Mod AASHTO	12			5		
	@ 90% Mod AASHTO	6	≥3	✳	4	≥3	✳
Insitu Moisture Content (%)							
Soil Classification							
TRH 14		G10			G10		
PRA System		A-2-4			A-2-4		
Unified System		SM			SM		

58678





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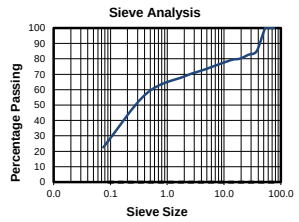
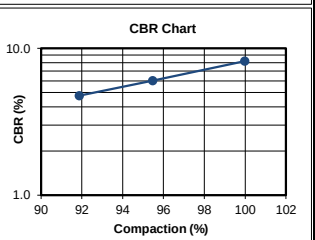
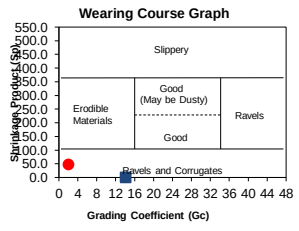




● 58678 ■ 58679



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For Outeniqua Lab (Pty) Ltd
Technical Signatory

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3. The uncertain (✳) indicates that the test result is either equal to or is above / below the specified limit by a margin less than the measurement uncertainty; it is therefore not possible to state compliant (✓) or non compliant (×) based on a 95% level of confidence with reference to SAMM GUIDANCE 1, Issue 2 : 20 June 2007 Section 2.
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Appendix 4

DCP test data

Outeniqua Geotechnical Services cc.

Geotechnical Engineering Consultants

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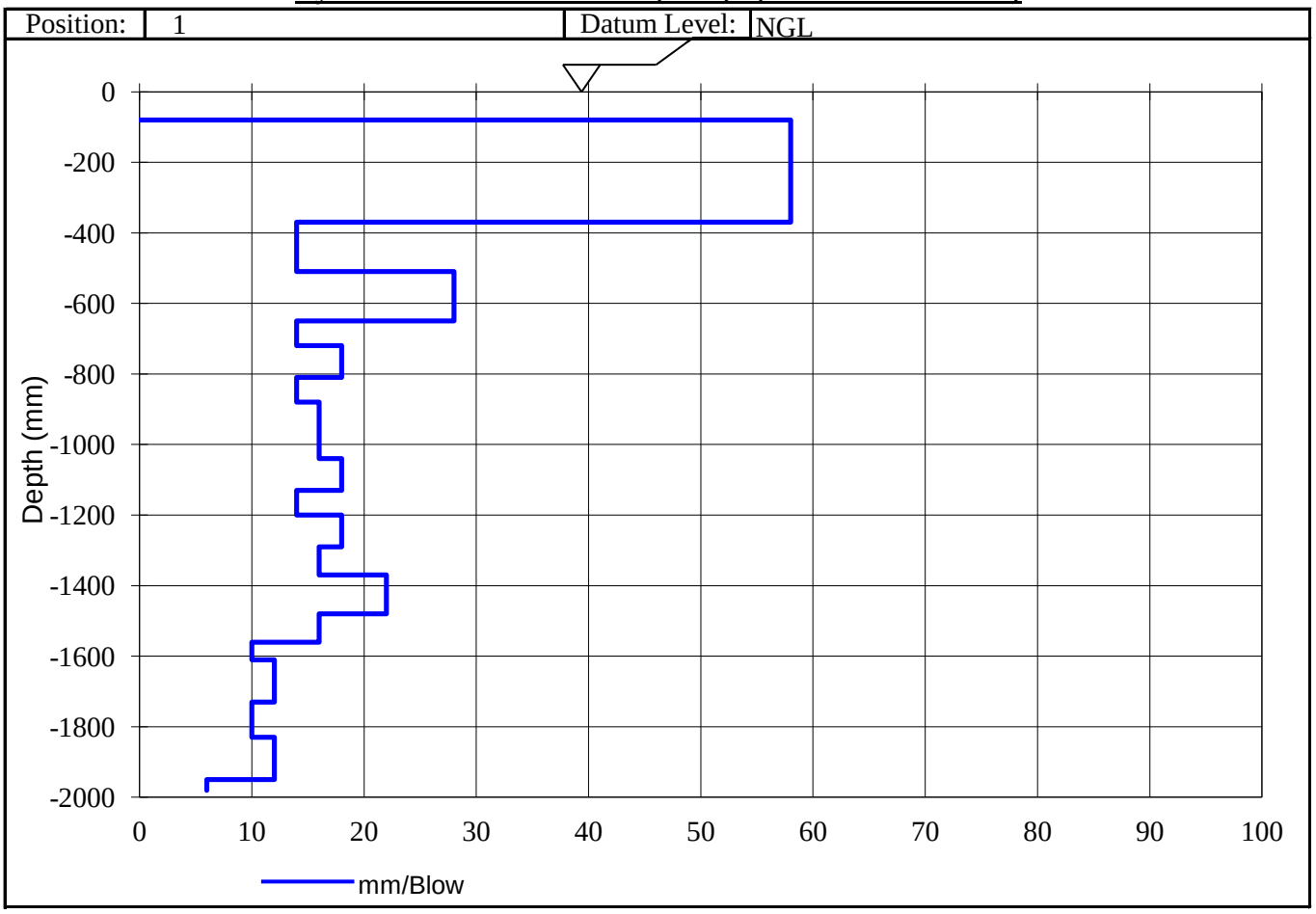
		Date Received :	3.12.14
		Date Reported :	05.12.2014
		Req. Number :	
Attention :	Andries Fourie	No. of Pages :	1 of 17

TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position: 1 Datum Level: NGL



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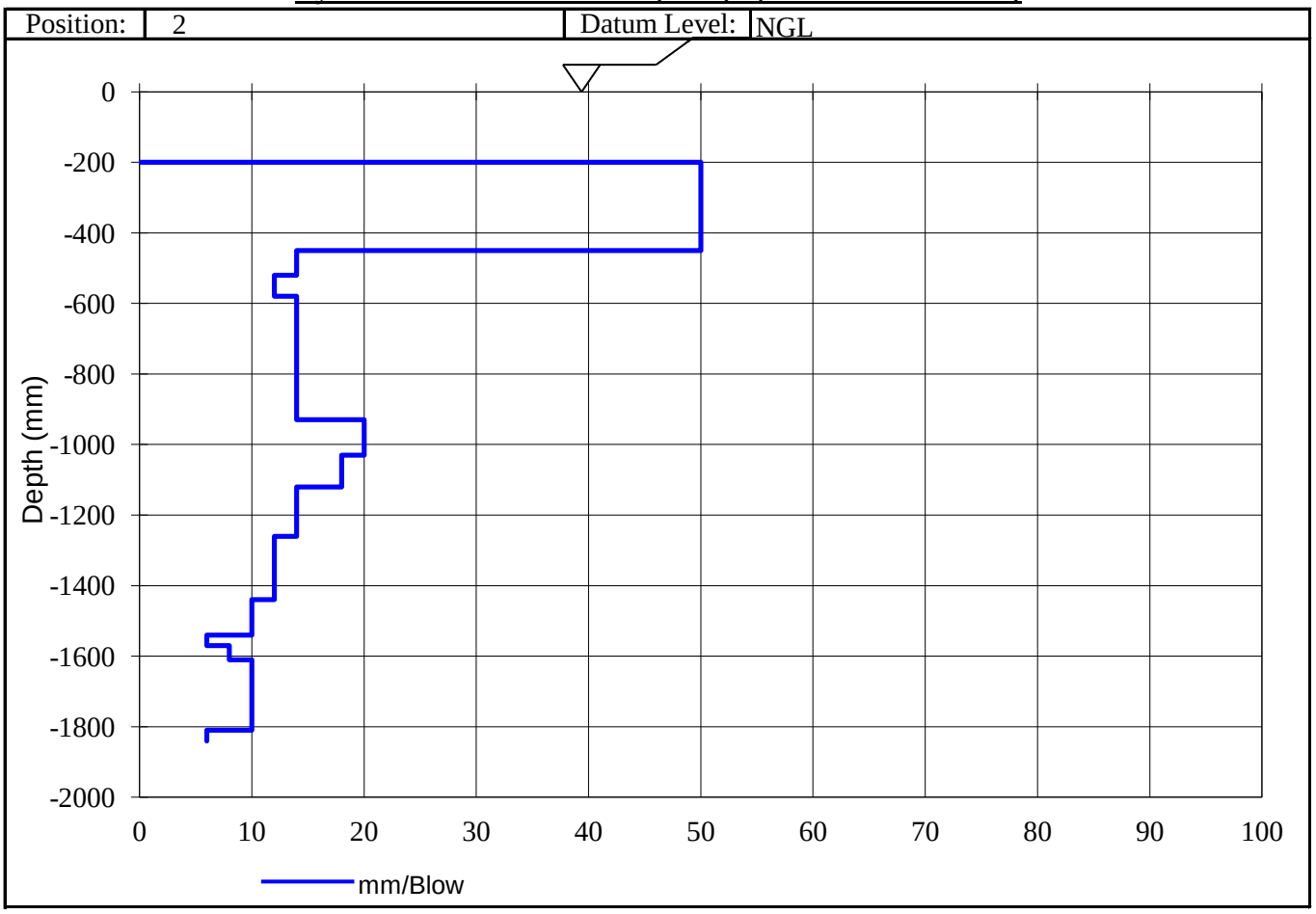
		Req. Number :	
Attention :	Andries Fourie	No. of Pages :	2 of 17

TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position: 2 Datum Level: NGL



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		Req. Number :	
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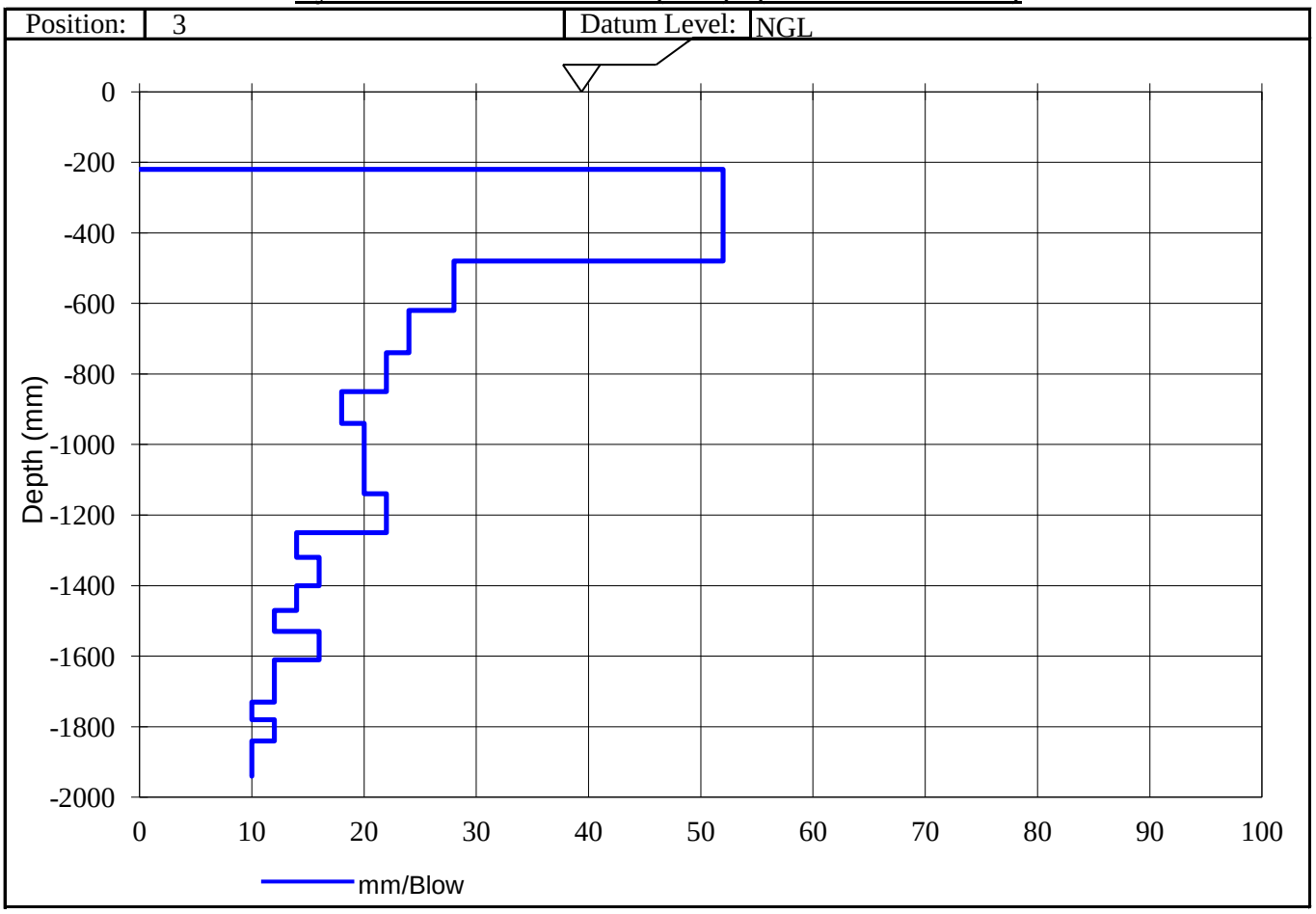
TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position: 3 Datum Level: NGL



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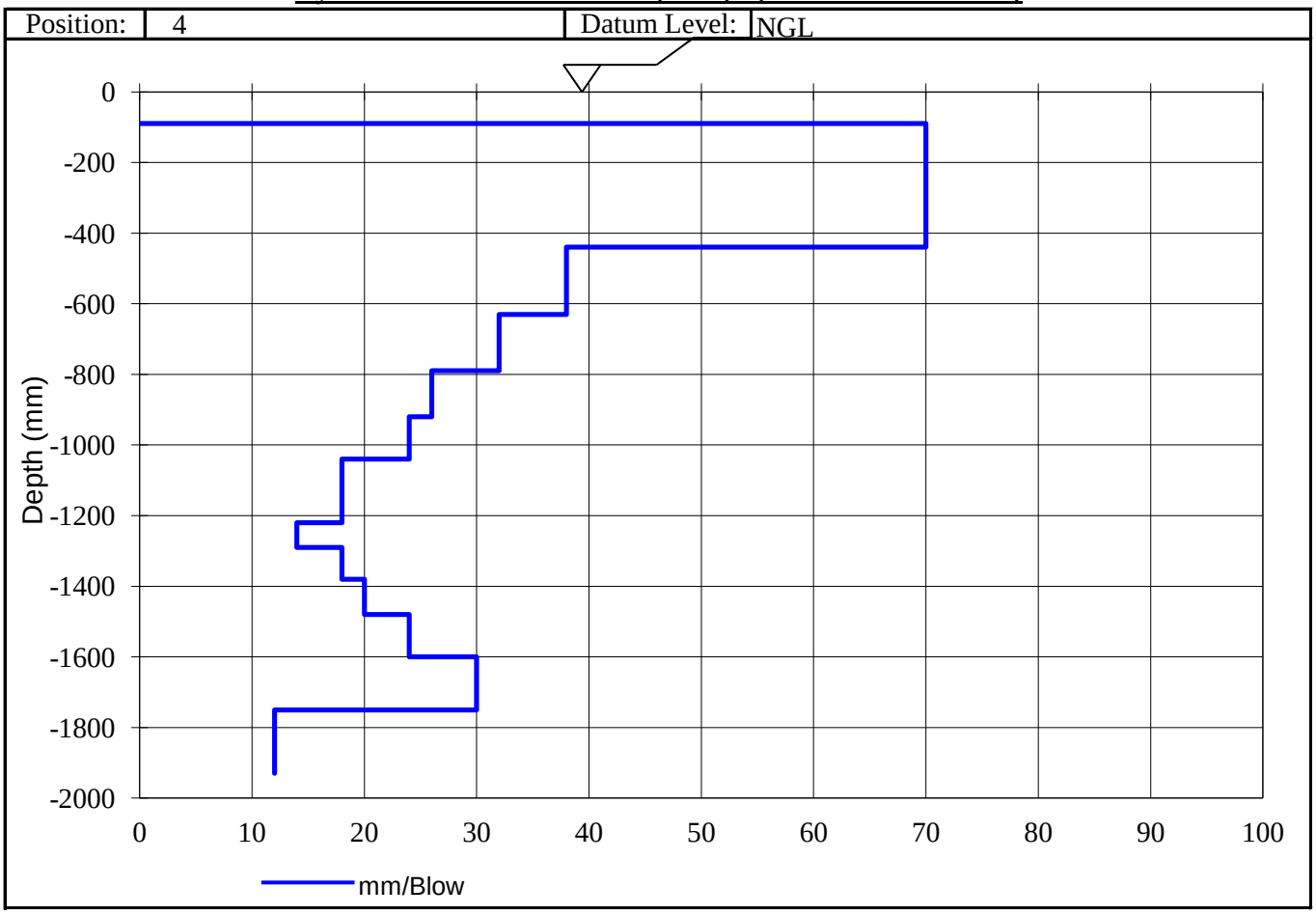
TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position: 4 Datum Level: NGL



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		Date Reported :	05.12.2014
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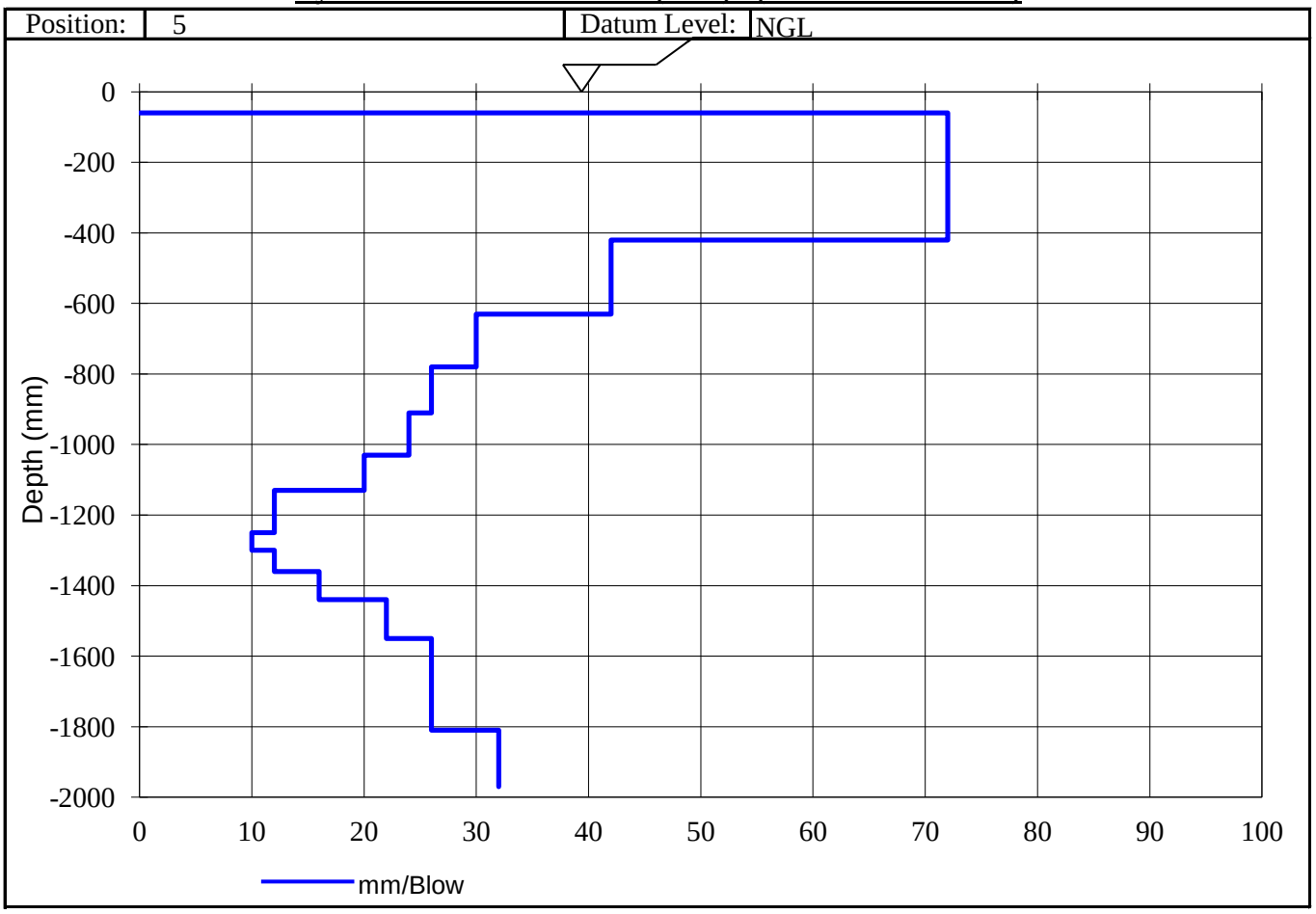
TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position: 5 Datum Level: NGL



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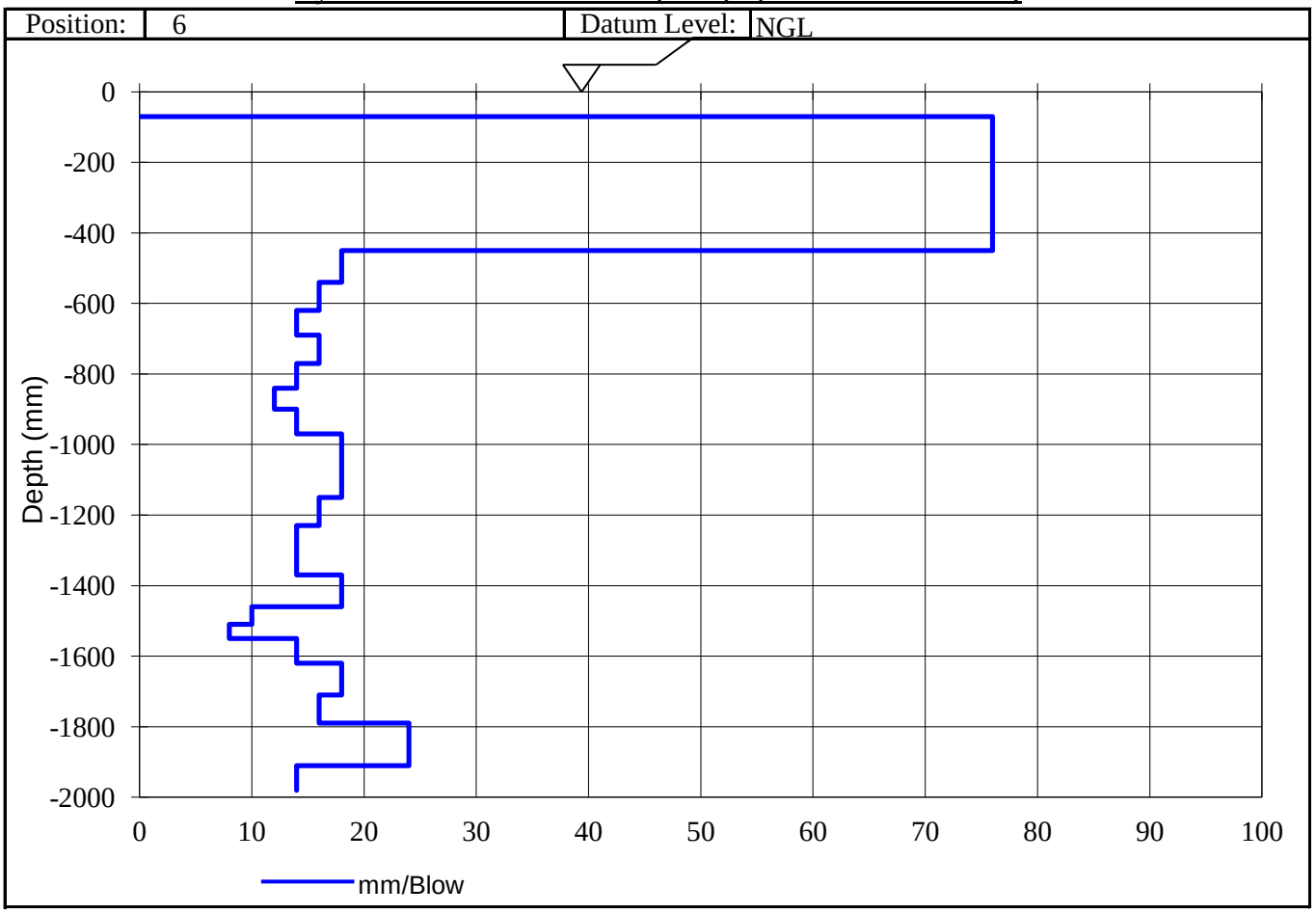
Attention :	Andries Fourie	No. of Pages :	6 of 17

TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position: 6 Datum Level: NGL



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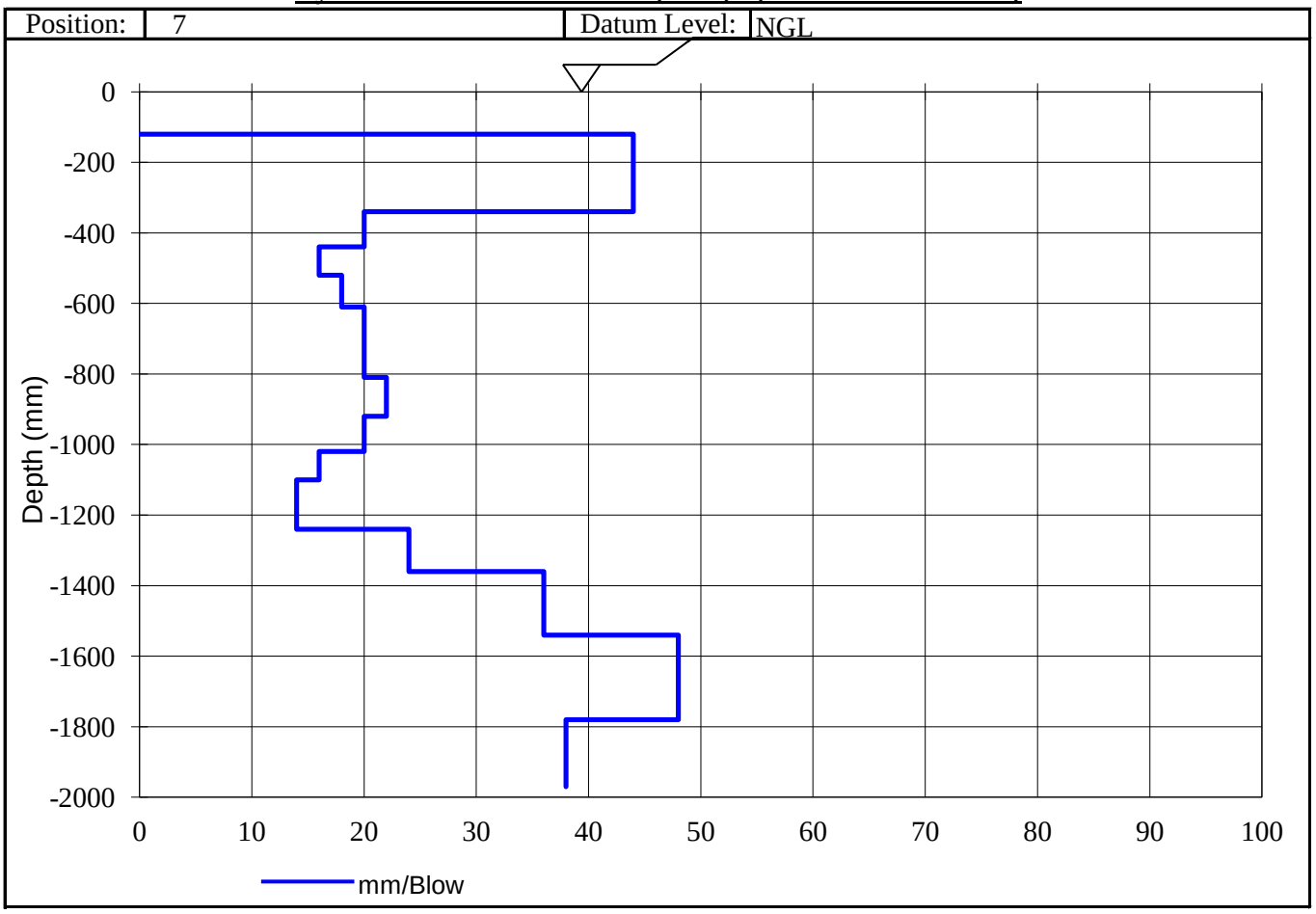
TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position: 7 Datum Level: NGL



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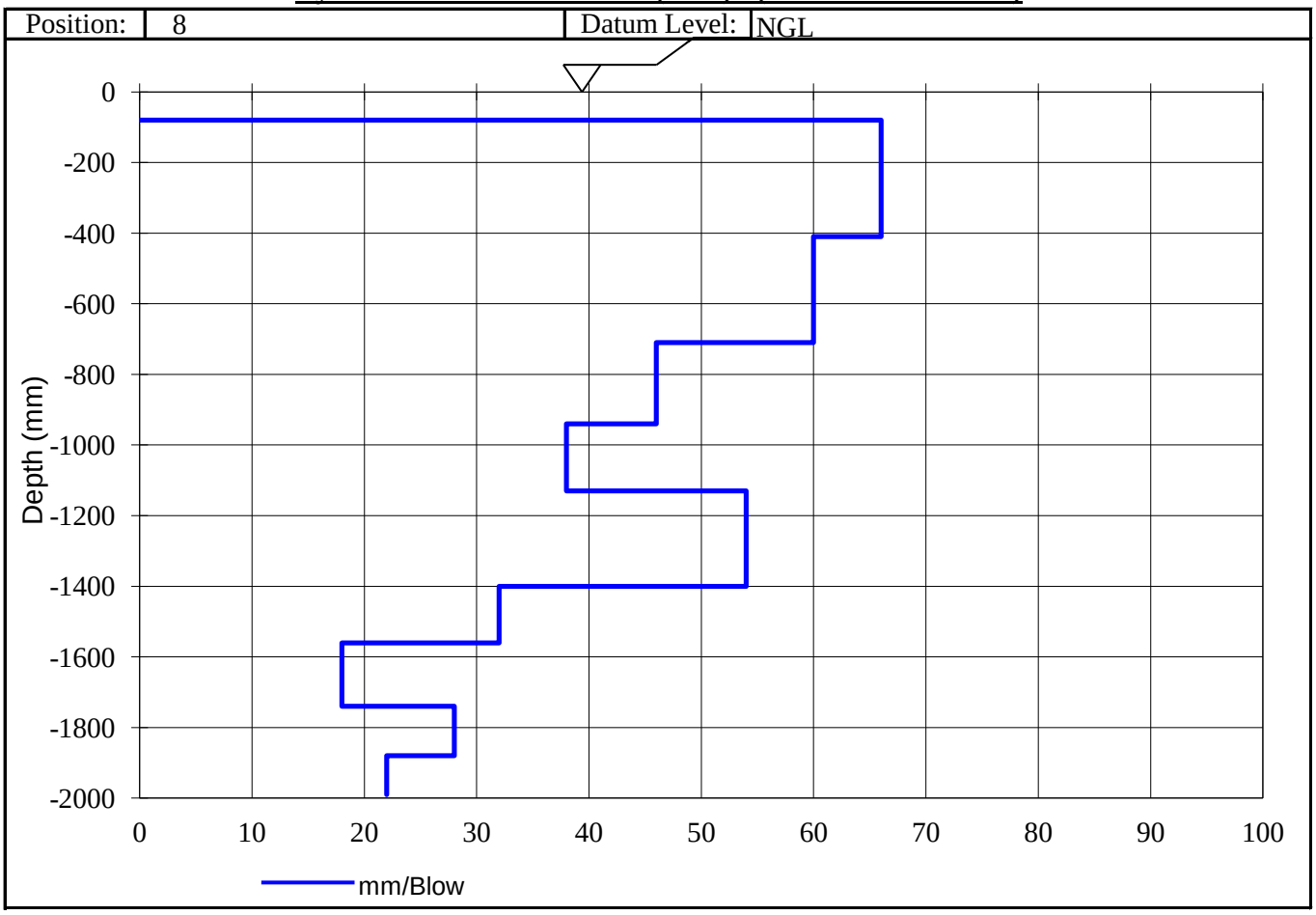
Attention :	Andries Fourie	No. of Pages :	8 of 17

TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position: 8 Datum Level: NGL



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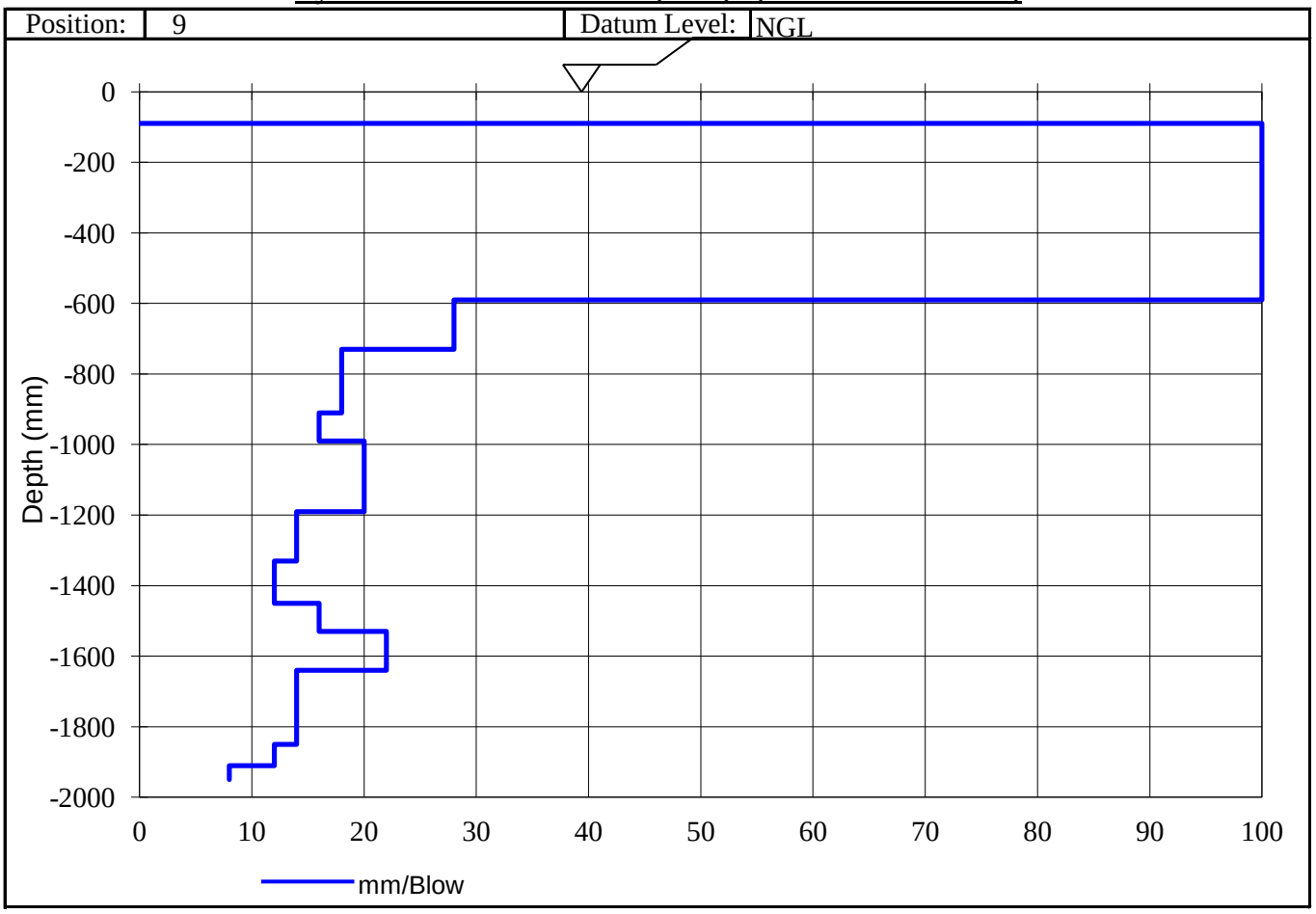
TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position: 9 Datum Level: NGL



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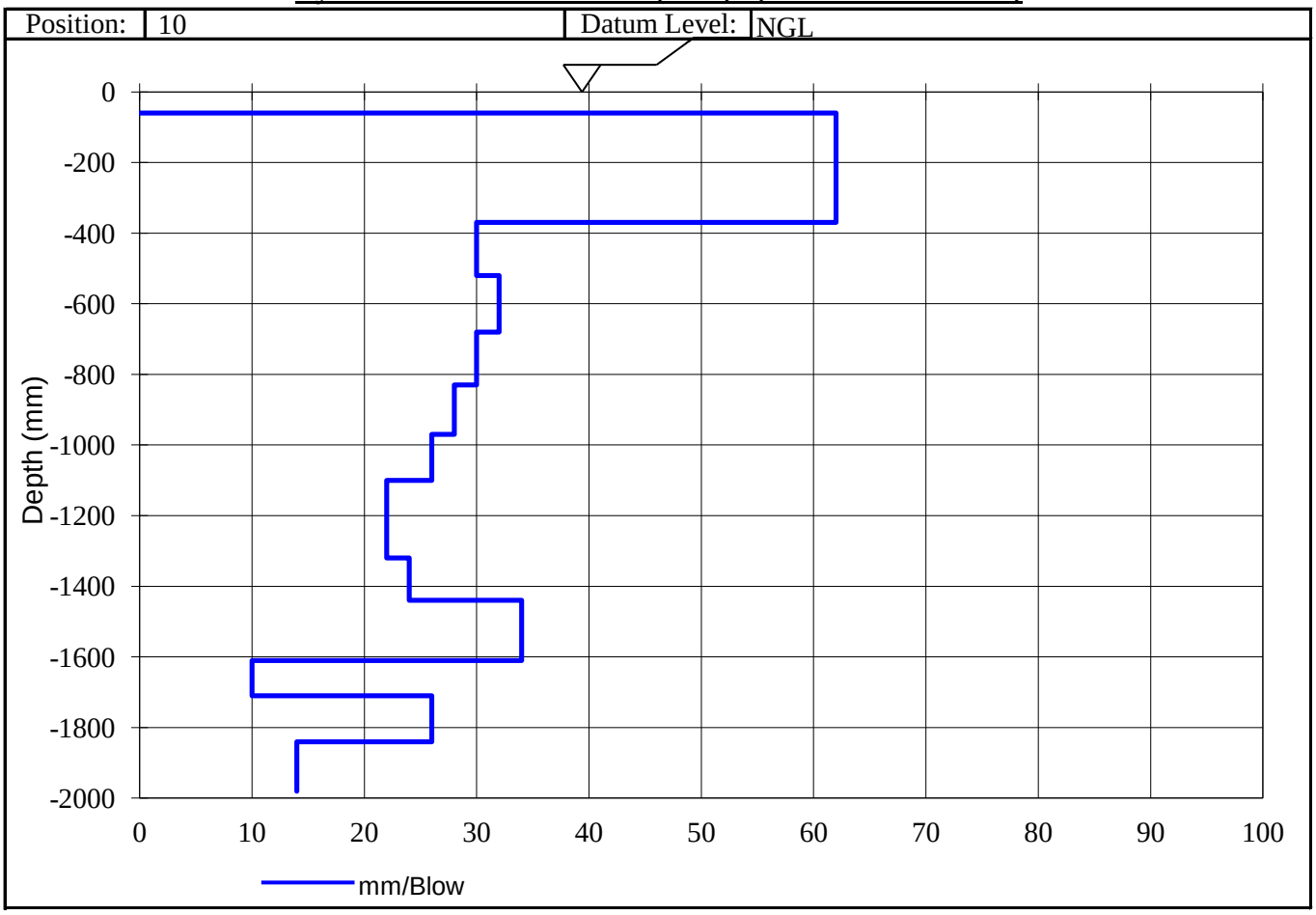
Attention :	Andries Fourie	No. of Pages :	10 of 17

TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position: 10 Datum Level: NGL



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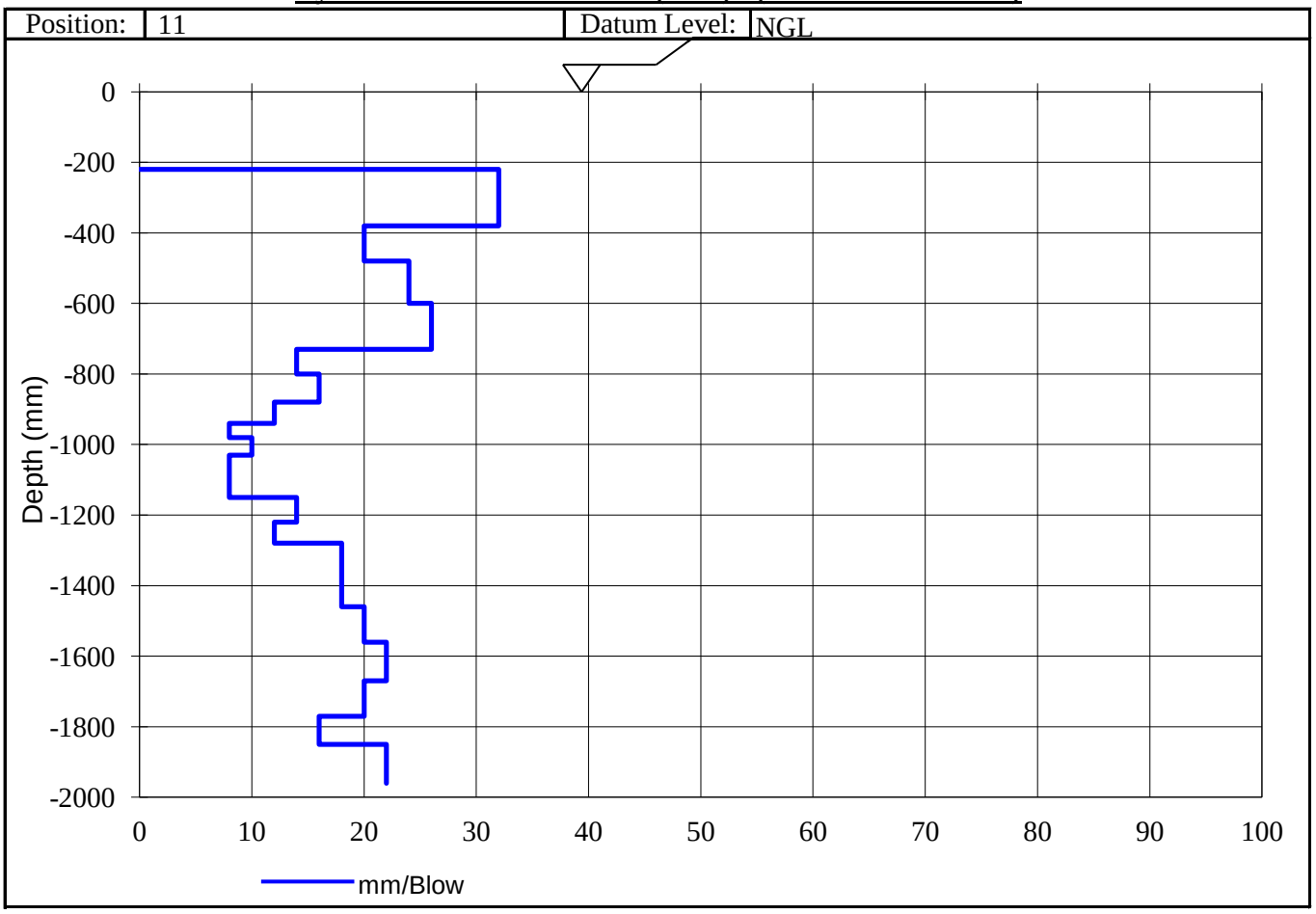
TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position: 11 Datum Level: NGL



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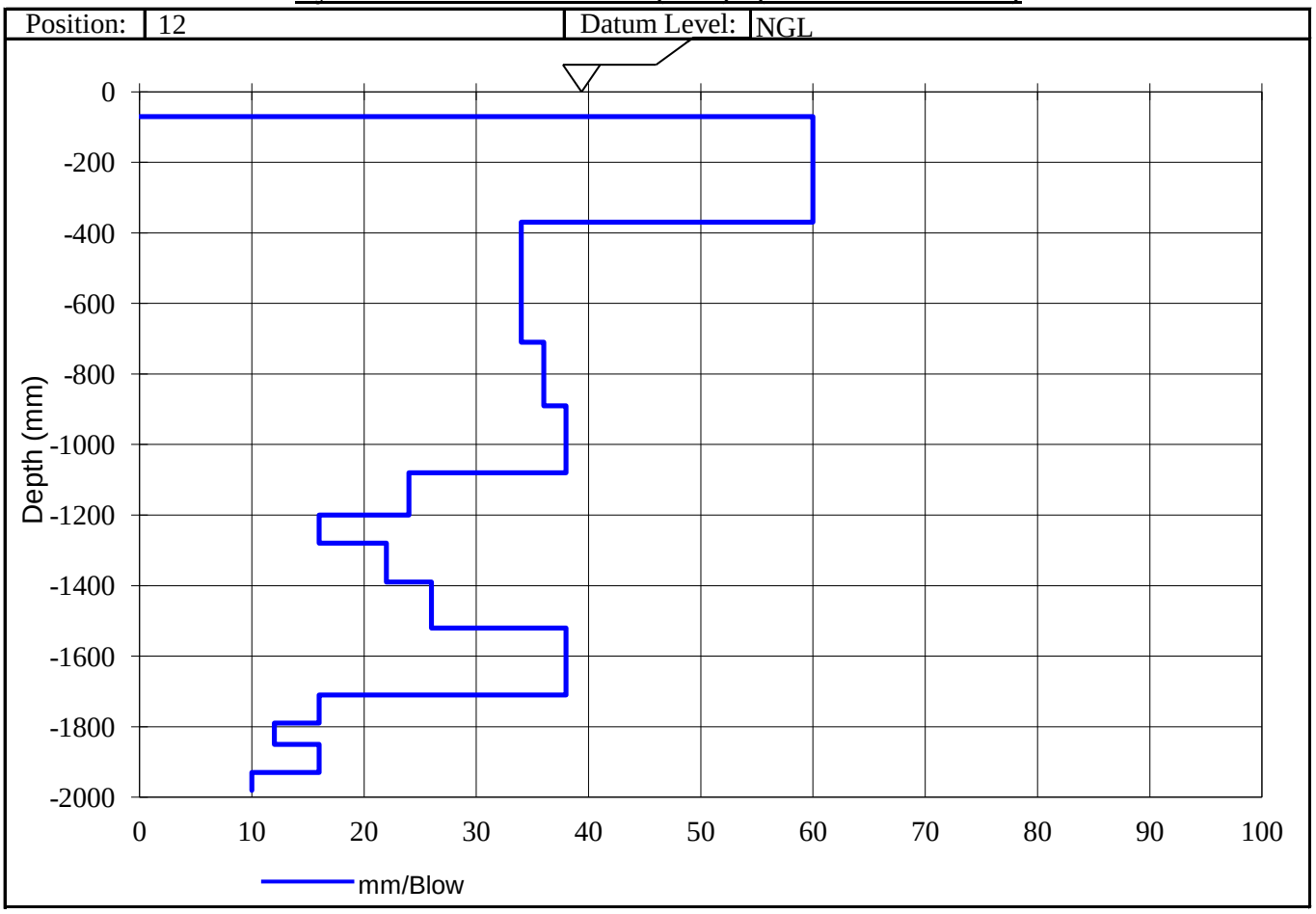
Attention :	Andries Fourie	No. of Pages :	12 of 17

TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position: 12 Datum Level: NGL



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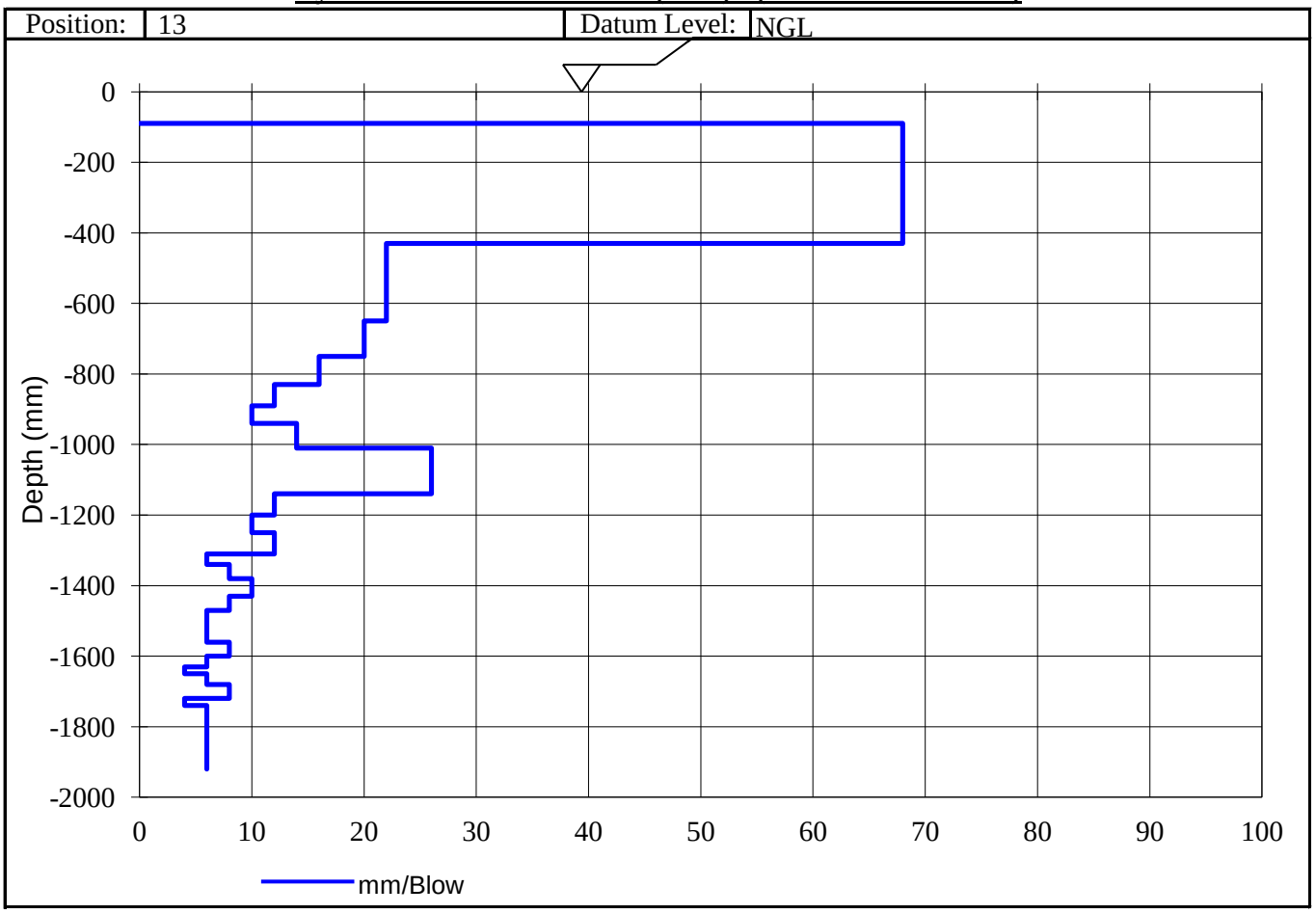
TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position: 13 Datum Level: NGL



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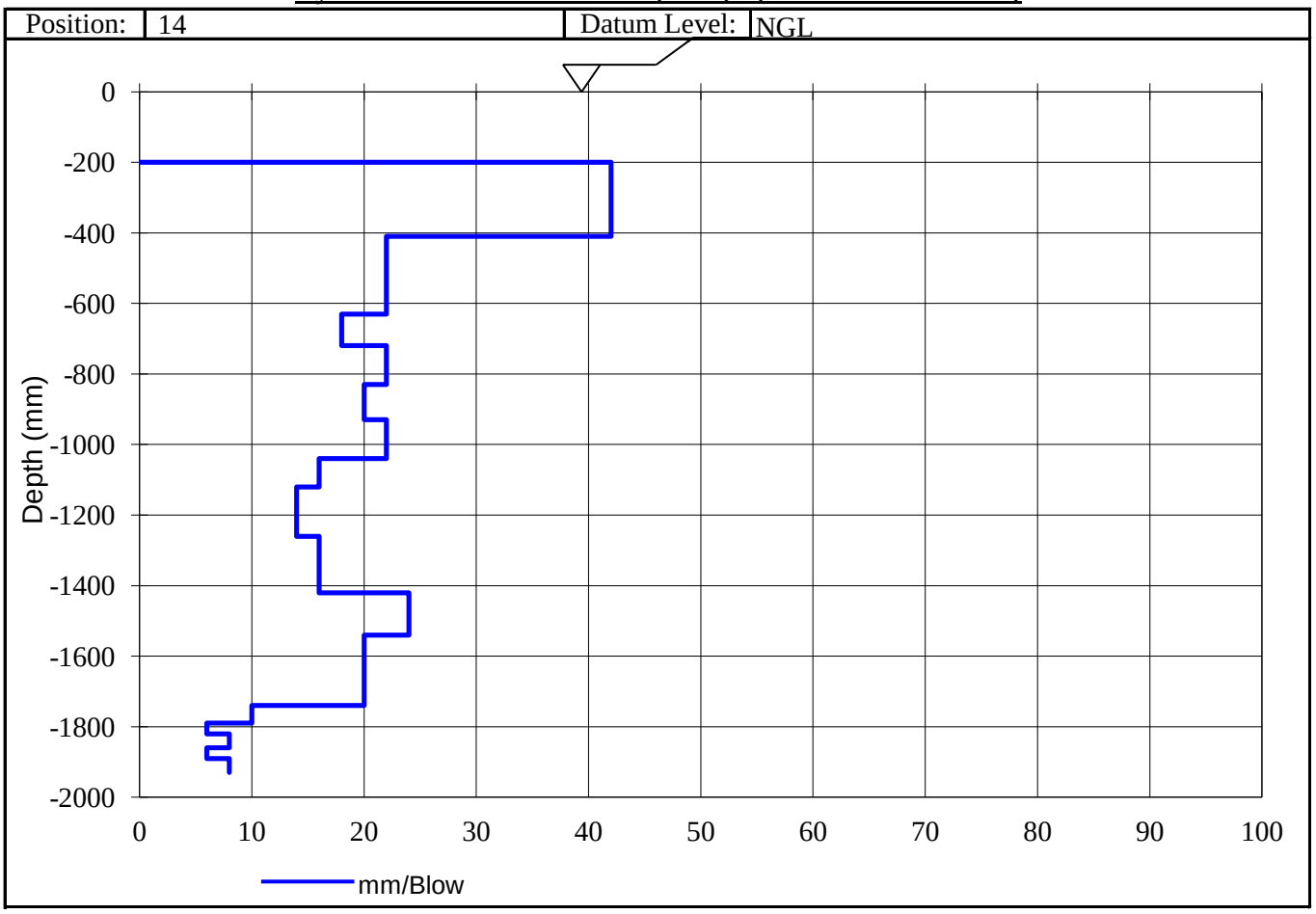
TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position: 14 Datum Level: NGL



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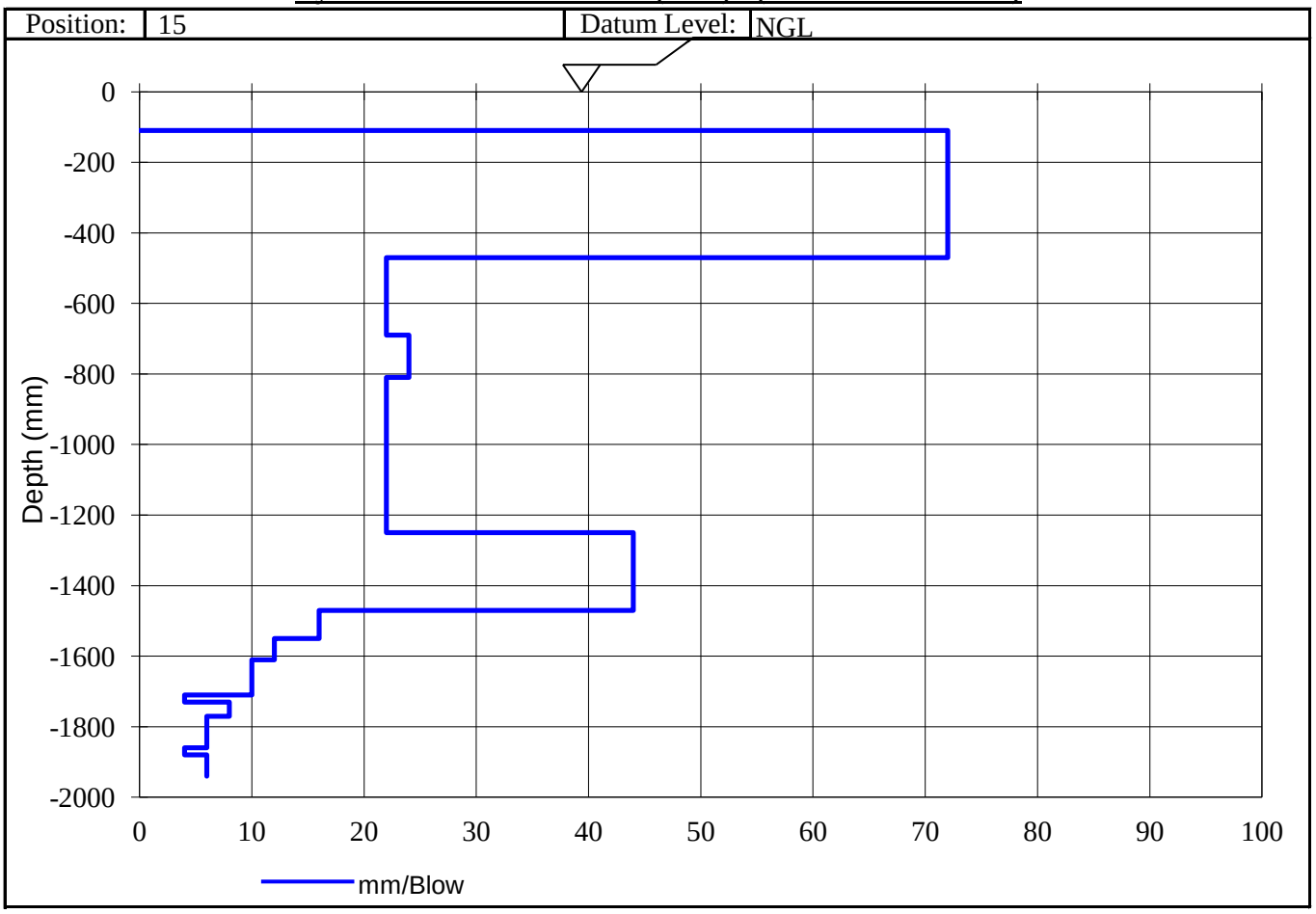
TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position: 15 Datum Level: NGL



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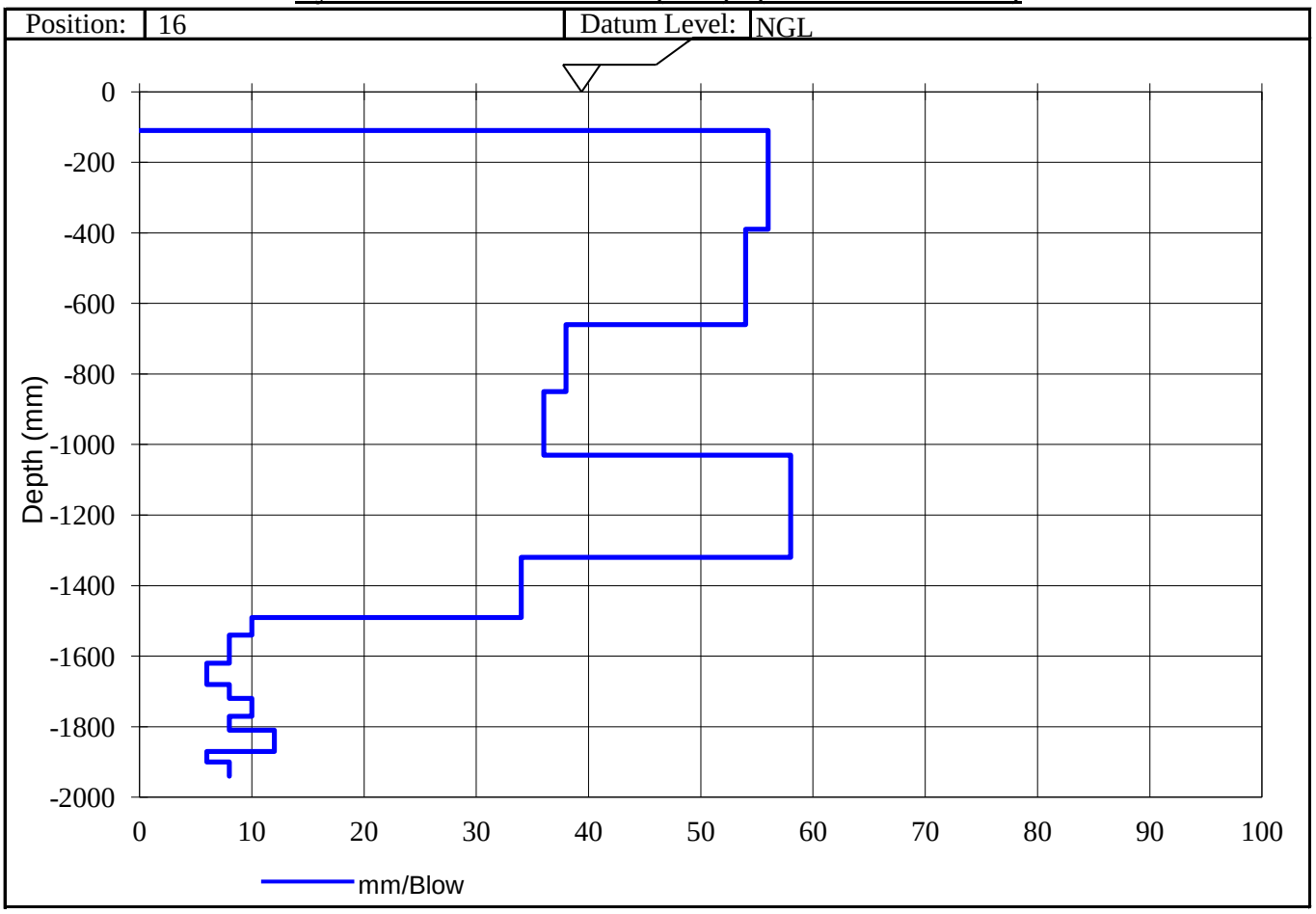
TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position: 16 Datum Level: NGL



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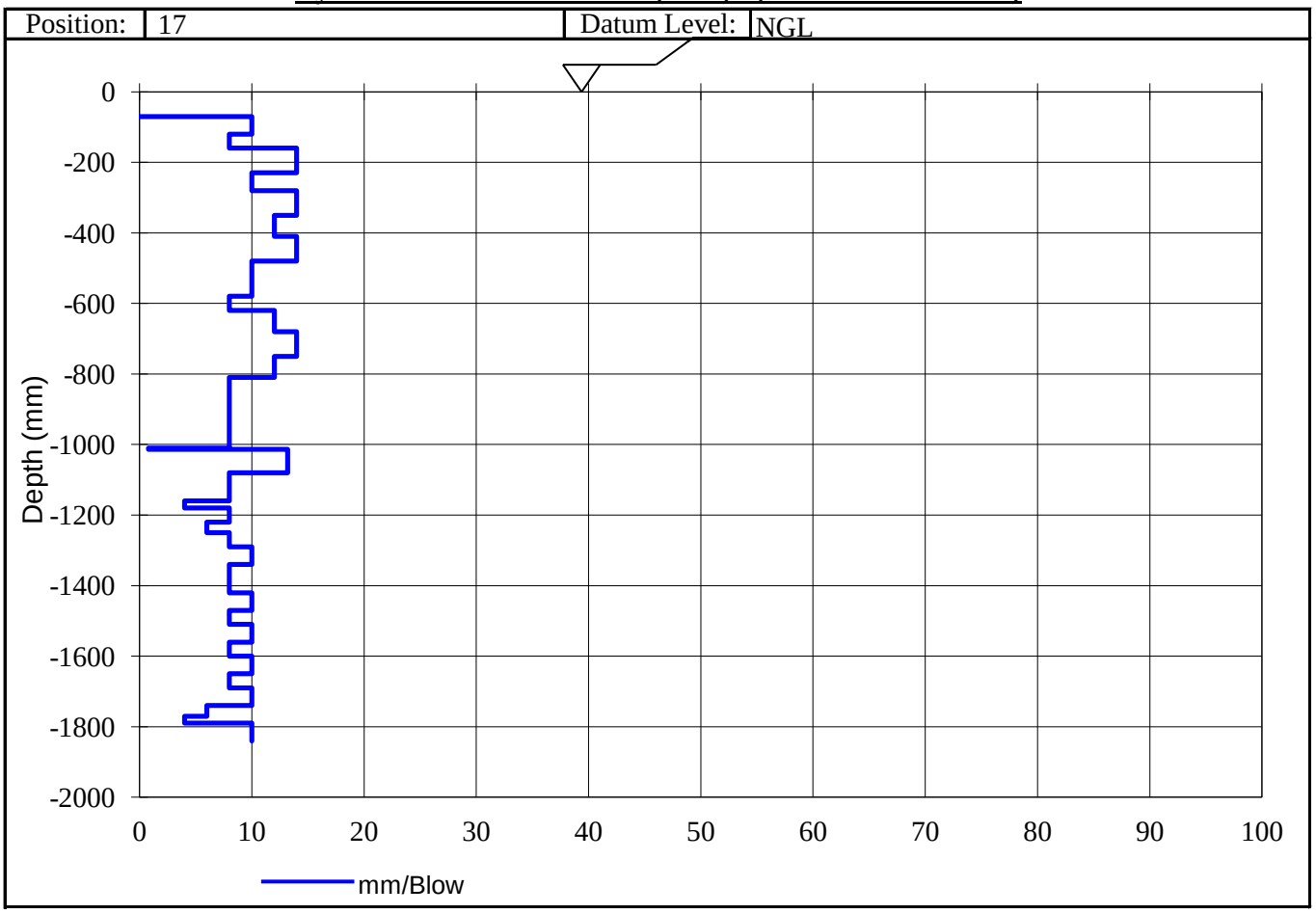
TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position: 17 Datum Level: NGL



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