Terra Geotechnical

ENGINEERING GEOLOGICAL INVESTIGATION

AALWYNDAL HOUSING DEVELOPMENT
ERF 21244 - MOSSEL BAY

WESTERN CAPE – SOUTH AFRICA

Final Report (Amended V1.1)

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AALWYNDAL HOUSING DEVELOPMENT
ERF 21244 - MOSSEL BAY

WESTERN CAPE – SOUTH AFRICA

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1. Introduction

1.1. General

This report described the results of a detailed geotechnical site investigation conducted for the Aalwyndal Housing Development, on the erf 21244, Mossel Bay.

1.2. Terms of Reference

Terra Geotechnical was appointed in June 2019, by Roadlab Mosslab JV (Pty) Ltd, to conduct this geotechnical investigation. The area of investigation was defined by the client and approved before the commencement of the investigation. The distribution of testing locations and the associated sampling were done to best model the geotechnical character of the site for this specific development.

Standard soils laboratory testing was conducted by Roadlab Mosslab JV Civil Engineering Materials Laboratory, with specialist geotechnical soils testing conducted by Steyn Wilson Geotechnical in Cape Town. The quantity and nature of samples were governed by the nature of the proposed development and the in-situ characteristics of the material excavated across the site.

The investigation was undertaken according to the normal requirements to assess the suitability of the site (SANS 634: Geotechnical Investigations For Township Development, SANS 633: Profiling, and Percussion and Core Borehole Logging In Southern Africa for Engineering Purposes, Home Building Manual Part 1 & 2", National Home Builders Registration Council, 1999). and Guidelines for Urban Engineering Geological Investigations 1997).

1.3. Sources of Information

The following sources of information were utilized:

- Geological and Hydrogeological Maps:
  - Geological Series Map 3322; scale 1:250 000 (Digital Copy)
- Topocadastral Maps:
  - 3422 AA; scale 1:50 000 (digital format)
- Remote Sensing Information:
  - Google Earth Pro TM
  - Elevation Heat Map; Online Resource
  - Planet GIS
  - 1Map Spatial Solutions (Pty) Ltd

1.4. Scope of the Investigation

The investigation had the following aims:

- identify potential hazards
- to determine and evaluate the mechanical properties of the soil material occurring within the boundaries of the study area regarding the construction of residential buildings
- define the ground conditions and classify the conditions through detailed soil profile descriptions and groundwater occurrences within the zone of influence of foundations
- to determine the reusability of the natural soil materials during the construction phase
- to evaluate site excavatability
- to recommend measures to be implemented during design and development of the area
- Provide the geotechnical basis for safe and appropriate land use planning, infrastructure and housing unit design as well as formulation of precautionary measures and risk management procedures

The development potential of the study area is assessed based on the following premises:

- Three-storey masonry residential structures will be built

It must be noted that this investigation was conducted to assist with the design and construction phases.

1.5. Development within 1:100 year flood lines

It must be noted that the National Water Act (Act 36 of 1998) states the following regarding development within the 1 : 100 year-flood line of any stream or river (Thompson, 2006):

Section 21(c):

> Impeding or diverting the flow of water in watercourses (including alteration of the hydraulic characteristics of flood events) requires licensing according to the Act

Section 21(i):

> Any action that may alter the bed, banks, courses or characteristics of watercourses (including flood events) requires licensing according to the Act, including:
>
> i. widening or straightening of the bed or banks of a river to allow for the construction of a bridge, sports ground or housing development
>
> ii. altering the course of a river partially or completely (i.e.: river diversion) to be able to use or develop the area where the watercourse originally was.

2. General Location and Description of Site

2.1. Location

The study area for this investigation is located on the outskirts of the town of Mossel bay, within the Mossel Bay Local Municipality forming part of the Eden District Mossel Bay within the south eastern portion of the Western cape Province of South Africa.

Figure 1 (Appendix A) graphically depicts the location of the study area.

The site is defined as the area known as the Erf 21244 and is roughly rectangularly shaped. This site covers a surface area of approximately 10 ha.

The site, which has been mostly undeveloped, is covered in dense natural vegetation. An overhead power line traverses the north eastern corner of the site. The northern and north western boundary of the site displays evidence of vegetation clearance for a firebreak. Scattered heaps of dumped material, which over time have been covered with vegetation is also scattered across the site. A drainage is seen to traverse the site in its far north western corner.

The site is located roughly at the following coordinates:

Latitude: 34.147611° S Longitude: 22.093301° E

Image 1 on the following page visually depicts the site conditions.

Image 1

Site Description

Terra Geotechnical

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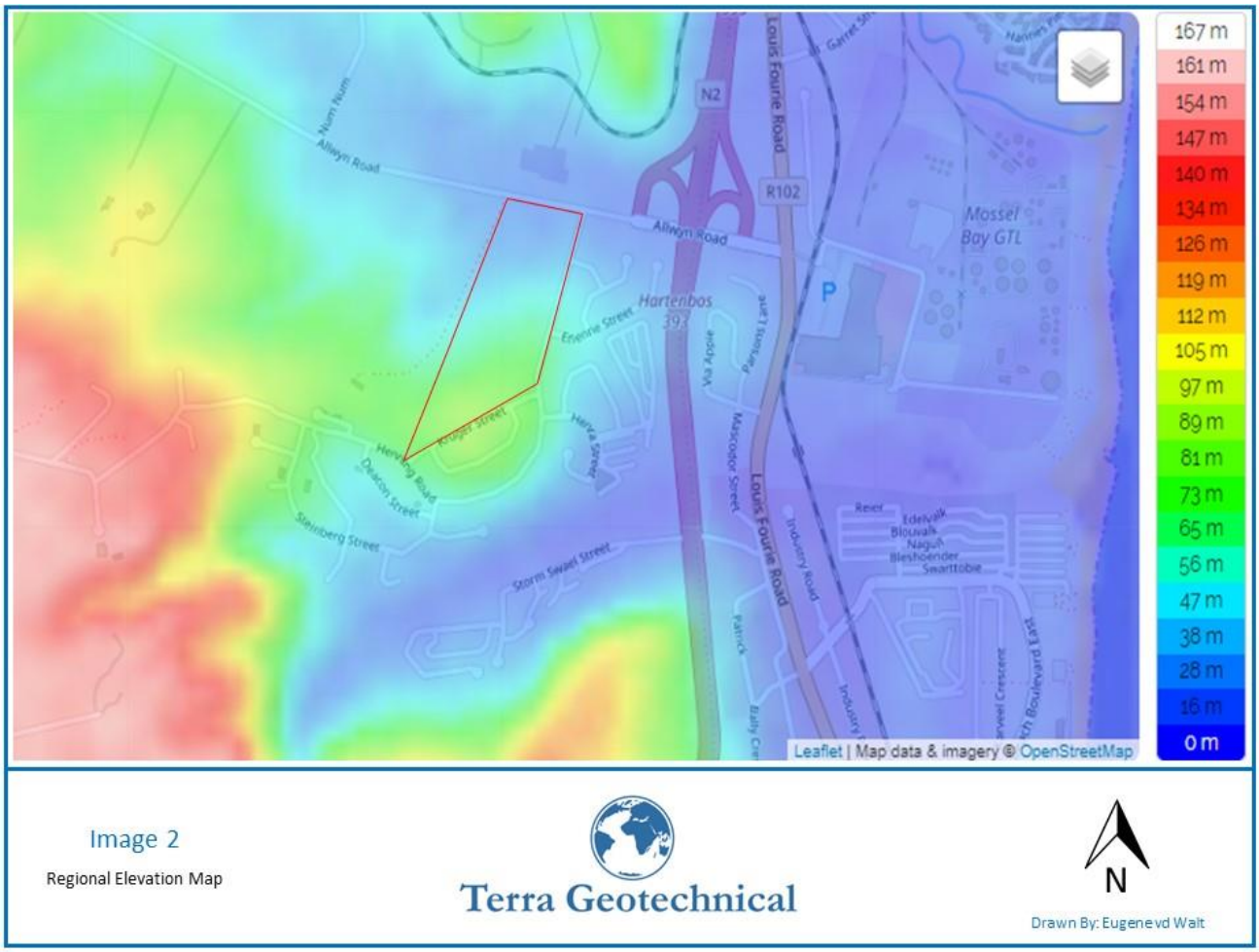
Drawn By: Eugene vd Walt

2.2. Topography

2.2.1 Regional Topography

Regionally, the study area is seen to display a highly undulating surface topography, prominent ridges separated by steeply dipping valleys. The colour coded image below clearly depicts the variable nature of the study area, with the **higher lying ridge structures depicted by the pink** and the **lower lying valley structures depicted by the green and blue colours**

Image 2 graphically depicts the elevation and topography of the study area.



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2.2.2 Site Topography

The site which is located on the northern slope of a localized hill, spans from the gentle sloping summit through the steeply sloping sideslope to the gentle sloping footslope of the hill. Overall, the site is seen to display a variable sloping nature, with the slope generally following a radial sloping nature around the hill summit. The major slope is however in a northerly direction, from the higher lying hill summit in the south (approximately 85 mamsl) towards the lower lying non-perennial drainage area in the north (approximately 30 mamsl).

Image 3 graphically depicts the elevation and topography of the site

The available 5 m surface elevation contours (Planet GIS) were used to divide the study area into slope classes based on one of the parameters of the regional geotechnical classification system of Partridge et al (1993). The following results were obtained, (Image 3):

- Most Favourable: gentle slopes (between 2 and 6°)
- Intermediate Favourable: steep slopes (between 6 and 18°)

The study area generally exhibit gentle- to steep slopes. Due to the dense vegetation across the site, it is expected that surface water will exhibit low flow velocities.

A non-perennial stream is also found to cut through the north western portion of the site.

2.3. Drainage

The study area is located in the Breede-Gouritz Water Management Area, with the area falling within Quaternary Catchment Area K10A.

The study area is drained mainly by means of surface run-off (i.e.: sheetwash), with storm water flowing mainly towards the lower lying areas in the north. According to the available topographic information and as was confirmed on site, a non-perennial streams cuts through the north western portion of the site.

A non-perennial stream is seen to traverse the site within its north western most corner.

2.4. Climate

The study area experiences rainfall throughout the year. The mean annual precipitation ranges from 333mm to 445mm. Mean monthly maximum and minimum temperatures for the nearby Mossel bay are 18.4˚C in July and 26˚C in January.

The climatic N-value (Weinert, 1980) of the area is deemed to be 3; therefore, chemical decomposition rather than mechanical disintegration, of the parent rocks is deemed the principal mode of weathering.

2.5. Vegetation

The study area falls within the Groot Brak Dune Strandveld vegetation region of the Fynbos Biome. The site is covered by dense bush.

3 Geology and Geo-Hydrology of the Site

3.2 Regional Geological Setting

According to the geology map of Oudtshoorn 3322, the study area is completely underlain by Conglomerate, Sandstone, Siltsone and Clay of the Enon Formation. This formation consists of reddish-brown, coarse-grained conglomerate containing pebbles, cobbles and boulders, typically of quartzite. It was deposited in the form of alluvial fans by rivers.

The regional geological setting of the study area (minus the surficial soil cover) is illustrated by **Figure 3** (Appendix A).

The study area does not reflect any risk for the formation of sinkholes or subsidence caused by the presence of water-soluble rocks (dolomite or limestone), and as such is **not deemed "*dolomitic land*"**.

3.3 Prominent Geological Structures

The available geological information does not indicate the presence of any linear structures, within the vicinity of the site.

3.4 Seismic Risk

According to **Kijko *et al.* (2003)** the regional seismic hazard in the project area can be defined as **LOW**, exhibiting a 10% probability of a seismic event with a peak ground acceleration of approximately 0.1 G within a period of 50 years.

4 Geotechnical Field Investigation and Laboratory Testing

4.2 Reconnaissance Study

The investigation commenced with the conducting of the following actions:

- The collation and evaluation of available geological, geo-hydrological and geotechnical information.
- The compilation of a base map showing the regional geological setting

4.3 Site Investigation

The field work phase was conducted by Terra Geotechnical during June 2019. Test pits were placed throughout the study area in such a way as to accurately describe the general soil conditions occurring within the boundaries of the study area. The succession of soil and rock layers exposed within the test pits were logged according to the industry-standard method proposed by Jennings *et al* (1973), and a series of detailed photographs were taken of the different soil layers, and samples were taken of the soil- and rock material deemed to be important to the proposed development.

4.4 Laboratory Testing

The following tests were conducted on **soil samples** taken during the field work phase:

- Standard **foundation indicator tests** were conducted by **Roadlab Mosslab JV**, on disturbed soil samples in order to determine its composition (i.e.: the relative percentages of gravel, sand, silt and clay present within each sample), to evaluate the heave and compressibility potential of these soils, and to calculate the maximum heave and/or differential settlement that can be expected. The following tests were conducted:
    - Atterberg Limits (Liquid Limit and Plasticity Index) and Linear Shrinkage
    - Particle-size distribution
- Standard **road indicator tests** were conducted by **Roadlab Mosslab JV**, on bulk soil samples in order to determine its composition, and to evaluate the suitability of the materials for use in the construction of access roads and parking areas. The following additional tests were conducted:
    - Maximum Dry Density versus Optimum Moisture Content
    - Californian Bearing Ratio versus Compaction Effort (MOD AASHTO method)
- **Specialised Geotechnical testing** on the Undisturbed samples were conducted by **Steyn Wilson Geotechnical** in order to determine the in-situ properties of the material present across the site. The following tests were conducted:
    - Swell Potential and Consolidation test (Single Oedometer).

4.5 Report Writing

The investigation concluded with the compilation of a technical report detailing all methodology utilised during the study and all results obtained. This report includes a detailed potential evaluation of the site in terms of the proposed development, based on the results of the geotechnical investigation, with recommendations regarding foundations, construction and excavatability.

5 Geotechnical Setting

5.2 Trenching

5.2.1 Excavation of test pits

A total of 10 test pits, numbered TP1 to TP10 **(Figure 5)**, were excavated across the site, by means of a TLB-type light mechanical excavator in June 2019, at which time the exposed soil layers were profiled.

5.2.2 Generalised engineering geological parameters

The following general engineering geological characteristics were noted:

- **Site Excavatability**

  No problems are foreseen during the excavation of **shallow foundation trenches.** Localized difficulty in excavation of deep **service trenches** from a depth of **1.00 m** below the existing ground level, through the use of a TLB-type light mechanical excavator.

  The excavation type to a depth of **1.70 m** below the existing ground level is deemed to be **Soft Excavation**. (SANS 1200D). followed by **Intermediate to Hard Rock Excavation** conditions as a result of weathered bedrock encountered across the site. **Localized Intermediate Excavation** from a depth of 1.0 m below existing ground level is expected in the higher lying southern portions of the site.

- **Rock- and/or pedocrete outcrops**

  Bedrock or pedocrete outcrops were not encountered within the investigated area.

- **Sidewall stability**

  Within all of the test pits, the **side walls remained generally stable** for a period of at least 1 hour.

- **Groundwater seepage**

  Groundwater seepage was not encountered in the test pits excavated at the time the field explorations were performed.

  There is the possibility that localized saturation of the soil material overlying less permeable material (e.g.: weathered bedrock) may occur throughout the site during and directly after the rainfall season, especially after heavy precipitation events (i.e.: perched water tables).

5.2.3 Generalised soil profile

Note: this description is based on field observations, and does not reflect the results of any laboratory tests

The results of the trenching phase indicate that the whole site is covered by a relatively homogeneous succession of soil layers, although the thickness of the layers was found to vary considerably across the site.

Transported topsoil

The whole study area is covered transported material deemed to be hillwash or alluviam, comprising clayey silt, exhibiting soft to firm consistency and a shattered structure. This hoizon is seen to vary significantly with regards to thickness. material extends from the surface to a depth of between 2.8 m in a single location.

Residuum

The transported soil is underlain in the majority of the test pits by **residual siltstone** (i.e.: totally weathered bedrock). The residual material is present as silty/clayey sand containing at times, gravel- and cobble-sized, sub-angular, highly weathered fragments, and exhibits firm to very stiff consistency with a pin-holed structure.

with a pin-holed structure. The residual material extends to depths of between 1.0 and 1.4 m.

The residual material becomes less weathered at depth where larger fragments occur, where after highly weathered bedrock may be encountered.

Detailed test pit profiles are included in Appendix B

6 Geotechnical Evaluation

6.2 Engineering- and material characteristics

6.2.1 Sampling

The following samples were taken:

Disturbed samples	:	3 x Alluvium
		3 x Residual Siltstone
Bulk samples	:	3 x Alluvium
		3 x Residual Siltstone
Undisturbed samples	:	1 x Alluvium
		2 x Residual Siltstone

Detailed soil test results are included as in Appendix C.

It should be noted that when saturated and loaded, the soils will undergo an instantaneous loss of strength with the soil grains being forced into a denser state of packing and a reduction in void ratio (decrease in volume). The result of which is varying degrees of consolidation and collapse settlement. For this reason, the assessment and quantification of both the degree and nature of consolidation, heave and collapse, under planned foundation loads, will form the basis of the mechanical assessment of the sites' subsoils to follow.

6.2.2 Soil Test Results: Alluvial Material

In the light of the soil test results and visual observations, the **Alluvial Material** sampled across the site can be summarised as follows:

- This material is deemed to be **potentially highly expansive** and **potentially compressible.**
- This material is deemed to be **moderately plastic**, with measured PI values of between **19** and **28**.
- According to the Unified Soil Classification the material classifies as an organic silt **(OH)**, with and a single sample tested as inorganic silt **(CL)** with a **Grading Modulus** of between **0.6 and 1.1**.

The results of road indicator tests conducted on the bulk samples of this material can be summarized as follows:

This material classifies as a **worse than G9-type** material (COLTO classification system). The results of these tests indicate that this material reacts **poorly** to compaction, with measured a CBR-value of 1 at a compaction effort of 93% MOD AASHTO. This translates to a calculated bearing capacity value of 10 kPa at 93% MOD AASHTO, allowing for a Factor of Safety of

1.5.

6.2.3 Soil Test Results: Residual Siltstone

In the light of the soil test results and visual observations, the **Residual Siltstone** sampled across the site can be summarised as follows:

- This material is deemed to be **potentially compressible and/or collapsible.**
- This material is deemed to have a **low plasticity**, with measured PI values of between **8** and **13**.
- According to the Unified Soil Classification the majority of the material classifies as a low plasticity Silt (**ML**), with a Grading Modulus of between **1.2** and **1.8**.

The results of road indicator tests conducted on the bulk samples of this material can be summarized as follows:

- This material classifies as a **G6-type** and **G8-type** material according to the COLTO classification system.

The results of these tests indicate that this material reacts **moderately** to **well** to compaction, with measured CBR-values of between 9 and 21 at a compaction effort of 90% MOD AASHTO increasing to CBR-values of between 14 and 29 at 95% MOD AASHTO. This translates to calculated bearing capacity values of approximately 80 and 165 kPa at 93% MOD AASHTO, allowing for a Factor of Safety of 1.5.

The laboratory test results are summarized in **Table 1** on the next page.

Detailed laboratory test results are in **Appendix C**

Table 1 Summary of Laboratory Test Results

Soil Profile Make-up and Associated Sampling (Field Observations)			Material Characteristics- Laboratory Assessment Bulk and Disturbed samples tested by Roadlab Mosslab JV																
Test Pit nr & Material Description	Sample Depth (meters below ground level)	Sample nr	Soil Composition					Fines Analysis (measured from material passing the 0.075 mm sieve)				Unified Soil Classification System				Material Compaction Characteristics				
			Sieve Analysis (cumulative percentage passing)				Grading Modulus (GM)	Plasticity Index (PI)		Linear Shrinkage (LS)		USCS Symbol	Inferred Properties			COLTO Classification	Measured CBR Values (percentage compaction of MOD AASTHO; CBR of 13.344 kN)			Calculated remoulded bearing Capacity @ 93 % MOD AASHTO (Factor of Safety of 1.5)
			75.0 mm	5.0 mm	0.075 mm	0.002 mm		Minimum	Maximum	Minimum	Maximum		Material Description	Shearing Resistance	Resistivity RΩ (Ωm)		90%	93%	95%	
TP 7 Alluvium	From: 0,0 To: 1,5	7135	100	88	69,5	30,6	**0,6**	25		9,7		**OH**	high plasticity organic SILT/low plasticity CLAYAY			**<G9**	0	1	1	**10 kPa**
TP 8 Alluvium	From: 0,4 To: 2,8	7146	100	71	54	22,4	**1,1**	28		13,4		**OH**	high plasticity organic SILT/low plasticity CLAYAY			**<G9**	1	1	2	**10 kPa**
TP 10 Alluvium	From: 0,6 To: 2,0	7134	100	88	72,5	24,1	**0,6**	19		6		**CL**	low plasticity CLAY	24	25 to 60	**<G9**	1	1	2	**10 kPa**
TP 1 Residual Siltsone	From: 0,8 To: 1,7	7147	100	86	25	2	**1,8**	8		3,2		**ML**	low plasticity SILT	32	30 to 80	**G6**	21	25	28	**165 kPa**
TP 4 Residual Siltsone	From: 0,3 To: 1,4	7136	100	89	45,8	4,9	**1,2**	9		3,6		**ML**	low plasticity SILT	32	30 to 80	**G6**	13	21	29	**145 kPa**
TP 5 Residual Siltsone	From: 0,2 To: 0,8	7133	100	93	24	3,4	**1,7**	13		5,9		**ML**	low plasticity SILT	32	30 to 80	**G8**	9	11	14	**80 kPa**

6.3 Material usage

In the light of the soil tests which were completed on the **alluvium** sampled across the site, the material classifies as a **worse than G9- type** material according to the COLTO classification system.

It is recommended that the material be removed and **not be used for any layer works during construction.**

In the light of the soil tests which were completed on the **residual siltstone** sampled across the site, the material classifies as a **G6- and G8- type** material according to the COLTO classification system. As such, the materials can be used as selected material in road layer works and is deemed suitable for use in foundations (suitability based on engineers' design). All organic material should be removed prior to the re-use of the material.

Soil testing is done under controlled conditions within a laboratory with measured/standardised compaction methodology and sample preparation. Similar methodologies should be implemented on-site in order to achieve the same results as required for the construction.

Table 3 below, describes the use of material encountered on-site based on the Unified Soil Classification System.

6.4 Undisturbed Sample Results

6.4.1 Introduction

A total of three undisturbed soil blocks were extracted to analyse the in-situ properties of the material present underlying the site. The sampling details are summarized in Table 2 below.

The extracted samples were submitted for standard consolidation and swell potential testing.

Please note that the extraction of block samples changes the samples natural state (unloading of in-situ stresses); and as such, the test is only an indication of the in-situ material properties.

Detailed soil test results for the undisturbed sample is included in **Appendix C**

Table 2: Undisturbed Sampling

Sample Number	Horizon	Depth	Test
TP1	Residual Siltstone	1,2 – 1,6	Free Swell coupled with Single Oedometer
TP2	Residual Siltstone	1,5 – 2,0	Free Swell coupled with Single Oedometer
TP8	Alluvium	1,0 – 1,5	Free Swell coupled with Single Oedometer

6.4.2 Calculation and Results

These calculations are based on the construction of various shallow foundation infrastructural units across the site (or structures which display similar foundation loads).

Calculation assumptions:

- The force applied to the material is horizontally uniform. (i.e. no point loads applied)
- Pre-consolidation pressure calculated from the depth to the center of the sample.
- Foundation width of 0.6 meters.
- Assume a load of 50 and 100 kPa respectively

Refer to Table 3 and Table 4 for the summarised results from the undisturbed sample analysis

6.4.3 Heave Characteristics of the In-Situ Soils

Soil heave is the process of the change in volume correlating to a change in moisture content. This phenomenon is prominent in soils containing a high content of active clays. In undisturbed testing, heave is quantified through two properties; swell pressure and free swell. The heave properties were determined through a Free Swell Test coupled with a Consolidation Test, whereby a sample is initially inundated with water and allowed to swell. Once the sample ceases to swell, the final change in height is calculated and the swell percentage is determined. Thereafter, a standard consolidation test is conducted whereby the sample is loaded at increasing increments. The swell pressure of the material is obtained from the pressure required to consolidate the sample to its original height, before inundation. The tables below depict the results and associated analysis of the free swell test results:

Table 3: Free Swell Test Results Summary

Free Swell Test Results								
Sample Number	**Sample Depth m**	**Horizon Thickness m**	**Free Swell %**	**Swell Presssure kPa**	**Foundation Load kPa**	**% Swell**	**Swell mm**	**Result**
TP1 Residual Siltstone	**1,2 - 1,6**	**0,9**	0	1	25	Negligible	Negligible	N/A
					50	Negligible	Negligible	
TP2 Residual Siltstone	**1,5 - 2,0**	**1,5**	0,1	4	25	Negligible	Negligible	N/A
					50	Negligible	Negligible	
TP8 Alluvium	**1,0 - 1,5**	**2,4**	14,8	249	25	6,166	83,24	58 to 83 mm heave
					50	4,306	58,14	

According to the free swell test, the **Residual Siltsone** encountered across the site yielded low free swell values and associated swell pressures. Furthermore, the disturbed sample testing indicated a **low to medium plasticity** coupled with a **low to medium potential for volume change.** As such, this material is interpreted to undergo **negligible heave** under the planned foundation loads.

According to the free swell test, the **Alluvium** encountered across the site yielded a measured **free swell of 14.8 %**, with an associated **swell pressure of 249 kPa**. As such, this material is deemed to be **very highly expansive** at a predicted foundation load of 50 kPa.

Please note, the degree of soil heave displays an inversely proportional relationship to the bearing loads, and therefore the degree of heave reduces with an increased bearing load. This is of greater concern for light structures, such as walkways, pavements, surface beds, etc.

6.4.4 Standard Consolidation Characteristics of the In-Situ Soils

There are three components to settlement namely immediate settlement (also referred to as elastic settlement), primary consolidation settlement and secondary consolidation (also referred to as creep). Immediate settlement takes place as a load is exerted on the soil mainly due to distortion of the soil. As pore water begins to flow out of the soil a time dependant decrease in volume occurs which is termed consolidation settlement. This settlement will continue until a condition of constant effective stress is reached. This primary consolidation settlement takes place generally in fine grained materials (high percentage of clay or silt). Secondary consolidation settlement is not considered a concern as this type of settlement usually occurs in soft organic clays where plastic flow within the soil mass results in displacement of the soil particles. The table below summarizes the settlement character of the various horizons across the site:

Table 4: Summarised Settlement Character of the on-site Materials

Material Horizon	Calculated Settlement Ranges at the Associated Foundation Loads		
	25 kPa	50 kPa	100 kPa
Residual Siltstone TP1	< 5 mm	< 5 mm	< 5 mm
Residual Siltstone TP2	< 5 mm	< 5 mm	< 5 mm
Alluvium TP8	50 to 100 mm	> 100 mm	> 100 mm

Based on the results presented in the table above, the various **residual siltstone** deposits encountered within the typical founding depths will undergo **low settlement** under **foundation loads of 50 kPa**

Based on the results presented in the table above, the **alluvial deposits** encountered across the site, within the typical founding depths, will undergo **settlements of in excess of 100 mm** under **foundation loads of 50 kPa**. As such, this material displays a **highly compressible nature.**

6.4.5 Collapse Settlement Characteristics of the In-Situ Soils

Collapse settlement is defined as the sudden loss of volume of a material once saturated, as compared to the more gradual settlement related to standard consolidation. As such, these soils typical undergo low settlement in the dry state (apparent strength), with a sharp increase in settlement upon saturation.

The susceptibility of a soil to collapse settlement can be **inferred** from a combination between the soils in-situ dry density, and its liquid limit (Das, 2009).

Each of the sampled materials yielded low to moderate in-situ dry density values, coupled with high liquid limits.

The material across the site **is not deemed** to be susceptible to **collapse settlement**.

7 Geotechnical Site Classification

7.2 General

The results of this study reveal that the site exhibits geotechnical characteristics that may require the implementation of specific design and precautionary measures to reduce the risk of structural damage due to adverse geotechnical conditions.

The following constraints needs to be considered;

- The occurrence of a **non-perennial river** traversing the north western corner of the site; with expected elevated volumes of surface water runoff and associated erosion within, and adjacent to this channel. The exact extent of this channel and its 1:100 flood line needs to be determined.
- The occurrence of **topsoil material** deemed to be **potentially highly expansive** and **potentially highly compressible**
- The occurrence of residuum material deemed to be **potentially slightly compressible.**
- The scattered occurrence of boulder size cobbles within the soil profile amplifying the predicted degree of **differential movement.**
- **Localized occurrence of difficult excavation** at shallow depth resulting in hard rock excavation of **less than 10%** of the total volume of material to a depth of 1.5 m below the ground surface.
- **Steep slopes** of between 6 and 12 degrees across the majority of the site.
- Across the site, the occurrence of **dense vegetation** and extensive large root systems.

However, these characteristics do not disqualify the site from being used for the proposed development, but rather require the implementation of site-specific precautionary measures.

7.3 Site Classification

In the light of the results of this study, the site can be subdivided into **FOUR** geotechnical entities/development potential zones **(Figure 6).**

Please refer to **Table 5** overleaf which details the sites' zonation.

The table applies to **light foundation masonry residential structures**.

Table 5: Site Zonation and Geotechnical Character

Development Potential Zone	NHBRC Site Classification	Partridge, Wood and Brink (1993) Classification	Excavation Class	Slope Stability
Zone A	H1/S1	**2C-** Moderate soil Heave **2C-** Moderate soil Compressibility **2F-** Difficulty of excavation to a depth of 1.5 m with between 10 and 40% of the material deemed to be hard rock excavation	Soft Conditions to depths of approximately 1.0 m.	Stable- and gentle slopes
Zone B	H1/S1	**2C-** Moderate soil Heave **2C-** Moderate soil Compressibility **2I-** Localized areas with slopes between 6 and 12 degrees	Soft Conditions to a depth of 1.8 m	Stable- with localized steep slopes
Zone C	H3/S2	**3C-** High soil Heave **2C-** High soil Compressibility **2I-** Large portions of the site with slopes between 6 and 12 degrees	Soft Conditions to a depth of 1.7 m	Stable- and steep slopes
Zone D	H3/S2	**3C-** High soil Heave **2C-** High soil Compressibility **2I-** Localized area of the site with slopes less than 2 degrees **2L –** Areas adjacent to a known drainage channel (Exact extent of 1:100 year flood line needs to be determined)	Soft Conditions to a depth of 2.8 m	Stable- with very gentle to gentle slopes

7.4 Groundwater Occurrence

Zone A, B, C

Groundwater was not encountered in any of the test pits excavated across the site.

There is the possibility that localized saturation of the soil material overlying less permeable material (e.g.: weathered bedrock) may occur throughout the site during and directly after the rainfall season, especially after heavy precipitation events (i.e.: perched water tables).

Zone D

A non-perennial drainage traversing this zone may increase the subsurface waterflow.

7.5 Soil Excavatability

Zone A, C, D

No problems are foreseen during the excavation of **shallow foundation trenches** or **deep service trenches** to a depth of 1.7 m.

Material to a depth of 1.7 m deemed to be **Soft Excavation** (SANS 1200D).

Zone B

No problems are foreseen during the excavation of **shallow foundation trenches,** although **problems** are foreseen with the excavation of **deep service trenches**, due to the occurrence of shallow bedrock.

Between 10 and 40 % of the material to a depth of 1.0 m deemed to be **Intermediate Excavation** conditions (SANS 1200D).

All Zones

The following additional comments on excavation of service trenches apply:

- Trenches near the non-perennial streams may have to be dewatered, especially after heavy precipitation events.
- The side walls of deep excavations should be shored to prevent injury or death due to side wall failure

7.6 Slope Stability

Zone A & D

In the light of the **gentle slopes** and localized **very gentle slopes** across these zones, specialised methods for the stabilisation of cuts into the slopes **are not** deemed necessary.

Zone B & C

In the light of the **steep slopes** across these zones, specialised methods for the stabilisation of cuts into the slopes **are** deemed necessary

8 Foundation Recommendations and Solutions

In the light of the results of this investigation, the study is deemed suitable for development, provided due cognisance is given to the following:

- The soils covering the site may undergo a degree of **consolidation and heave** (i.e.: loss and gain of volume) under loading or when saturated, requiring that structures be adequately strengthened to prevent structural damage due to **differential movement** beneath foundations.
- Due to its variable nature, it is recommended that the **highly expansive organic rich topsoil** across the site be removed beyond the perimeter of the proposed developments. The decomposition of the organic material within the soil may induce structural damage due to differential movement beneath foundations.
- Due to its variable nature, it is recommended that all the **heaps of fill** material in the north of the site be removed beyond the perimeter of the proposed development.
- Due to the identified drainage feature traversing the north western portion of the site, it is recommended that detailed **1:100 flood line survey** be conducted to identify the extent of this feature
- In areas hosting shallow bedrock; it is recommended that foundations do not span from rock to natural soils or engineered fills, so as to limit differential settlement.
- The presented geotechnical model is based on point data, for this reason, inconsistencies identified during the construction phase of the project should be assessed on site by a qualified individual

It is recommended that EITHER of the following foundation designs be used in the development:

Zone A & B (NHBRC Site Class H1/S1)

1. **Modified Normal:**
    - Reinforced strip footings.
    - Articulated joints at some internal and all external doors.
    - Light reinforcement in masonry.
    - Site drainage and plumbing/service precautions.
2. **Soil Raft:**
    - Remove all or part of expansive horizon to 1.0 m beyond the perimeter of the structure and replace with inert backfill, compacted to 93% MOD AASHTO density at -1% to +2% of optimum moisture content.
    - Normal construction with lightly reinforced strip footings and light reinforcement in masonry.

- Site drainage and plumbing/service precautions

It must be noted that differential settlement is assumed to equal 50 % of the total movement. The relaxation of some of these requirements, e.g. the reduction or omission of steel or articulation joints, may result in a Category 2 level of expected damage.

Zone C & D (NHBRC Site Class H2/S2)

1. **Stiffened or cellular raft:**
   - Stiffened or cellular raft with articulated joints or lightly reinforced masonry.
   - Site drainage and plumbing/service precautions.
2. **Piled Construction:**
   - Piled foundations with suspended floor slabs with or without ground beams.
   - Site drainage and plumbing/service precautions
3. **Soil raft:**
   - Remove all or part of expansive horizon to 1.0 m beyond the perimeter of the structure and replace with inert backfill, compacted to 93% MOD AASHTO density at -1% to +2% of optimum moisture content.
   - Normal construction with lightly reinforced strip footings and light reinforcement in masonry.
   - Site drainage and plumbing/service precautions

Please note that if a soil raft is not selected, it is recommended that the problems soils (expansive and compressible material) immediately beneath the concrete surface beds be removed and replaced with a competent inert backfill, with depths and quality in accordance with design recommendations.

It must be noted that differential settlement is assumed to equal 50 % of the total movement. The relaxation of some of these requirements, e.g. the reduction or omission of steel or articulation joints, may result in a Category 2 level of expected damage

Please consult a qualified professional for additional options and final designs.

Due to the fact that this report is compiled using point data scattered over the site, provisions must be made to allow for changes in soil quality over short distances. It is recommended that a geotechnical investigation be undertaken by a suitably qualified geo-professional for each of the stands before construction to establish its own geotechnical nature.

9 Good Construction Practices

9.2 Drainage

An important factor in the promotion of a stable site is the control and removal of both surface and ground water from the site. It is important that the design of the storm water management system allow for the drainage of accumulated surface water. Disposal of storm water should in any case conform to the Department of Water Affairs and Forestry and local authority requirements. This includes the obtaining of water use licenses when necessary.

The report stated that there will be a significant increase in moisture content during periods of high rainfall and the high clay content will render the alluvial soils susceptible to volumetric change (swell) and alternatively shrink during dry periods. It is therefore important that effective drainage is achieved

9.2.1 Surface Drainage

It is recommended that an efficient surface drainage system be installed around all structures and along all roads throughout the study area in order to:

- prevent the ponding of water next to structures directly after heavy precipitation events, this may lead to differential settlement as the saturated material undergoes densification.
- prevent large-scale changes in soil moisture beneath the structures on a seasonal basis
- prevent the seasonal formation of perched water tables (i.e.: short-term groundwater seepage) within the soil material at shallow depth.
- prevent the possible lateral movement of liquids within the upper soil horizons

The precautionary measures should ideally include:

- the sealing of open ground surfaces by means of either of the following:
    - the cultivation of a natural soil cover (e.g.: grass)
    - compaction of the soil surface
    - bitumen or concrete paving
- the removal of surface water to a distance of at least 1 m beyond structures by means of watertight paving.
- the removal of surface run-off by means of an efficient surface drainage system.
- roads should preferably be constructed parallel to the natural surface elevation contours rather than perpendicular to it, in order to reduce run-off velocities

9.2.2 Sub Surface Drainage

Areas requiring subsoil drainage will have to be assessed on site during the construction phase of the development. No groundwater seepage was encountered during this investigation, however, if groundwater seepage is encountered during construction, these zones will need to be controlled with effective subsoil drains, particularly where water is likely to gain ingress into the structural layers of roads.

9.3 Earthworks

It is recommended that all earthworks be carried out in accordance with SABS 1200 (current version). The fill should be placed in layers not exceeding 200 mm loose thickness and compacted to a minimum of 90% Modified AASHTO maximum dry density.

Cut and fill slopes should be top soiled and planted with grass. This will limit erosion of these slopes and the problems associated with wash-aways of fill embankments.

10 Bibliography

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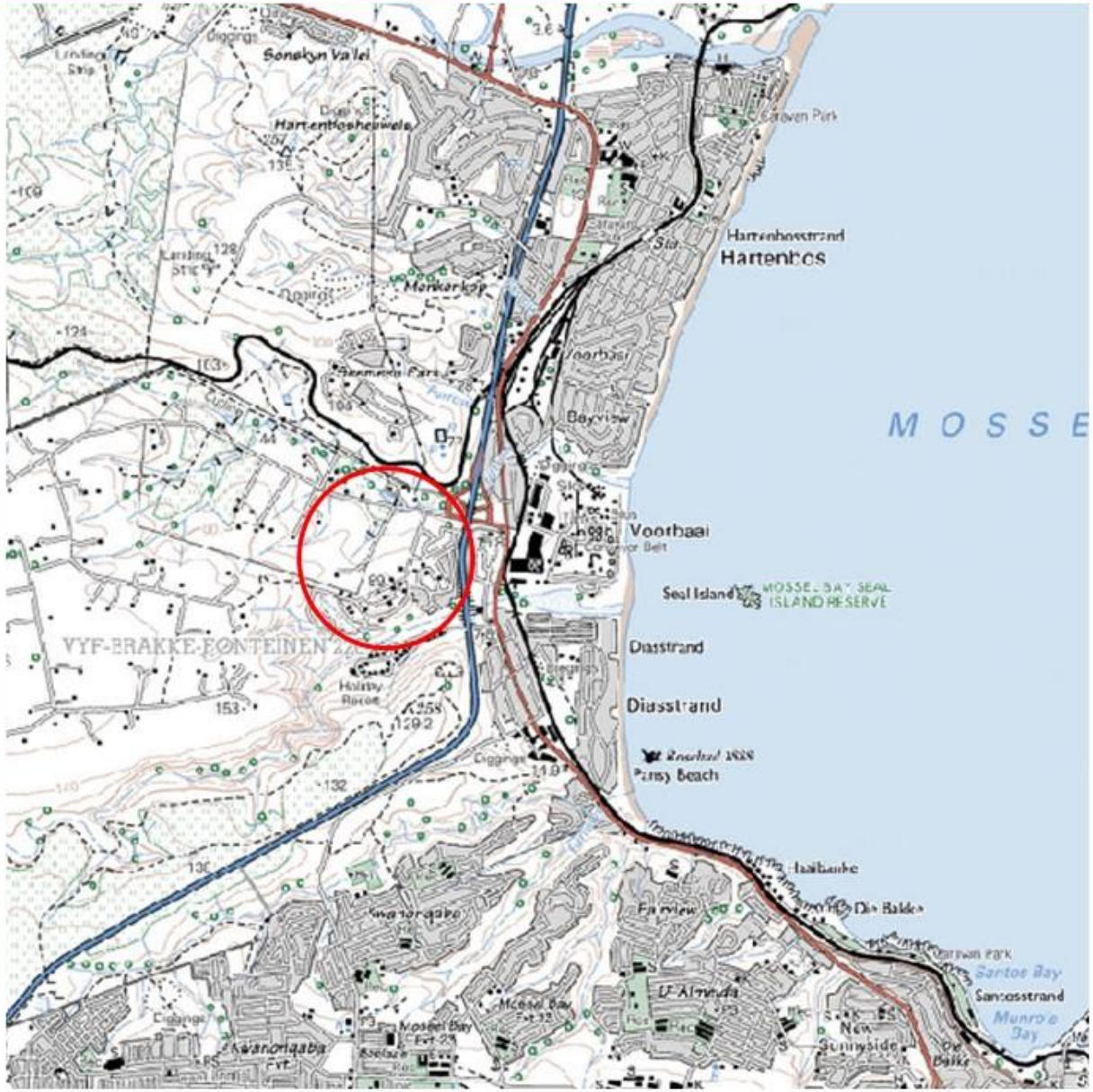
APPENDIX A

MAPS



Terra Geotechnical

Figure 1

Study Area Location

LEGEND

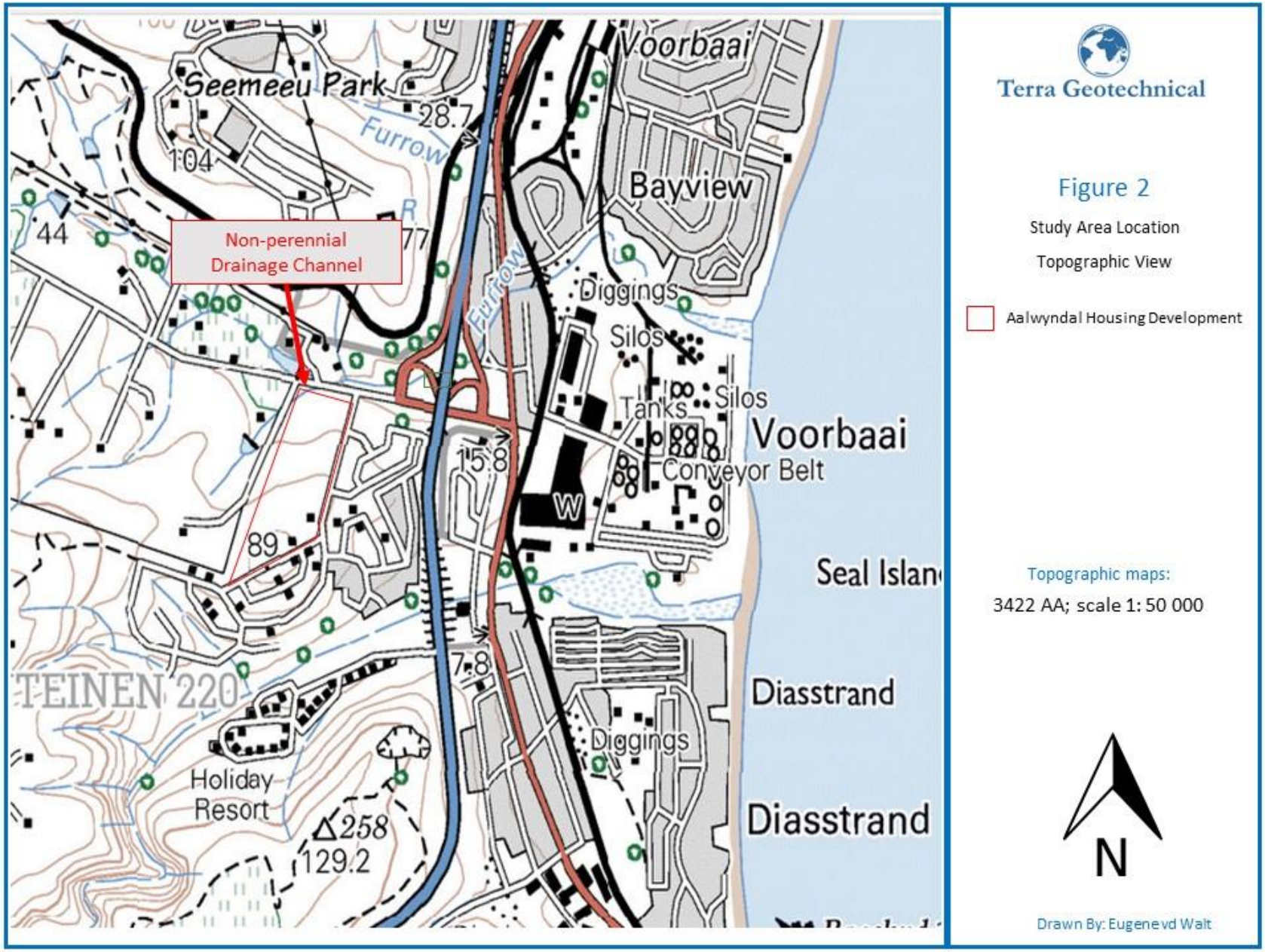
Study Area

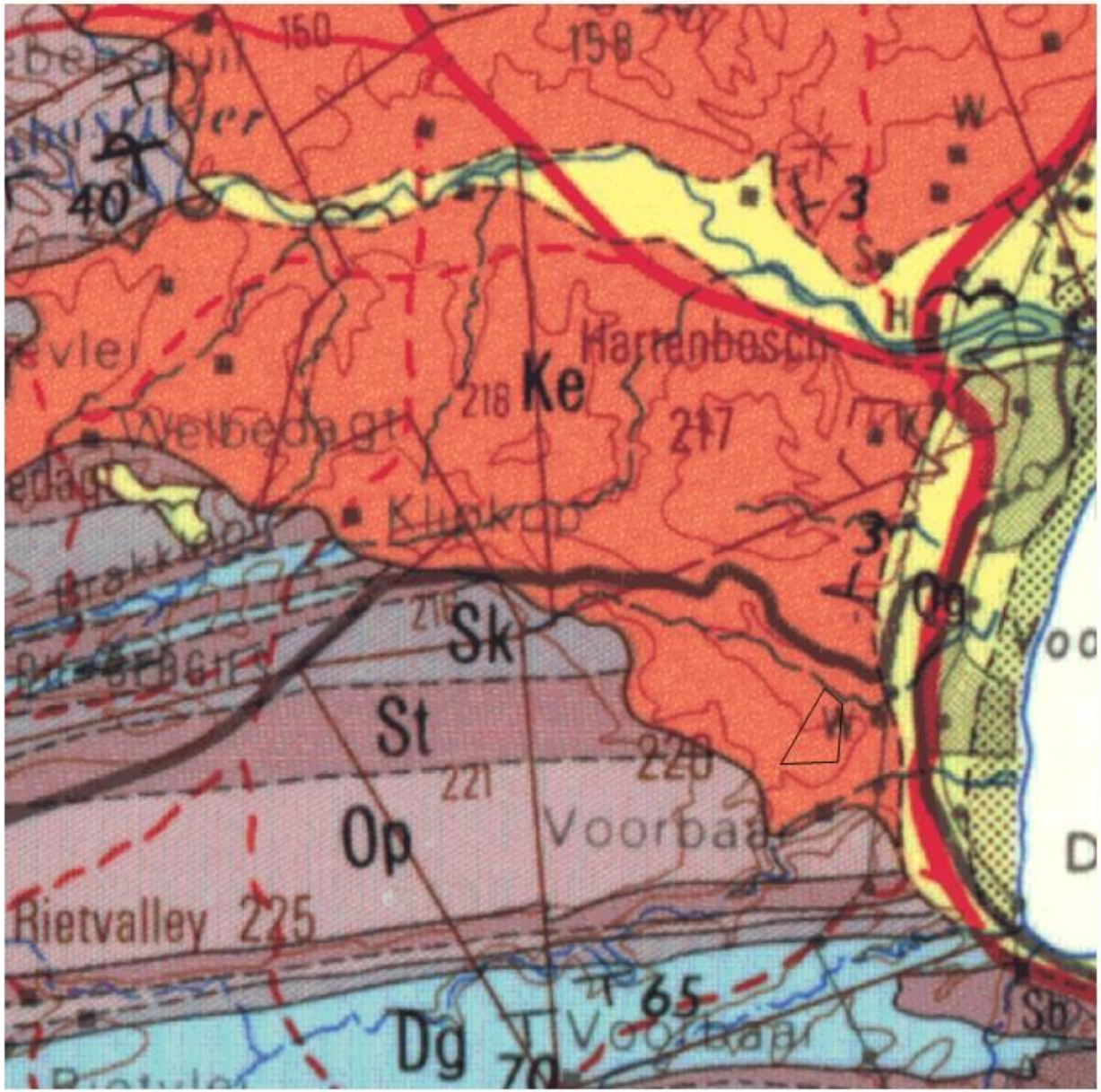
Topographic maps:

3422 AA; scale 1: 50 000

N

Drawn By: Eugene vd Walt


Seemeeu Park
Voorbaai
Furrow
28.7
104
Bayview
44
Non-perennial
Drainage Channel
77
Furrow
Diggings
Silos
Tanks
Silos
Voorbaai
15.8
Conveyor Belt
W
89
Seal Islan
7.8
TEINEN 220
Diasstrand
Diggings
Holiday
Resort
258
129.2
Diasstrand
Terra Geotechnical
Figure 2
Study Area Location
Topographic View
Aalwyndal Housing Development
Topographic maps:
3422 AA; scale 1: 50 000
N
Drawn By: Eugene vd Walt



Terra Geotechnical

Figure 3

Regional Geological Map

LEGEND

Site location

Qg **Qg-** Marine gravel

Ke **Ke-** Conglomerate, Sandstone, Siltstone and Clay

Geological Series Map:
3322 Oudtshoorn
Scale 1 : 250 000

N

Drawn By: Eugene vd Walt


Die Voor Bay
Image © 2019 Maxar Technologies
© 2018 Google
© 2018 AfriGIS (Pty) Ltd.
Terra Geotechnical
Figure 4
Site Location
Aerial View
N
Drawn By: Eugene vd Walt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Terra Geotechnical
Figure 5
Testing Locations
Test Pits
LEGEND
Investigative Boundary
Test Pit
N
Drawn By: Eugene vd Walt

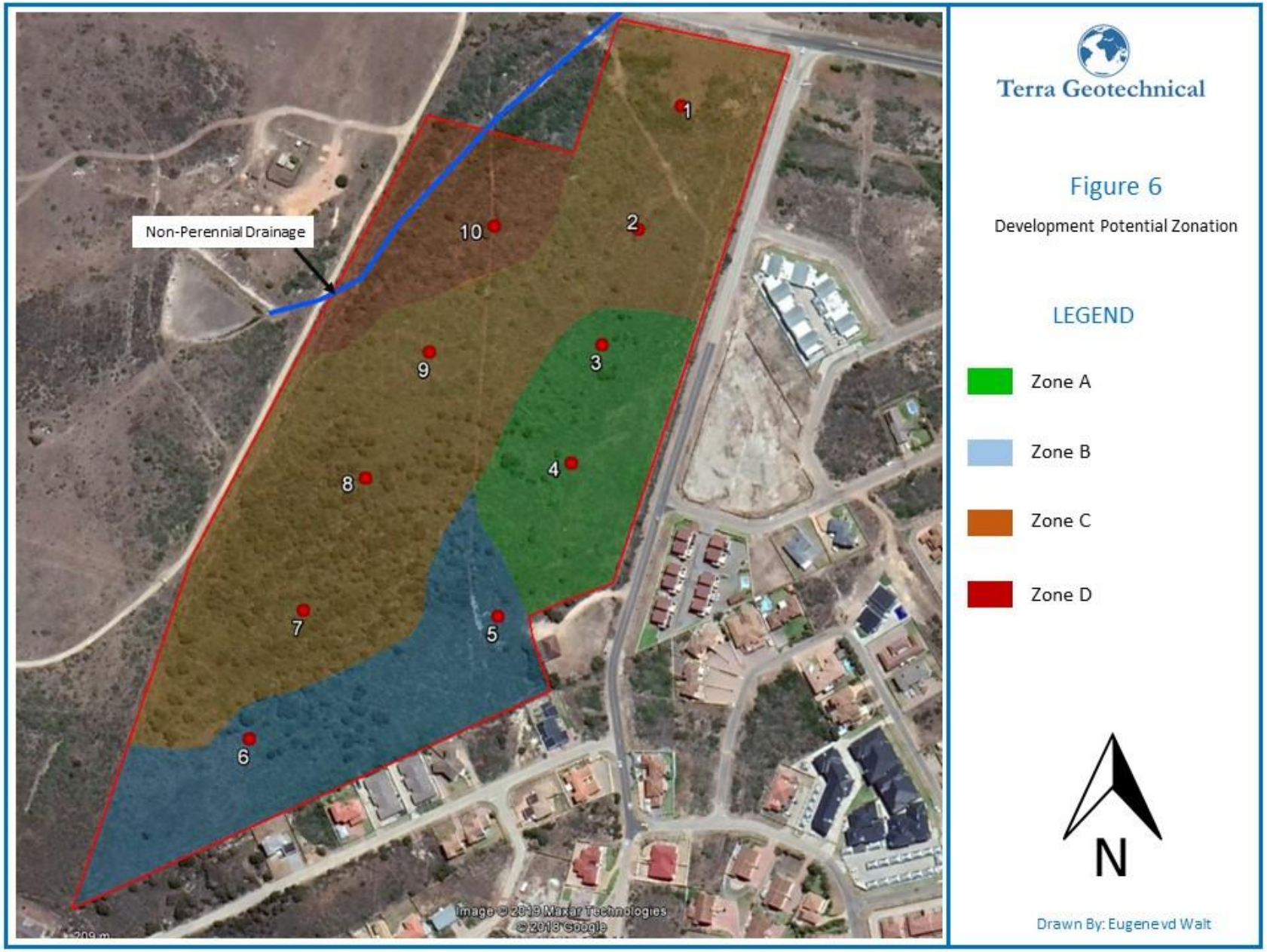
Non-Perennial Drainage
1
2
3
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Image © 2019 Maxar Technologies
© 2018 Google
Terra Geotechnical
Figure 6
Development Potential Zonation
LEGEND
Zone A
Zone B
Zone C
Zone D
N
Drawn By: Eugene vd Walt

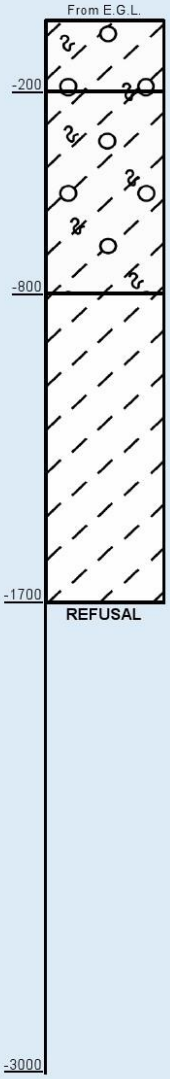
Appendix B

Soil Profiles

Terra Geotechnical

Site:	Development on Erf 21244
Project:	Aalwyndal Housing Development
Client:	Great Karoo Eco Investments

Soil Profile for Test Pit TP1



slightly moist; light brown; firm; intact; clayey silt with frequent sub angular gravels; HILLWASH; frequent roots; Not Sampled.

~Variable contact (200 to 300)

slightly moist; dark brown; stiff; shattered; clayey silt with frequent angular gravels; COLLUVIUM; traces of roots; Not Sampled.

~Undulating contact (800 to 900)

slightly moist; olive grey; very stiff; pinholed; clayey silt; Residual Siltsone; Bulk Sample No. 7147; Undisturbed Sample No. TP1.

Test Pit Notes

Coordinates:	34°08.783' S 22°05.783' E
Method of Excavation:	TLB Type Light Mechanical Excavator- CAT 426F
Excavation Character:	Refusal on very stiff material at 1,7 m below existing ground level
Date Excavated:	20/06/2019
Date Profiled:	20/06/2019
Groundwater Seepage:	N/A
Samples Extracted:	1 Bulk Sample, 1 Undisturbed Sample
Notes:	N/A
Profiled by:	Eugene van der Walt (Pri.Sci.Nat)

Terra Geotechnical Aalwyndal Housing Development

Soil Profile Photo of Test Pit TP1

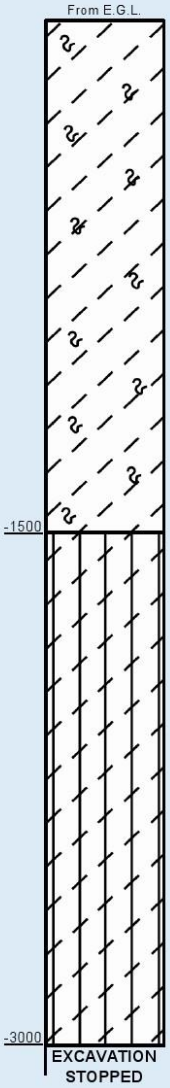
Terra Geotechnical Aalwyndal Housing Development

Material Present in Test Pit TP1

Terra Geotechnical

Site:	Development on Erf 21244
Project:	Aalwyndal Housing Development
Client:	Great Karoo Eco Investments

Soil Profile for Test Pit TP2



slightly moist; dark brown; firm; shattered; frequent sub-angular cobbles and boulders in a matrix of clayey silt; clast supported; SCREE; frequent roots; Not Sampled.

~Variable contact (1500 to 1600)

slightly moist; olive grey; very stiff; pinholed; clayey silt; Residual SILTSONE; Undisturbed Sample No. TP2.

~Undulating excavation depth

Test Pit Notes

Coordinates:	34°08.834' S 22°05.689' E
Method of Excavation:	TLB Type Light Mechanical Excavator- CAT 426F
Excavation Character:	Excavation Stopped due to maximum reach of the TLB Type Light Mechanical Excavator
Date Excavated:	20/06/2019
Date Profiled:	20/06/2019
Groundwater Seepage:	N/A
Samples Extracted:	1 Undisturbed Sample
Notes:	N/A
Profiled by:	Eugene van der Walt (Pri.Sci.Nat)

Terra Geotechnical Aalwyndal Housing Development

Soil Profile Photo of Test Pit TP2

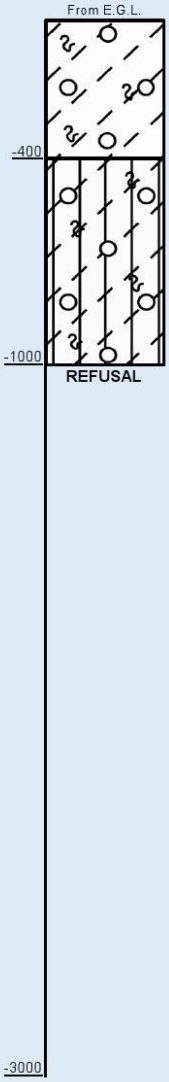
Terra Geotechnical Aalwyndal Housing Development

Material Present in Test Pit TP2

Terra Geotechnical

Site:	Development on Erf 21244
Project:	Aalwyndal Housing Development
Client:	Great Karoo Eco Investments

Soil Profile for Test Pit TP3



slightly moist; dark brown; stiff; shattered; clayey silt with frequent angular gravels; COLLUVIUM; frequent roots; Not Sampled.

slightly moist; greyish yellow brown; stiff; intact; clayey silt with frequent angular gravels; Residual SILTSONE; traces of roots; Not Sampled.

Test Pit Notes

Coordinates:	34°08,878' S 22°05.670' E
Method of Excavation:	TLB Type Light Mechanical Excavator- CAT 426F
Excavation Character:	Refusal on Bedrock at 1 m below existing ground level
Date Excavated:	20/06/2019
Date Profiled:	20/06/2019
Groundwater Seepage:	N/A
Samples Extracted:	N/A
Notes:	N/A
Profiled by:	Eugene van der Walt (Pri.Sci.Nat)

Terra Geotechnical Aalwyndal Housing Development

Soil Profile Photo of Test Pit TP3

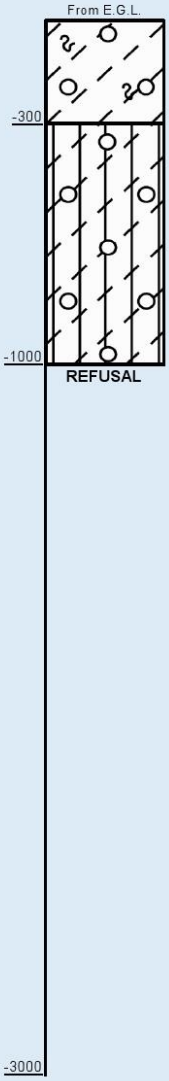
Terra Geotechnical Aalwyndal Housing Development

Material Present in Test Pit TP3

Terra Geotechnical

Site:	Development on Erf 21244
Project:	Aalwyndal Housing Development
Client:	Great Karoo Eco Investments

Soil Profile for Test Pit TP4



slightly moist; dark brown; stiff; shattered; clayey silt with frequent angular gravels; COLLUVIUM; frequent roots; Not Sampled.

slightly moist; yellowish orange brown; firm with soft patches; voided; clayey silt with frequent highly weathered quartz gravels and cobbles; residual SILTSONE; Bulk Sample No. 7136.

Test Pit Notes

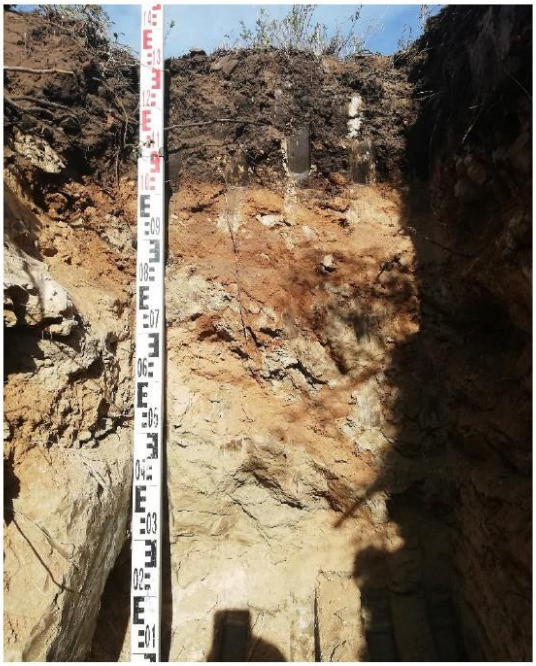
Coordinates:	34°08.921' S 22°05.652' E
Method of Excavation:	TLB Type Light Mechanical Excavator- CAT 426F
Excavation Character:	Refusal on Bedrock at 1 m below existing ground level
Date Excavated:	20/06/2019
Date Profiled:	20/06/2019
Groundwater Seepage:	N/A
Samples Extracted:	1 Bulk Sample
Notes:	Large Quartzite boulder encountered at the surface
Profiled by:	Eugene van der Walt (Pri.Sci.Nat)

Terra Geotechnical Aalwyndal Housing Development

Soil Profile Photo of Test Pit TP4

Terra Geotechnical Aalwyndal Housing Development

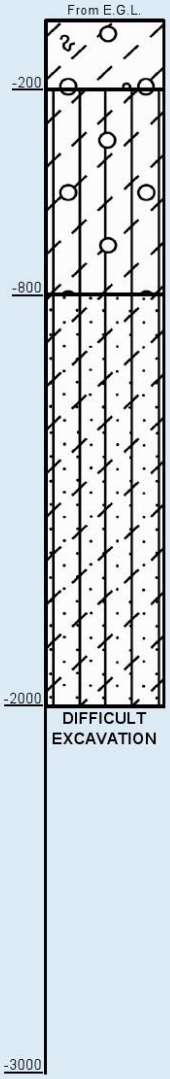
Material Present in Test Pit TP4



Terra Geotechnical

Site:	Development on Erf 21244
Project:	Aalwyndal Housing Development
Client:	Great Karoo Eco Investments

Soil Profile for Test Pit TP5



slightly moist; dark brown; stiff; shattered; clayey silt with frequent angular gravels; COLLUVIUM; frequent roots; Not Sampled.

slightly moist; yellowish orange brown; soft; voided; clayey silt with frequent highly weathered quartz gravels and cobbles; residual SILTSTONE; Bulk Sample No. 7133.

slightly moist; yellowish grey; firm; intact; frequent rounded and sub-rounded cobbles and boulders in a matrix of clayey sandy silt; Residual SILTSTONE; Not Sampled.

Test Pit Notes

Coordinates:	34°08.960' S 22°05.592' E
Method of Excavation:	TLB Type Light Mechanical Excavator- CAT 426F
Excavation Character:	Difficult Excavation on Bedrock at 2 m below existing ground level
Date Excavated:	20/06/2019
Date Profiled:	20/06/2019
Groundwater Seepage:	N/A
Samples Extracted:	1 Bulk Sample
Notes:	N/A
Profiled by:	Eugene van der Walt (Pri.Sci.Nat)

Terra Geotechnical Aalwyndal Housing Development

Soil Profile Photo of Test Pit TP5

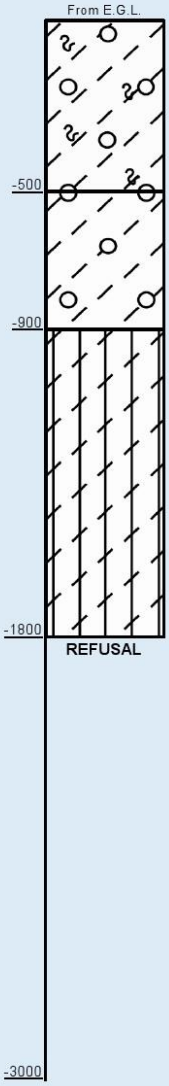
Terra Geotechnical Aalwyndal Housing Development

Material Present in Test Pit TP5

Terra Geotechnical

Site:	Development on Erf 21244
Project:	Aalwyndal Housing Development
Client:	Great Karoo Eco Investments

Soil Profile for Test Pit TP6



slightly moist; dark brown; stiff; shattered; clayey silt with frequent angular gravels; COLLUVIUM; frequent roots; Not Sampled.

slightly moist; yellowish orange brown; soft; voided; clayey silt with frequent highly weathered quartz gravels and cobbles; ALLUVIUM; Not Sampled.

slightly moist; olive grey; very stiff; pinhole voided; clayey silt; residual SILTSONE; Not Sampled.

Test Pit Notes

Coordinates:	34°08.960' S 22°05.592' E
Method of Excavation:	TLB Type Light Mechanical Excavator- CAT 426F
Excavation Character:	Refusal on Bedrock at 1,8 m below existing ground level
Date Excavated:	20/06/2019
Date Profiled:	20/06/2019
Groundwater Seepage:	N/A
Samples Extracted:	N/A
Notes:	N/A
Profiled by:	Eugene van der Walt (Pri.Sci.Nat)

Terra Geotechnical Aalwyndal Housing Development

Soil Profile Photo of Test Pit TP6

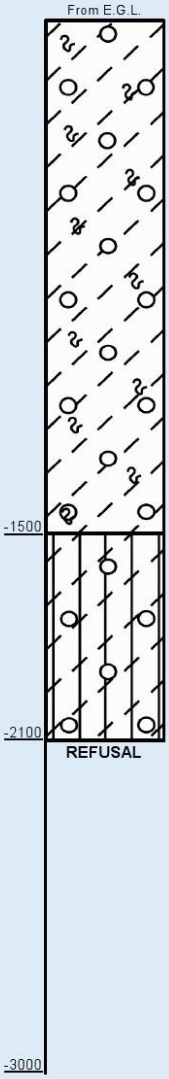
Terra Geotechnical Aalwyndal Housing Development

Material Present in Test Pit TP6

Terra Geotechnical

Site:	Development on Erf 21244
Project:	Aalwyndal Housing Development
Client:	Great Karoo Eco Investments

Soil Profile for Test Pit TP7



slightly moist; dark brown; stiff; slickensided; clayey silt with frequent sub-angular gravels; ALLUVIUM; frequent roots; Bulk Sample No. 7135.

slightly moist; yellowish orange brown; stiff; intact; clayey silt with frequent highly weathered quartz gravels and cobbles; residual SILTSONE; Not Sampled.

Test Pit Notes

Coordinates:	34°08.915' S 22°05.522' E
Method of Excavation:	TLB Type Light Mechanical Excavator- CAT 426F
Excavation Character:	Refusal on Bedrock at 2,1 m below existing ground level
Date Excavated:	20/06/2019
Date Profiled:	20/06/2019
Groundwater Seepage:	N/A
Samples Extracted:	1 Bulk Sample
Notes:	N/A
Profiled by:	Eugene van der Walt (Pri.Sci.Nat)

Terra Geotechnical Aalwyndal Housing Development

Soil Profile Photo of Test Pit TP7

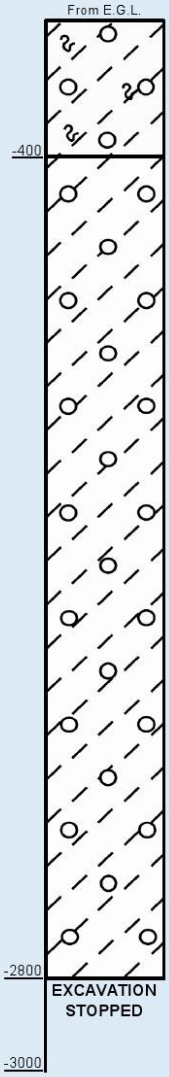
Terra Geotechnical Aalwyndal Housing Development

Material Present in Test Pit TP7

Terra Geotechnical

Site:	Development on Erf 21244
Project:	Aalwyndal Housing Development
Client:	Great Karoo Eco Investments

Soil Profile for Test Pit TP8



slightly moist; dark brown; stiff; slickensided; clayey silt with frequent sub-angular gravels; ALLUVIUM; frequent roots; Not Sampled.

~Undulating contact (300 to 400)

slightly moist; dark brown; stiff; slickensided; clayey silt with frequent gravels and scattered cobbles; ALLUVIUM; Bulk Sample No. 7146; Undisturbed Sample No. TP8.

Test Pit Notes

Coordinates:	34°08.875' S 22°05.579' E
Method of Excavation:	TLB Type Light Mechanical Excavator- CAT 426F
Excavation Character:	Excavation Stopped due to maximum reach of the TLB Type Light Mechanical Excavator
Date Excavated:	20/06/2019
Date Profiled:	20/06/2019
Groundwater Seepage:	N/A
Samples Extracted:	1 Bulk Sample, 1 Undisturbed Sample
Notes:	N/A
Profiled by:	Eugene van der Walt (Pri.Sci.Nat)

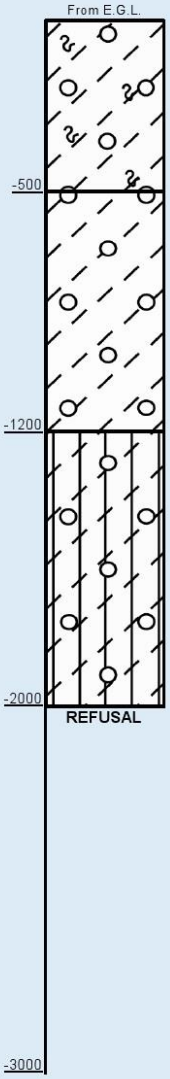
Terra Geotechnical Aalwyndal Housing Development

Soil Profile Photo of Test Pit TP8

Terra Geotechnical

Site:	Development on Erf 21244
Project:	Aalwyndal Housing Development
Client:	Great Karoo Eco Investments

Soil Profile for Test Pit TP9



slightly moist; dark brown; stiff; slickensided; clayey silt with frequent sub-angular gravels; COLLUVIUM; frequent roots; Not Sampled.

~Undulating contact (400 to 500)

slightly moist; dark brown; stiff; slickensided; clayey silt with frequent gravels and scattered cobbles; ALLUVIUM; Not Sampled.

slightly moist; greyish yellow brown; very stiff; pinhole voided; clayey silt with frequent rounded and sub-rounded gravels; residual SILTSTONE; Not Sampled.

Test Pit Notes

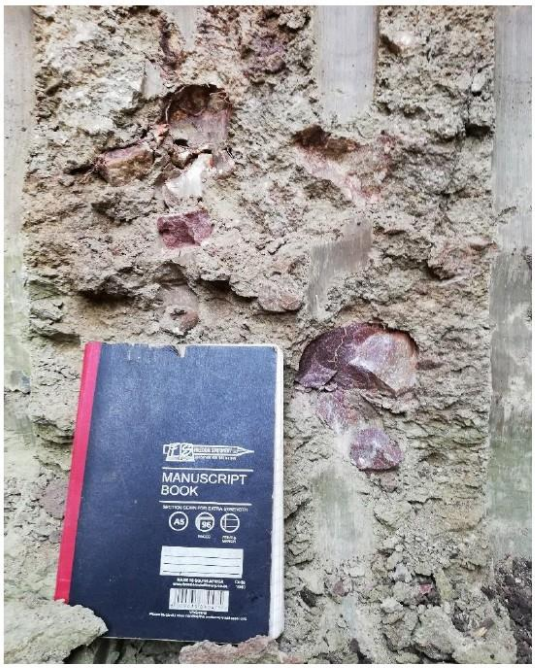
Coordinates:	34°08.830' S 22°05.611' E
Method of Excavation:	TLB Type Light Mechanical Excavator- CAT 426F
Excavation Character:	Refusal on Bedrock at 2 m below existing ground level
Date Excavated:	20/06/2019
Date Profiled:	20/06/2019
Groundwater Seepage:	N/A
Samples Extracted:	N/A
Notes:	N/A
Profiled by:	Eugene van der Walt (Pri.Sci.Nat)

Terra Geotechnical Aalwyndal Housing Development

Soil Profile Photo of Test Pit TP9

Terra Geotechnical Aalwyndal Housing Development

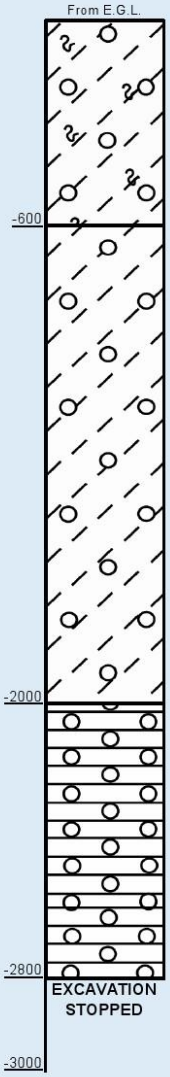
Material Present in Test Pit TP9



Terra Geotechnical

Site:	Development on Erf 21244
Project:	Aalwyndal Housing Development
Client:	Great Karoo Eco Investments

Soil Profile for Test Pit TP10



slightly moist; dark brown; stiff; shattered; clayey silt with frequent sub-angular gravels; ALLUVIUM; frequent roots & organic material; Not Sampled.

~Undulating contact (500 to 600)

slightly moist; dark brown; stiff; slickensided; clayey silt with scattered gravels; ALLUVIUM; Bulk Sample No. 7134.

slightly moist; greenish brown; very stiff; pinhole voided; clayey silt with frequent angular and sub-angular gravels; residual SILTSTONE; Not Sampled.

Test Pit Notes

Coordinates:	34°08.787' S 22°05.634' E
Method of Excavation:	TLB Type Light Mechanical Excavator- CAT 426F
Excavation Character:	Excavation Stopped due to maximum reach of the TLB Type Light Mechanical Excavator
Date Excavated:	20/06/2019
Date Profiled:	20/06/2019
Groundwater Seepage:	N/A
Samples Extracted:	1 Bulk Sample
Notes:	N/A
Profiled by:	Eugene van der Walt (Pri.Sci.Nat)

Terra Geotechnical Aalwyndal Housing Development

Soil Profile Photo of Test Pit TP10

Terra Geotechnical Aalwyndal Housing Development

Material Present in Test Pit TP10

Appendix C

Laboratory Results

ROADLAB MOSSLAB JV

Civil Engineering Materials Laboratory

7 Bally Crescent, Voorbaai, Mossel Bay
Tel. : (044) 695 2387
P.O. Box 35, Hartenbos, 6520
e-mail : mosslab@roadlab.co.za

sanas Testing Laboratory T0716

Client:	Great Karoo Eco Investments Bus 38 Rietbron 6450	Date Reported: 15/07/2019	Job nr: M12828
		Specification: COLTO	Order no: -
Attention:	**Kobus Steyn, 0815864848**	Project: Development of Erf 21244, Voorbaai, Mossel Bay	

SOIL ANALYSIS TEST REPORT

SAMPLE INFORMATION

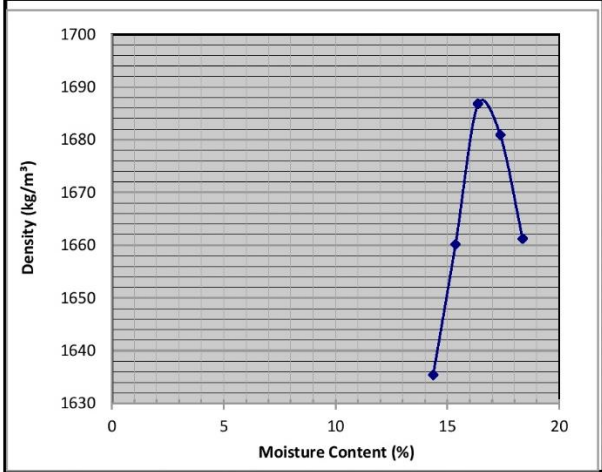
Material Description	Silty Clay		
Source	TP 1	Position/ Layer	NGL -800 to -1700mm
Date Received	20/06/2019	Date Tested	09/07/2019
Sampling Method	TMH5	Sample Number	7147

MOD , BD & AD Analysis

MDD	1687	kg/m³	OMC	16.4	%
BD	-		WA	-	
AD	-				
Method	Crushed		% Scalped	0.0	%

Uncertainty

MDD		kg/m³	OMC		%



Fractured Faces

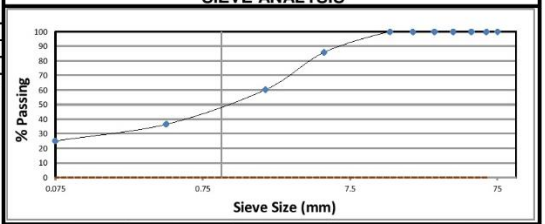
Size	Fractured Faces %		Size	Fractured Faces %		
37.5			14			#N/A
28			5			
20			All>5			

✓	In Spec
×	Out of Spec
□	Even with a 95%Certainty, Reading could be Out of Spec.

MATERIAL PROPERTIES

GRADING Sieve Size	% Passing	G6 Specifications	Uncertainty	Opinion ✓ or x
75	100			
63	100			
50	100			
37.5	100			
28	100			
20	100			
14	100			
5	86			
2	60			
0.425	36			
0.075	25.0			

SIEVE ANALYSIS



Test	Results	Specifications		Opinion
Grading Modulus	1.8	1.2<2.6		✓
Coarse Sand Ratio	39	N/A		
Strength (kN)				
10% FACT (Dry)		Mudrock Only		
10% FACT (Wet)				
Wet/Dry Rel. (%)				
CBR				
Moulding MC%	16.9			
CBR @ 98%	34			
CBR @ 97%	32	-		
CBR @ 95%	28	Min 25		✓
CBR @ 93%	25			
CBR @ 90%	21	-		
Swell				
Swell @ 100%	0.1	Max 1.0%		✓
Durability (%)				
ACV (Dry)				
ACV (Wet)				
Flakiness Index				
20mm<28mm				
14mm<20mm				
Atterberg Limits				
-0.425mm				
Liquid Limit	29			
Plastic Limit	22			
Linear Shrinkage	3.0	Max 5		✓
LSx%Pass0.425	109			
Plasticity index	8	Max 13.6		✓
-0.075mm				
Liquid Limit	-			
Plastic Limit	-			
Linear Shrinkage	-			
Plasticity index	-			
Classification:	**G6**			

Jacobus Phillipus Van Rensburg
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Jaco van Rensburg

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ROADLAB MOSSLAB JV

Civil Engineering Materials Laboratory

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sanas Testing Laboratory T0716

Client:	Great Karoo Eco Investments Bus 38 Rietbron 6450	Date Reported: 15/07/2019	Job nr: M12828
		Specification: COLTO	Order no: -
Attention:	**Kobus Steyn, 0815864848**	Project: Development of Erf 21244, Voorbaai, Mossel Bay	

SOIL ANALYSIS TEST REPORT

SAMPLE INFORMATION

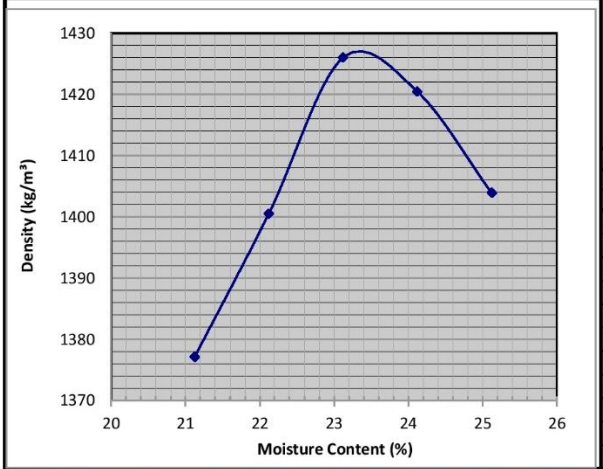
Material Description	Silty Clay		
Source	TP 4	Position/ Layer	NGL -300 to -1400mm
Date Received	20/06/2019	Date Tested	09/07/2019
Sampling Method	TMH5	Sample Number	7136

MOD , BD & AD Analysis

MDD	1426	kg/m³	OMC	23.1	%
BD	-		WA	-	
AD	-				
Method	Crushed		% Scalped	0.0	%

Uncertainty

MDD		kg/m³	OMC		%



Fractured Faces

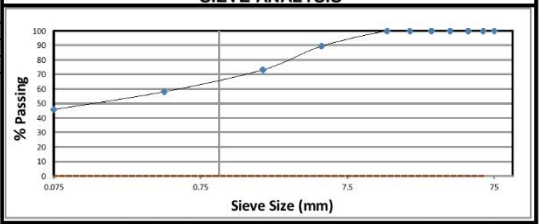
Size	Fractured Faces %		Size	Fractured Faces %		
37.5			14			#N/A
28			5			
20			All>5			

✓	In Spec
×	Out of Spec
□	Even with a 95%Certainty, Reading could be Out of Spec.

MATERIAL PROPERTIES

GRADING Sieve Size	% Passing	G6 Specifications	Uncertainty	Opinion ✓ or x
75	100			
63	100			
50	100			
37.5	100			
28	100			
20	100			
14	100			
5	89			
2	73			
0.425	58			
0.075	45.8			

SIEVE ANALYSIS



Test	Results	Specifications		Opinion
Grading Modulus	1.2	1.2<2.6		✓
Coarse Sand Ratio	21	N/A		
Strength (kN)				
10% FACT (Dry)		Mudrock Only		
10% FACT (Wet)				
Wet/Dry Rel. (%)				
CBR				
Moulding MC%	23.6			
CBR @ 98%	48			
CBR @ 97%	41	-		
CBR @ 95%	29	Min 25		✓
CBR @ 93%	21			
CBR @ 90%	13	-		
Swell				
Swell @ 100%	0.2	Max 1.0%		✓
Durability (%)				
ACV (Dry)				
ACV (Wet)				
Flakiness Index				
20mm<28mm				
14mm<20mm				
Atterberg Limits				
-0.425mm				
Liquid Limit	26			
Plastic Limit	17			
Linear Shrinkage	4.0	Max 5		✓
LSx%Pass0.425	232			
Plasticity index	9	Max 12.5		✓
-0.075mm				
Liquid Limit	-			
Plastic Limit	-			
Linear Shrinkage	-			
Plasticity index	-			
Classification:	**G6**			

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ROADLAB MOSSLAB JV

Civil Engineering Materials Laboratory

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P.O. Box 35, Hartenbos, 6520
e-mail : mosslab@roadlab.co.za

sanas Testing Laboratory T0716

Client:	Great Karoo Eco Investments Bus 38 Rietbron 6450	Date Reported: 15/07/2019	Job nr: M12828
		Specification: COLTO	Order no: -
Attention:	**Kobus Steyn, 0815864848**	Project: Development of Erf 21244, Voorbaai, Mossel Bay	

SOIL ANALYSIS TEST REPORT

SAMPLE INFORMATION

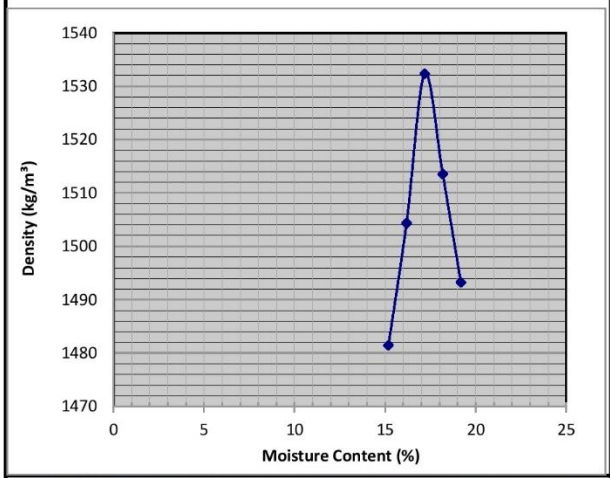
Material Description	Clayey Silt		
Source	TP 5	Position/ Layer	NGL -200 to -800mm
Date Received	20/06/2019	Date Tested	09/07/2019
Sampling Method	TMH5	Sample Number	7133

MOD , BD & AD Analysis

MDD	1532	kg/m³	OMC	17.2	%
BD	-		WA	-	
AD	-				
Method	Crushed		% Scalped	0.0	%

Uncertainty

MDD		kg/m³	OMC		%



Fractured Faces

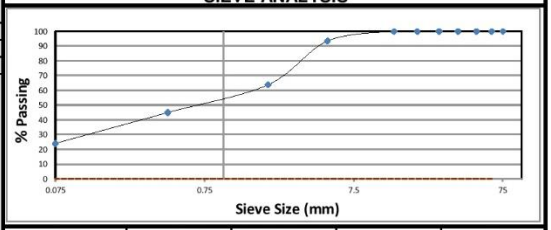
Size	Fractured Faces %		Size	Fractured Faces %		
37.5			14			#N/A
28			5			
20			All>5			

✓	In Spec
×	Out of Spec
□	Even with a 95%Certainty, Reading could be Out of Spec.

MATERIAL PROPERTIES

GRADING Sieve Size	% Passing	G8 Specifications	Uncertainty	Opinion ✓ or x
75	100			
63	100			
50	100			
37.5	100			
28	100			
20	100			
14	100			
5	93			
2	64			
0.425	45			
0.075	24.0			

SIEVE ANALYSIS



Test	Results	Specifications		Opinion
Grading Modulus	1.7	0.75<2.7		✓
Coarse Sand Ratio	30	N/A		
Strength (kN)				
10% FACT (Dry)		Mudrock Only		
10% FACT (Wet)				
Wet/Dry Rel. (%)				
CBR				
Moulding MC%	17.6			
CBR @ 98%	18			
CBR @ 97%	16	-		
CBR @ 95%	14			
CBR @ 93%	11	Min 10		✓
CBR @ 90%	9	-		
Swell				
Swell @ 100%	0.3	Max 1.5%		✓
Durability (%)				
ACV (Dry)				
ACV (Wet)				
Flakiness Index				
20mm<28mm				
14mm<20mm				
Atterberg Limits				
-0.425mm				
Liquid Limit	26			
Plastic Limit	12			
Linear Shrinkage	6.0			
LSx%Pass0.425	270			
Plasticity index	13	Max 15		✓
-0.075mm				
Liquid Limit	-			
Plastic Limit	-			
Linear Shrinkage	-			
Plasticity index	-			
Classification:	**G8**			

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Client:	Great Karoo Eco Investments Bus 38 Rietbron 6450	Date Reported: 15/07/2019	Job nr: M12828
		Specification: COLTO	Order no: -
Attention:	**Kobus Steyn, 0815864848**	Project: Development of Erf 21244, Voorbaai, Mossel Bay	

SOIL ANALYSIS TEST REPORT

SAMPLE INFORMATION

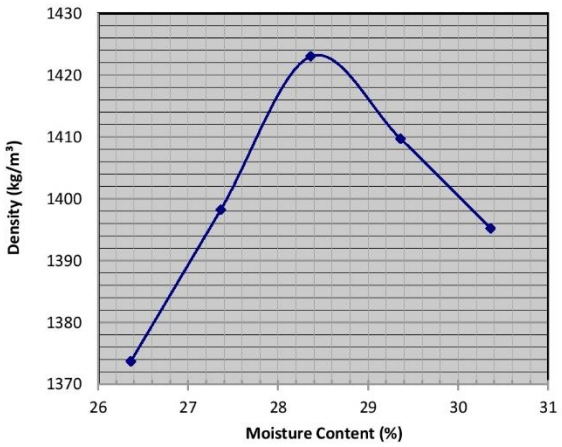
Material Description	Silty Clay		
Source	TP 7	Position/ Layer	NGL 0 to -1500mm
Date Received	20/06/2019	Date Tested	09/07/2019
Sampling Method	TMH5	Sample Number	7135

MOD , BD & AD Analysis

MDD	1423	kg/m³	OMC	28.4	%
BD	-		WA	-	
AD	-				
Method	Crushed		% Scalped	4.5	%

Uncertainty

MDD		kg/m³	OMC		%



Fractured Faces

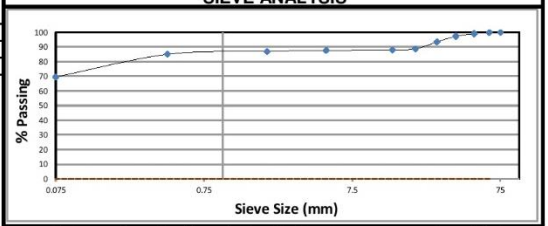
Size	Fractured Faces %		Size	Fractured Faces %		
37.5			14			#N/A
28			5			
20			All>5			

✓	In Spec
×	Out of Spec
□	Even with a 95%Certainty, Reading could be Out of Spec.

MATERIAL PROPERTIES

GRADING Sieve Size	% Passing	G9 Specifications	Uncertainty	Opinion ✓ or x
75	100			
63	100			
50	99			
37.5	97			
28	93			
20	89			
14	88			
5	88			
2	87			
0.425	85			
0.075	69.5			

SIEVE ANALYSIS



Test	Results	Specifications		Opinion
Grading Modulus	0.6	0.75<2.7		×
Coarse Sand Ratio	2	N/A		
Strength (kN)				
10% FACT (Dry)		Mudrock Only		
10% FACT (Wet)				
Wet/Dry Rel. (%)				
CBR				
Moulding MC%	28.6			
CBR @ 98%	1			
CBR @ 97%	1	-		
CBR @ 95%	1			
CBR @ 93%	1	Min 7		×
CBR @ 90%	0	-		
Swell				
Swell @ 100%	6.2	Swell<1.5%		×
Durability (%)				
ACV (Dry)				
ACV (Wet)				
Flakiness Index				
20mm<28mm				
14mm<20mm				
Atterberg Limits				
-0.425mm				
Liquid Limit	62			
Plastic Limit	37			
Linear Shrinkage	9.5			
LSx%Pass0.425	808			
Plasticity index	25	Max 12		×
-0.075mm				
Liquid Limit	-			
Plastic Limit	-			
Linear Shrinkage	-			
Plasticity index	-			
Classification:	**<G9**			

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ROADLAB MOSSLAB JV

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sanas Testing Laboratory T0716

Client:	Great Karoo Eco Investments Bus 38 Rietbron 6450	Date Reported: 15/07/2019	Job nr: M12828
		Specification: COLTO	Order no: -
Attention:	**Kobus Steyn, 0815864848**	Project: Development of Erf 21244, Voorbaai, Mossel Bay	

SOIL ANALYSIS TEST REPORT

SAMPLE INFORMATION

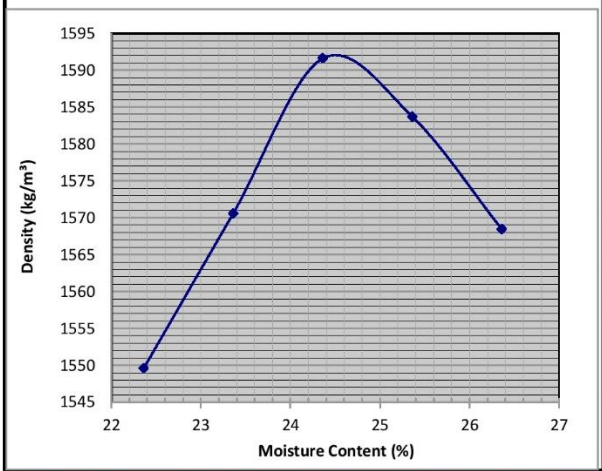
Material Description	Silty Clay		
Source	TP 8	Position/ Layer	NGL -400 tto -2800mm
Date Received	20/06/2019	Date Tested	09/07/2019
Sampling Method	TMH5	Sample Number	7146

MOD , BD & AD Analysis

MDD	1592	kg/m³	OMC	24.4	%
BD	-		WA	-	
AD	-				
Method	Crushed		% Scalped	12.2	%

Uncertainty

MDD		kg/m³	OMC		%



Fractured Faces

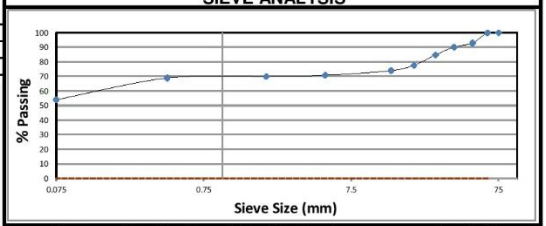
Size	Fractured Faces %		Size	Fractured Faces %		
37.5			14			#N/A
28			5			
20			All>5			

✓	In Spec
×	Out of Spec
□	Even with a 95%Certainty, Reading could be Out of Spec.

MATERIAL PROPERTIES

GRADING Sieve Size	% Passing	G9 Specifications	Uncertainty	Opinion ✓ or x
75	100			
63	100			
50	93			
37.5	90			
28	85			
20	78			
14	74			
5	71			
2	70			
0.425	69			
0.075	54.0			

SIEVE ANALYSIS



Test	Results	Specifications		Opinion
Grading Modulus	1.1	0.75<2.7		✓
Coarse Sand Ratio	2	N/A		
Strength (kN)				
10% FACT (Dry)		Mudrock Only		
10% FACT (Wet)				
Wet/Dry Rel. (%)				
CBR				
Moulding MC%	24.6			
CBR @ 98%	2			
CBR @ 97%	2	-		
CBR @ 95%	2			
CBR @ 93%	1	Min 7		×
CBR @ 90%	1	-		
Swell				
Swell @ 100%	3.1	Swell<1.5%		×
Durability (%)				
ACV (Dry)				
ACV (Wet)				
Flakiness Index				
20mm<28mm				
14mm<20mm				
Atterberg Limits				
-0.425mm				
Liquid Limit	64			
Plastic Limit	35			
Linear Shrinkage	13.5			
LSx%Pass0.425	930			
Plasticity index	29	Max 13.2		×
-0.075mm				
Liquid Limit	-			
Plastic Limit	-			
Linear Shrinkage	-			
Plasticity index	-			
Classification:	**<G9**			

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Digitally signed by Jacobus Phillipus Van Rensburg Date: 2019.07.15 18:39:17 +02'00'

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sanas Testing Laboratory T0716

Client:	Great Karoo Eco Investments Bus 38 Rietbron 6450	Date Reported: 15/07/2019	Job nr: M12828
		Specification: COLTO	Order no: -
Attention:	**Kobus Steyn, 0815864848**	Project: Development of Erf 21244, Voorbaai, Mossel Bay	

SOIL ANALYSIS TEST REPORT

SAMPLE INFORMATION

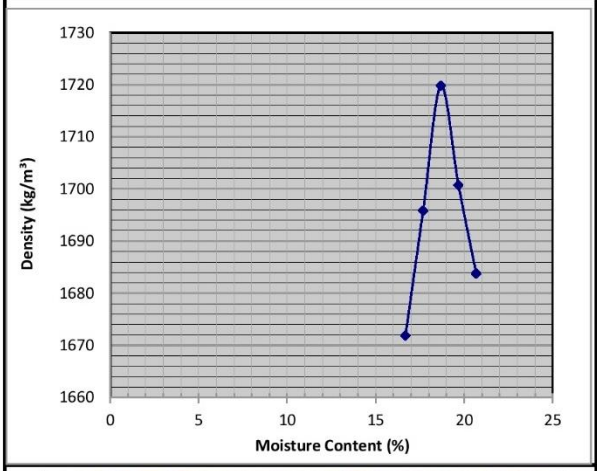
Material Description	Silty Clay		
Source	TP 10	Position/ Layer	NGL -600 to -2000mm
Date Received	20/06/2019	Date Tested	09/07/2019
Sampling Method	TMH5	Sample Number	7134

MOD , BD & AD Analysis

MDD	1720	kg/m³	OMC	18.7	%
BD	-		WA	-	
AD	-				
Method	Crushed		% Scalped	1.9	%

Uncertainty

MDD		kg/m³	OMC		%



Fractured Faces

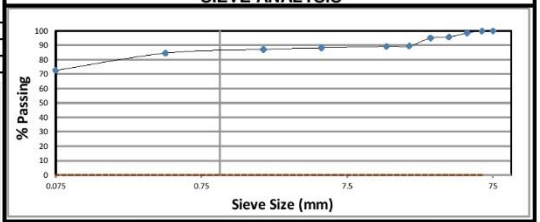
Size	Fractured Faces %		Size	Fractured Faces %		
37.5			14			#N/A
28			5			
20			All>5			

✓	In Spec
×	Out of Spec
□	Even with a 95%Certainty, Reading could be Out of Spec.

MATERIAL PROPERTIES

GRADING Sieve Size	% Passing	G9 Specifications	Uncertainty	Opinion ✓ or x
75	100			
63	100			
50	99			
37.5	96			
28	95			
20	89			
14	89			
5	88			
2	87			
0.425	85			
0.075	72.5			

SIEVE ANALYSIS



Test	Results	Specifications		Opinion
Grading Modulus	0.6	0.75<2.7		×
Coarse Sand Ratio	3	N/A		
Strength (kN)				
10% FACT (Dry)		Mudrock Only		
10% FACT (Wet)				
Wet/Dry Rel. (%)				
CBR				
Moulding MC%	18.8			
CBR @ 98%	2			
CBR @ 97%	2	-		
CBR @ 95%	2			
CBR @ 93%	1	Min 7		×
CBR @ 90%	1	-		
Swell				
Swell @ 100%	3.7	Swell<1.5%		×
Durability (%)				
ACV (Dry)				
ACV (Wet)				
Flakiness Index				
20mm<28mm				
14mm<20mm				
Atterberg Limits				
-0.425mm				
Liquid Limit	41			
Plastic Limit	22			
Linear Shrinkage	6.5			
LSx%Pass0.425	550			
Plasticity index	19	Max 12		×
-0.075mm				
Liquid Limit	-			
Plastic Limit	-			
Linear Shrinkage	-			
Plasticity index	-			
Classification:	**<G9**			

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Jaco van Rensburg

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ROADLAB MOSSLAB JV

Civil Engineering Materials Laboratory

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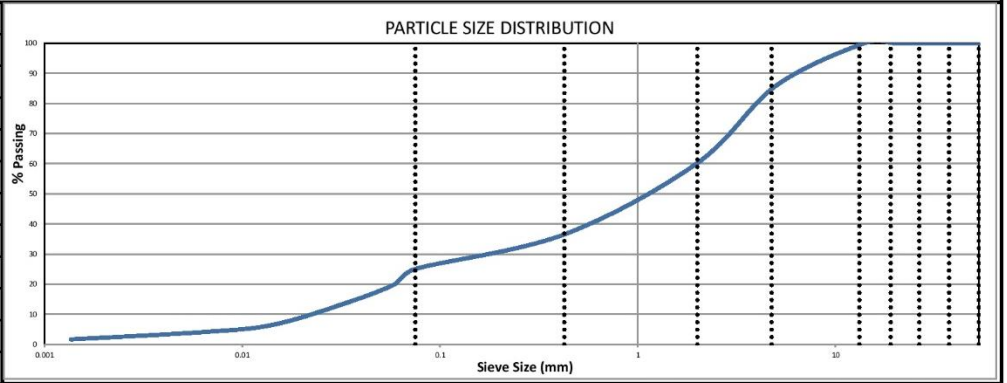
sanas Testing Laboratory T0716

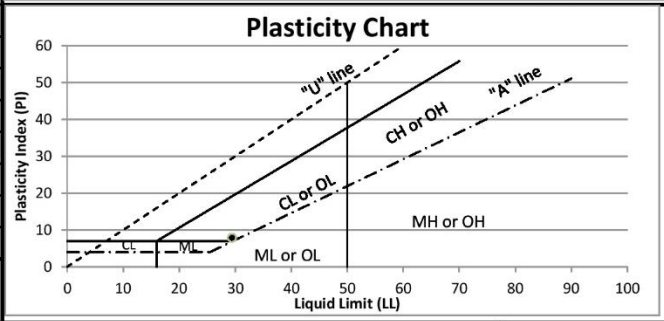
Client:	Great Karoo Eco Investments	Date:	15 July 2019	Job nr:	M12828
	Bus 38			Sample Number	7147
	Rietbron	Specification:	USCS	Order no:	-
	6450	Project:	Development of Erf 21244, Voorbaai, Mossel Bay		
Attention:	Kobus Steyn, 0815864848				

FOUNDATION INDICATOR TEST REPORT

Material Description	Silty Clay			Depth	NGL -800 to -1700mm	Date Received	20/06/2019
Source	Test Pit	Position/ Layer	TP 1	Moisture Content	-	Date Tested	27/06/2019

Sieve Size	% Pass
75	100
63	100
50	100
37.5	100
28	100
20	100
14	100
5	86
2	60
0.425	36
0.075	25.0
0.0589	19.9
0.0349	14.1
0.0147	6.6
0.0066	4.2
0.0014	1.7
Grading Modulus	1.8



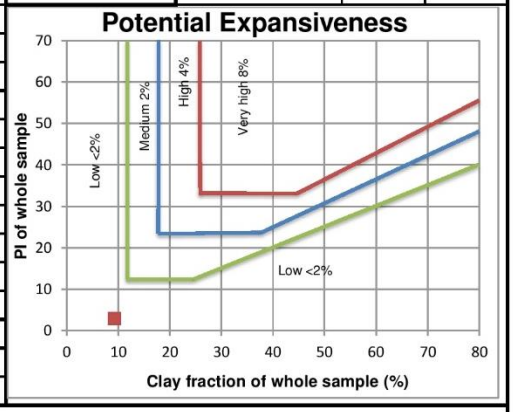


Activity	4.03	**Active**
USCS² Classification	Sandy ML	
NHBRC Classification		
USCS²	Lean Clay	CL
	Silt	ML
	Organic Clay	OL
	Fat Clay	CH
	Elastic Silt	MH
	Organic Silt	OH
Activity	< 0.75	Inactive
	0.75 - 1.25	Normal
	>1.25	Active

Atterberg Limits			
Liquid Limit	LL	29	%
Plastic Limit	PL	22	%
Linear Shrinkage	LS	3.2	%
Plasticity Index	PI_{425}	8	%

Grain Size Distribution¹				
Gravel	Coarse	75 - 20mm	0.0	%
	Fine	20 - 5.00mm	14.1	%
Sand	Coarse	5.00 - 2,00mm	25.7	%
	Medium	2,00 - 0,425mm	23.7	%
	Fine	0,425 - 0,075mm	11.5	%
Silt		0,075 - 0,002mm	23.1	%
Clay		<0,002mm	2.0	%

Swell			
M/C at compaction (%)	16.9	Swell after 4 days (%)	0.1



*1 Unified Soil Classification system on grain size
*2 Unified Soil Classification system

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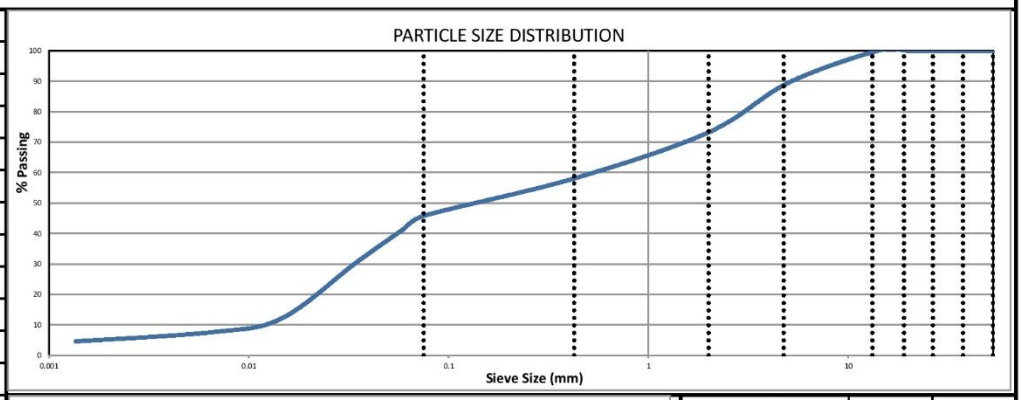
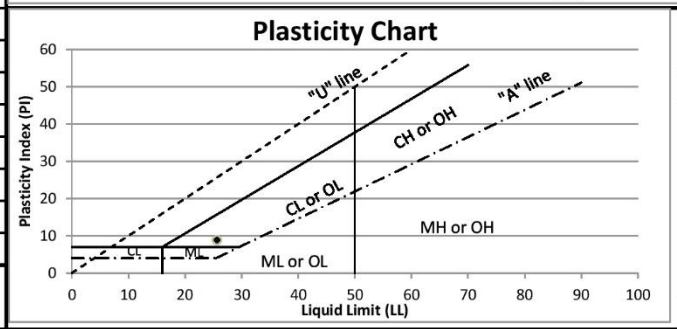
Client:	Great Karoo Eco Investments	Date:	15 July 2019	Job nr:	M12828
	Bus 38			Sample Number	7136
	Rietbron	Specification:	USCS	Order no:	-
	6450	Project:	Development of Erf 21244, Voorbaai, Mossel Bay		
Attention:	Kobus Steyn, 0815864848				

FOUNDATION INDICATOR TEST REPORT

Material Description	Silty Clay			Depth	NGL -300 to -1400mm	Date Received	20/06/2019
Source	Test Pit	Position/ Layer	TP 4	Moisture Content	-	Date Tested	27/06/2019

Sieve Size	% Pass
75	100
63	100
50	100
37.5	100
28	100
20	100
14	100
5	89
2	73
0.425	58
0.075	45.8
0.0583	41.0
0.0344	30.4
0.0147	12.1
0.0066	7.6
0.0014	4.6
Grading Modulus	1.2



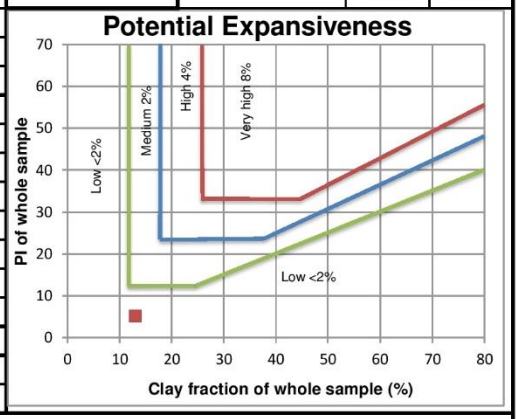


Activity	1.80	**Active**
USCS² Classification	Sandy ML	
NHBRC Classification		
USCS²	Lean Clay	CL
	Silt	ML
	Organic Clay	OL
	Fat Clay	CH
	Elastic Silt	MH
	Organic Silt	OH
Activity	< 0.75	Inactive
	0.75 - 1.25	Normal
	>1.25	Active

Atterberg Limits			
Liquid Limit	LL	26	%
Plastic Limit	PL	17	%
Linear Shrinkage	LS	3.6	%
Plasticity Index	PI_{425}	9	%

Grain Size Distribution¹				
Gravel	Coarse	75 - 20mm	0.0	%
	Fine	20 - 5.00mm	10.5	%
Sand	Coarse	5.00 - 2,00mm	16.3	%
	Medium	2,00 - 0,425mm	15.1	%
	Fine	0,425 - 0,075mm	12.3	%
Silt		0,075 - 0,002mm	40.8	%
Clay		<0,002mm	4.9	%

Swell			
M/C at compaction (%)	23.6	Swell after 4 days (%)	0.2



*1 Unified Soil Classification system on grain size
*2 Unified Soil Classification system

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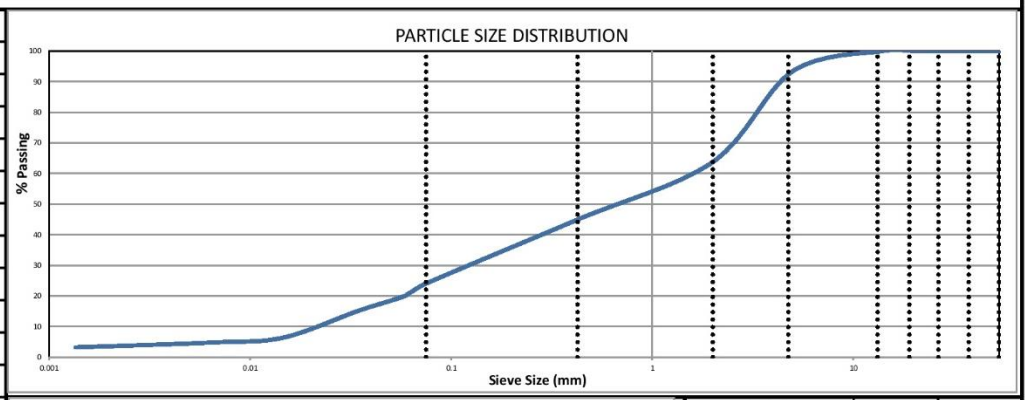
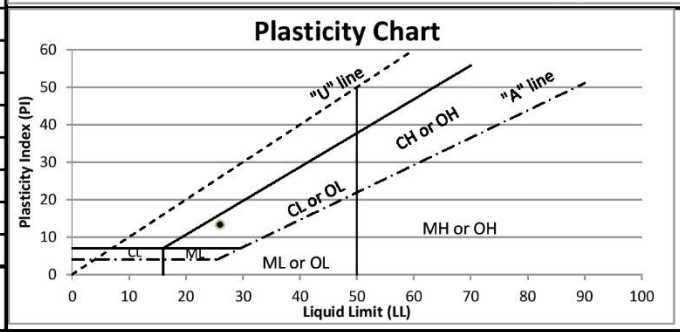
Client:	Great Karoo Eco Investments	Date:	15 July 2019	Job nr:	M12828
	Bus 38			Sample Number	7133
	Rietbron	Specification:	USCS	Order no:	-
	6450	Project:	Development of Erf 21244, Voorbaai, Mossel Bay		
Attention:	Kobus Steyn, 0815864848				

FOUNDATION INDICATOR TEST REPORT

Material Description	Clayey Silt			Depth	NGL -200 to -800mm	Date Received	20/06/2019
Source	Test Pit	Position/ Layer	TP 5	Moisture Content	-	Date Tested	25/06/2019

Sieve Size	% Pass
75	100
63	100
50	100
37.5	100
28	100
20	100
14	100
5	93
2	64
0.425	45
0.075	24.0
0.0585	19.9
0.0346	15.2
0.0147	6.4
0.0066	4.8
0.0014	3.2
Grading Modulus	1.7



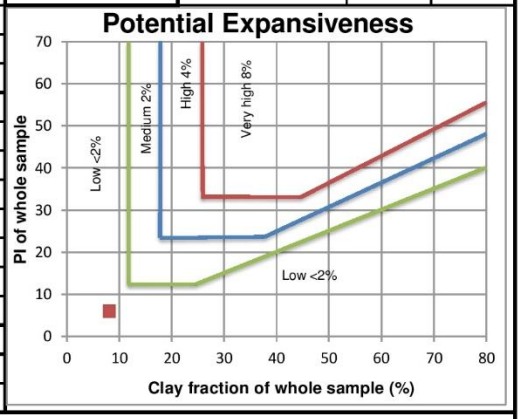


Activity	3.93	**Active**
USCS² Classification	Sandy ML	
NHBRC Classification		
USCS²	Lean Clay	CL
	Silt	ML
	Organic Clay	OL
	Fat Clay	CH
	Elastic Silt	MH
	Organic Silt	OH
Activity	< 0.75	Inactive
	0.75 - 1.25	Normal
	>1.25	Active

Atterberg Limits			
Liquid Limit	LL	26	%
Plastic Limit	PL	13	%
Linear Shrinkage	LS	5.9	%
Plasticity Index	PI_{425}	13	%

Grain Size Distribution¹				
Gravel	Coarse	75 - 20mm	0.0	%
	Fine	20 - 5.00mm	6.6	%
Sand	Coarse	5.00 - 2,00mm	29.7	%
	Medium	2,00 - 0,425mm	18.8	%
	Fine	0,425 - 0,075mm	20.9	%
Silt		0,075 - 0,002mm	20.6	%
Clay		<0,002mm	3.4	%

Swell			
M/C at compaction (%)	17.6	Swell after 4 days (%)	0.3



*1 Unified Soil Classification system on grain size
*2 Unified Soil Classification system

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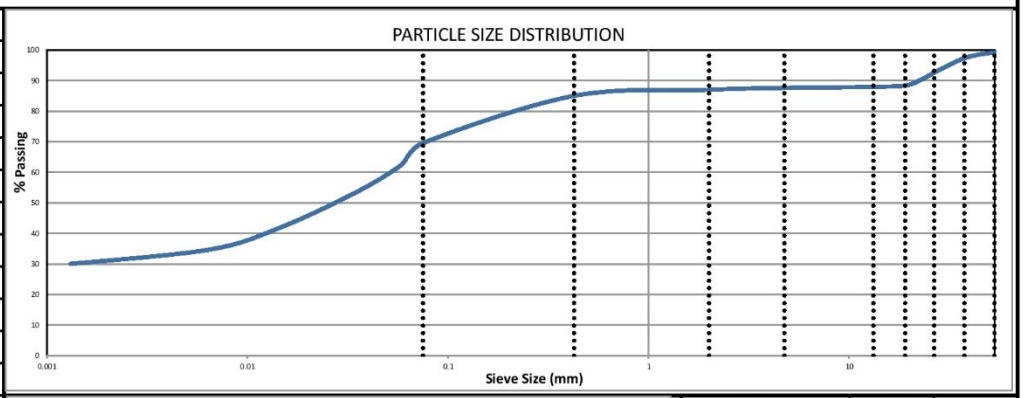
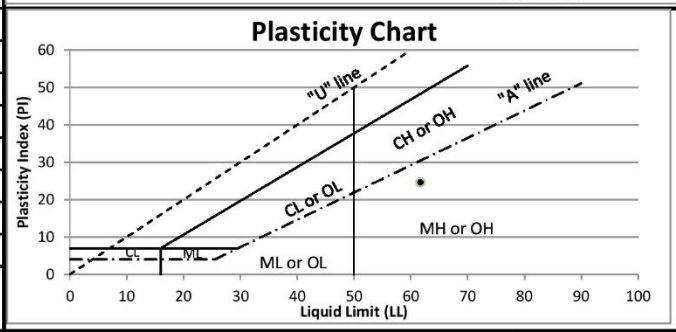
Client:	Great Karoo Eco Investments	Date:	15 July 2019	Job nr:	M12828
	Bus 38			Sample Number	7135
	Rietbron	Specification:	USCS	Order no:	-
	6450	Project:	Development of Erf 21244, Voorbaai, Mossel Bay		
Attention:	Kobus Steyn, 0815864848				

FOUNDATION INDICATOR TEST REPORT

Material Description	Silty Clay			Depth	NGL 0 to -1500mm	Date Received	20/06/2019
Source	Test Pit	Position/ Layer	TP 7	Moisture Content	-	Date Tested	27/06/2019

Sieve Size	% Pass
75	100
63	100
50	99
37.5	97
28	93
20	89
14	88
5	88
2	87
0.425	85
0.075	69.5
0.0583	62.3
0.0340	53.1
0.0141	41.6
0.0064	34.6
0.0013	30.0
Grading Modulus	0.6



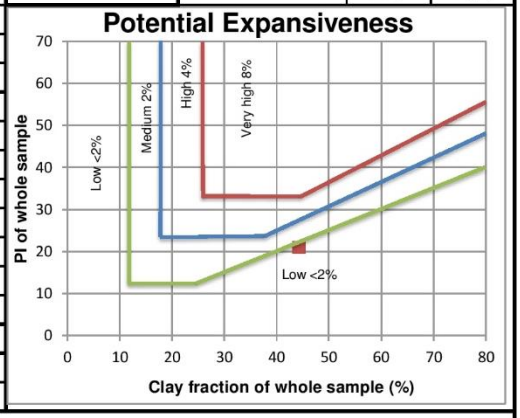


Activity	0.80	**Normal**
USCS² Classification	Sandy OH	
NHBRC Classification		
USCS²	Lean Clay	CL
	Silt	ML
	Organic Clay	OL
	Fat Clay	CH
	Elastic Silt	MH
	Organic Silt	OH
Activity	< 0.75	Inactive
	0.75 - 1.25	Normal
	>1.25	Active

Atterberg Limits			
Liquid Limit	LL	62	%
Plastic Limit	PL	37	%
Linear Shrinkage	LS	9.7	%
Plasticity Index	PI_{425}	25	%

Grain Size Distribution¹				
Gravel	Coarse	75 - 20mm	11.3	%
	Fine	20 - 5.00mm	1.0	%
Sand	Coarse	5.00 - 2,00mm	0.6	%
	Medium	2,00 - 0,425mm	2.0	%
	Fine	0,425 - 0,075mm	15.5	%
Silt		0,075 - 0,002mm	38.9	%
Clay		<0,002mm	30.6	%

Swell			
M/C at compaction (%)	28.6	Swell after 4 days (%)	6.2



*1 Unified Soil Classification system on grain size
*2 Unified Soil Classification system

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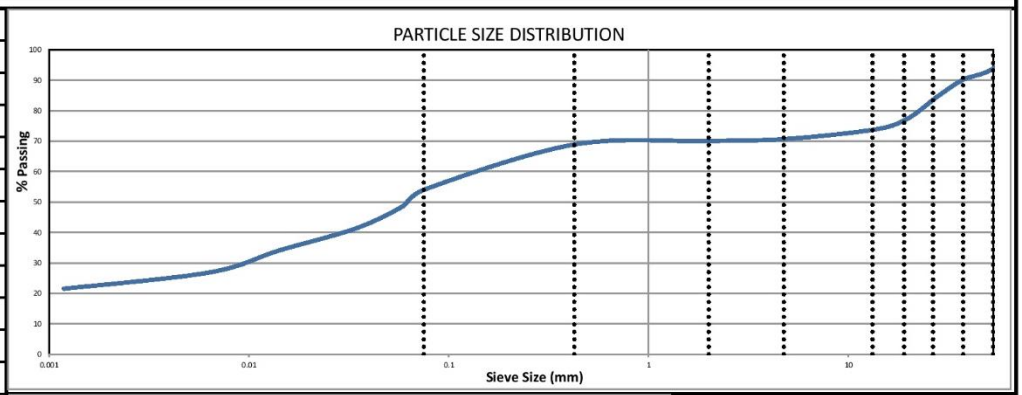
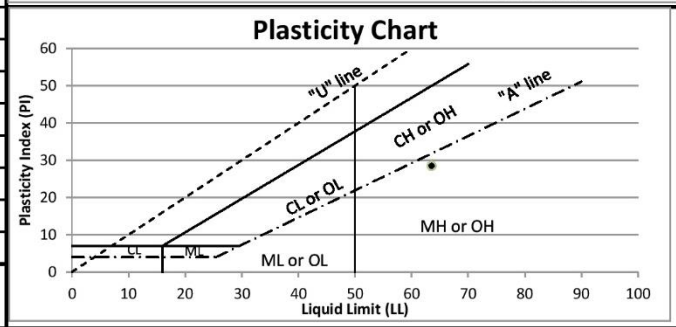
Client:	Great Karoo Eco Investments	Date:	15 July 2019	Job nr:	M12828
	Bus 38			Sample Number	7146
	Rietbron	Specification:	USCS	Order no:	-
	6450	Project:	Development of Erf 21244, Voorbaai, Mossel Bay		
Attention:	Kobus Steyn, 0815864848				

FOUNDATION INDICATOR TEST REPORT

Material Description	Silty Clay			Depth	NGL -400 to -2800mm	Date Received	20/06/2019
Source	Test Pit	Position/ Layer	TP 8	Moisture Content	-	Date Tested	27/06/2019

Sieve Size	% Pass
75	100
63	100
50	93
37.5	90
28	85
20	78
14	74
5	71
2	70
0.425	69
0.075	54.0
0.0583	48.4
0.0340	41.2
0.0141	34.1
0.0064	26.9
0.0012	21.5
Grading Modulus	1.1



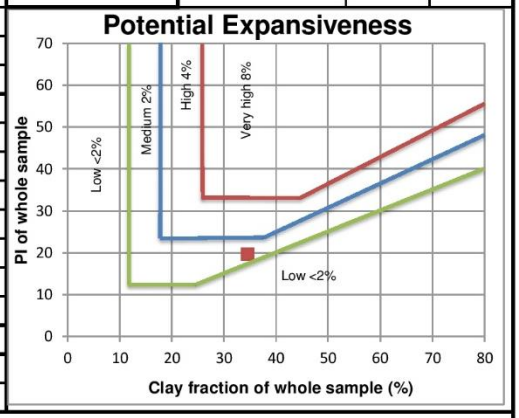


Activity	1.27	**Active**
USCS² Classification	Gravely OH	
NHBRC Classification		
USCS²	Lean Clay	CL
	Silt	ML
	Organic Clay	OL
	Fat Clay	CH
	Elastic Silt	MH
	Organic Silt	OH
Activity	< 0.75	Inactive
	0.75 - 1.25	Normal
	>1.25	Active

Atterberg Limits			
Liquid Limit	LL	64	%
Plastic Limit	PL	35	%
Linear Shrinkage	LS	13.4	%
Plasticity Index	PI_{425}	28	%

Grain Size Distribution¹				
Gravel	Coarse	75 - 20mm	22.4	%
	Fine	20 - 5.00mm	6.8	%
Sand	Coarse	5.00 - 2,00mm	0.8	%
	Medium	2,00 - 0,425mm	1.1	%
	Fine	0,425 - 0,075mm	14.9	%
Silt		0,075 - 0,002mm	31.7	%
Clay		<0,002mm	22.4	%

Swell			
M/C at compaction (%)	24.6	Swell after 4 days (%)	3.1



*1 Unified Soil Classification system on grain size
*2 Unified Soil Classification system

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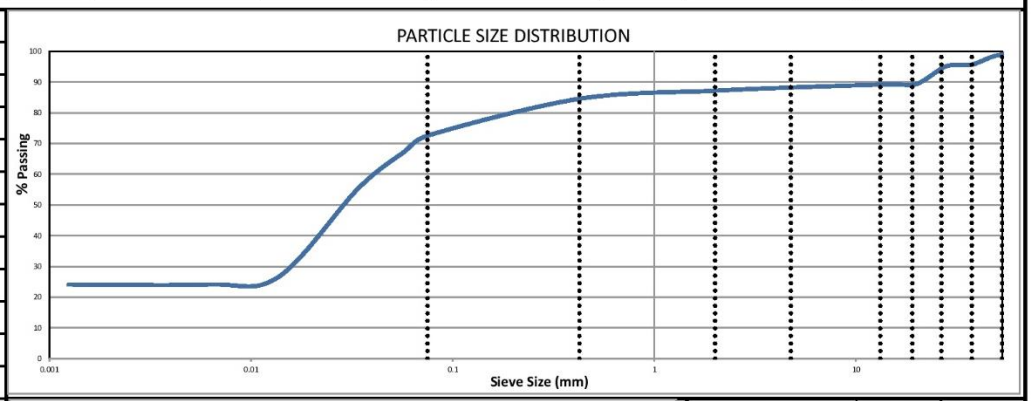
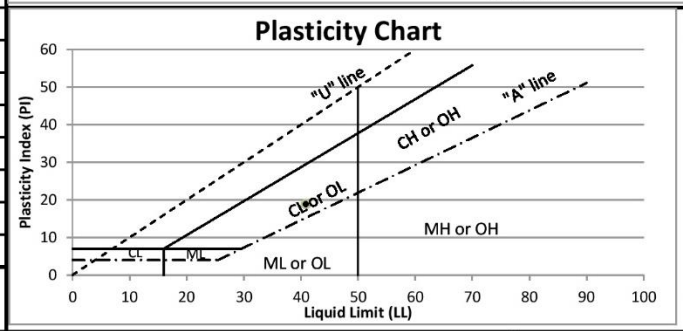
Client:	Great Karoo Eco Investments	Date:	15 July 2019	Job nr:	M12828
	Bus 38			Sample Number	7134
	Rietbron	Specification:	USCS	Order no:	-
	6450	Project:	Development of Erf 21244, Voorbaai, Mossel Bay		
Attention:	Kobus Steyn, 0815864848				

FOUNDATION INDICATOR TEST REPORT

Material Description	Silty Clay			Depth	NGL -600 to -2000mm	Date Received	20/06/2019
Source	Test Pit	Position/ Layer	TP 10	Moisture Content	-	Date Tested	27/06/2019

Sieve Size	% Pass
75	100
63	100
50	99
37.5	96
28	95
20	89
14	89
5	88
2	87
0.425	85
0.075	72.5
0.0579	67.4
0.0340	55.4
0.0136	26.5
0.0061	24.1
0.0012	24.1
Grading Modulus	0.6



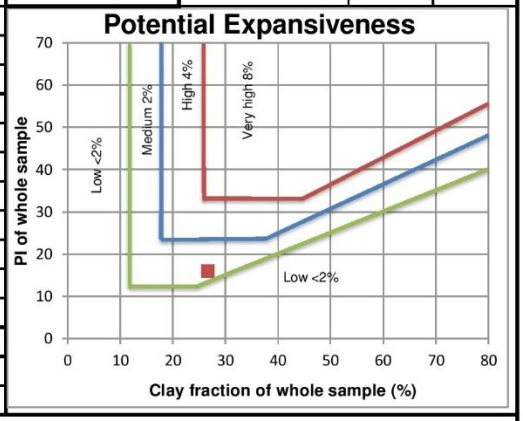


Activity	0.78	**Normal**
USCS² Classification	CL with sand	
NHBRC Classification		
USCS²	Lean Clay	CL
	Silt	ML
	Organic Clay	OL
	Fat Clay	CH
	Elastic Silt	MH
	Organic Silt	OH
Activity	< 0.75	Inactive
	0.75 - 1.25	Normal
	>1.25	Active

Atterberg Limits			
Liquid Limit	LL	41	%
Plastic Limit	PL	22	%
Linear Shrinkage	LS	6.0	%
Plasticity Index	PI_{425}	19	%

Grain Size Distribution¹				
Gravel	Coarse	75 - 20mm	10.6	%
	Fine	20 - 5.00mm	1.2	%
Sand	Coarse	5.00 - 2,00mm	1.1	%
	Medium	2,00 - 0,425mm	2.6	%
	Fine	0,425 - 0,075mm	12.0	%
Silt		0,075 - 0,002mm	48.5	%
Clay		<0,002mm	24.1	%

Swell			
M/C at compaction (%)	18.8	Swell after 4 days (%)	3.7



*1 Unified Soil Classification system on grain size
*2 Unified Soil Classification system

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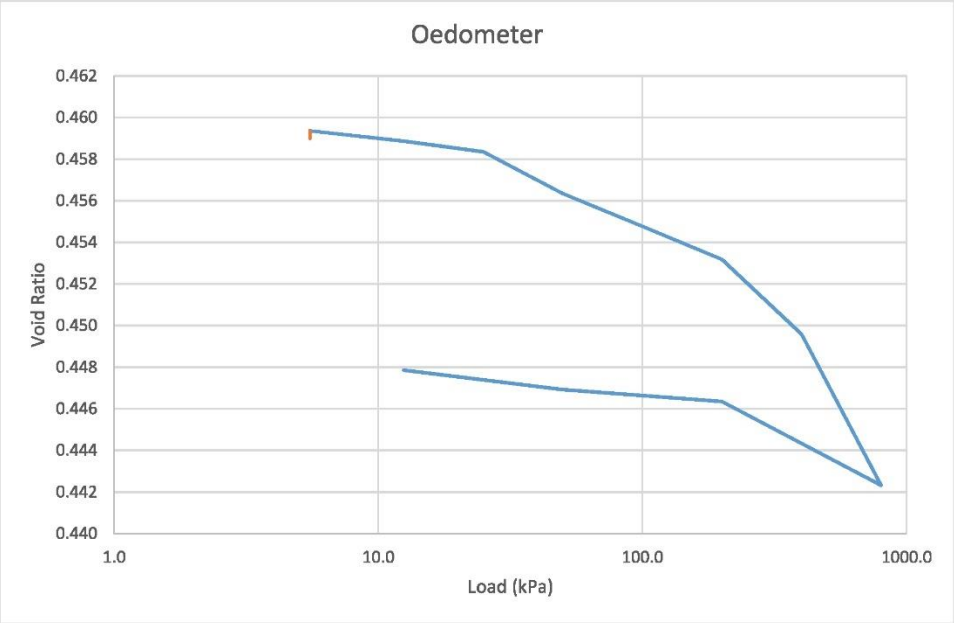
Oedometer Settlement Test

Sample Detail		Initial	Final
Height	(mm)	20.3	20.2
Diameter	(mm)	63.5	63.5
Weight	(g)	135.2	137.3
Moisture	(%)	16.0	17.6
Dry Density	(Mg/m^3)	1.82	1.83
Bulk Density	(Mg/m^3)	2.10	2.15
Void Ratio		0.459	0.448
Particle Density	(Mg/m^3)	2.65	

Swell Results	
Swell Percentage	0.0 %
Swell Pressure	1 kPa

Load (kPa)	Height (mm)	Void Ratio
5.5	20.300	0.459
5.5	20.305	0.459
12.5	20.303	0.459
25	20.296	0.458
50	20.268	0.456
100	20.246	0.455
200	20.224	0.453
400	20.174	0.450
800	20.073	0.442
200	20.129	0.446
50	20.137	0.447
12.5	20.150	0.448



STEYN-WILSON GEOTECHNICAL	Test Method	BS1377 - 5: 1990: Clause 3	Test Name Database: .\SQLEXPRESS \ Steyn Wilson Geotech
	Site Reference		Test Date 03/07/2019
	Jobfile	SWG00028	Sample TP1_1.2-1.6m
	Client	Roadlab_Mosslab	Borehole ERF21244
	Operator:FC	Checked: FC	Approved: FC

01/08/2018 Rev1 TR/GEO-SW0006 Compiled: M. Steyn Approved: R. Wilson

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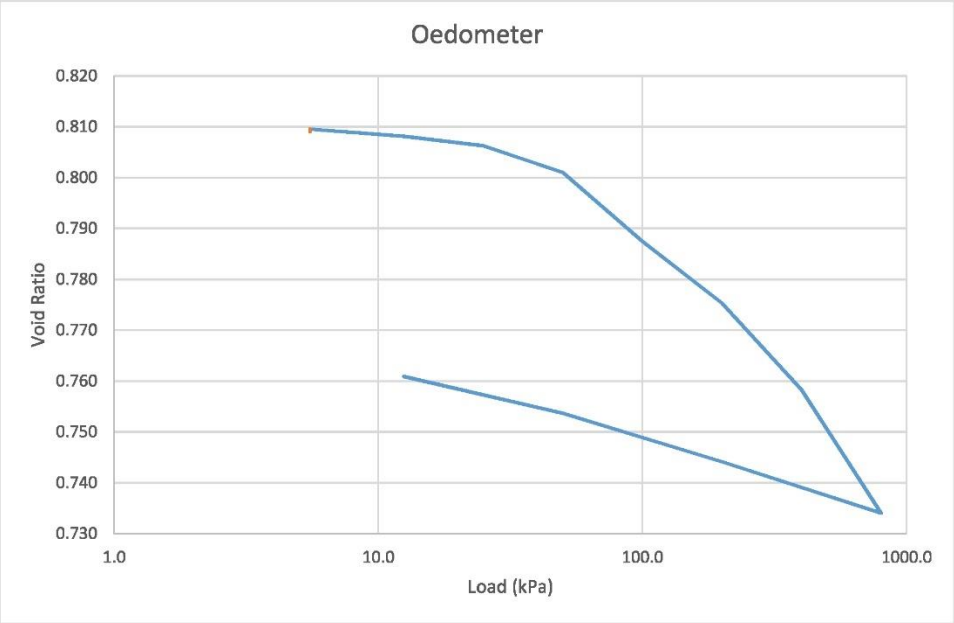
Oedometer Settlement Test

Sample Detail		Initial	Final
Height	(mm)	20.3	19.8
Diameter	(mm)	63.5	63.5
Weight	(g)	115.6	117.2
Moisture	(%)	23.0	32.4
Dry Density	(Mg/m^3)	1.46	1.41
Bulk Density	(Mg/m^3)	1.80	1.87
Void Ratio		0.809	0.761
Particle Density	(Mg/m^3)	2.65	

Swell Results	
Swell Percentage	0.1 %
Swell Pressure	4 kPa

Load (kPa)	Height (mm)	Void Ratio
5.5	20.300	0.809
5.5	20.306	0.810
12.5	20.296	0.808
25	20.275	0.806
50	20.216	0.801
100	20.064	0.787
200	19.928	0.775
400	19.737	0.758
800	19.465	0.734
200	19.578	0.744
50	19.685	0.754
12.5	19.766	0.761



STEYN-WILSON GEOTECHNICAL	Test Method	BS1377 - 5: 1990: Clause 3	Test Name Database: .\SQLEXPRESS \ Steyn Wilson Geotech
	Site Reference		Test Date 03/07/2019
	Jobfile	SWG00028	Sample TP2_1.5-2.0m
	Client	Roadlab_Mosslab	Borehole ERF21244
	Operator:FC	Checked: FC	Approved: FC

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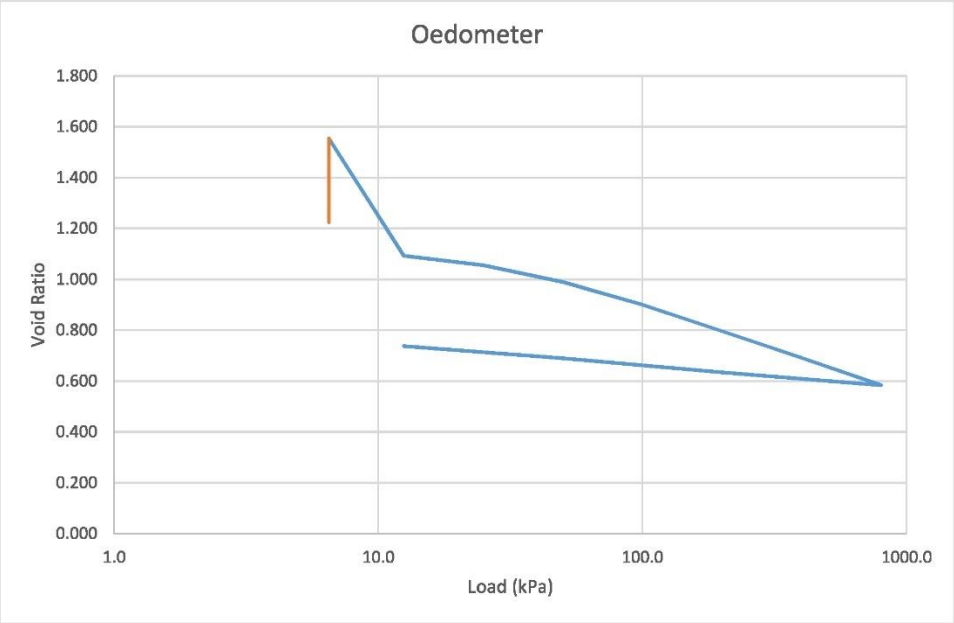
Oedometer Settlement Test

Sample Detail		Initial	Final
Height	(mm)	20.3	18.9
Diameter	(mm)	63.5	63.5
Weight	(g)	101.5	111.2
Moisture	(%)	33.0	46.1
Dry Density	(Mg/m^3)	1.19	1.27
Bulk Density	(Mg/m^3)	1.58	1.86
Void Ratio		1.224	0.737
Particle Density	(Mg/m^3)	2.65	

Swell Results	
Swell Percentage	14.8 %
Swell Pressure	249 kPa

Load (kPa)	Height (mm)	Void Ratio
6.5	20.300	1.224
6.5	23.311	1.554
12.5	22.107	1.092
25	21.769	1.055
50	21.169	0.989
100	20.348	0.899
200	19.413	0.797
400	18.451	0.692
800	17.467	0.584
200	17.924	0.634
50	18.429	0.689
12.5	18.866	0.737



STEYN-WILSON GEOTECHNICAL	Test Method	BS1377 - 5: 1990: Clause 3	Test Name Database: .\SQLEXPRESS \ Steyn Wilson Geotech
	Site Reference		Test Date 03/07/2019
	Jobfile	SWG00028	Sample TP8_1.0-1.5m
	Client	Roadlab_Mosslab	Borehole ERF21244
	Operator:FC	Checked: FC	Approved: FC

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