

**GEOTECHNICAL CONDITIONS ON PORTION 16 OF
THE FARM BOEGOEBERG SETTLEMENT 48: A
REPORT FOR THE EXPANSION AND
FORMALISATION OF GROBLERSHOOP COMMUNITY**

2020/J09/MCP_01



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EXECUTIVE SUMMARY

1 INTRODUCTION

It is envisaged to develop some 95 hectare of land on Portion 16 of the farm Boegoeberg Settlement 48 as an expansion of the existing Groblershoop community. For this purpose Cedar Land Geotechnical Consult (Pty) Ltd was appointed as subconsultant to Macroplan to conduct a geotechnical investigation on the property.

2 TERMS OF REFERENCE

The requirements of the following documents were adhered to in the conduct of the investigation and reporting of the project :

- The document Geotechnical Site Investigations for Housing Developments (Generic Specification GFSH-2), issued by the National Department of Housing in September 2002.*
- The document SANS 634-1 : Geotechnical Investigations for Township Development, issued by SABS in February 2012.*

3 SITE DESCRIPTION

3.1 Site Location

The area of investigation for the extension of Groblershoop is located on the south western side of National Route N10 to Marydale, opposite of the existing Sternham ; but directly adjacent to the south east of the industrial area of Groblershoop. Access to the area is directly from National Route N10. The size of the property is 95 hectare.

3.2 Topography and Drainage

The land investigated is located between 885,0mamsl and 868,0mamsl. Topographical it can be described as being located on the southern limit of undulating dunes encroaching from the north overlying level plain to the south. The dunes have been partially mechanically reworked and the slope of the dunes is variable up to approximately 4%. The plain to the south has possibly in been exposed by erosive action of wind and the river. The slope across the plain is less than 2% and generally towards the south.

Drainage takes place by means of surface sheetwash. Two non-perennial streams originate from the dunes and drain towards the north. The drainage courses are contained in narrow, shallow sloping and well defined gullies.

3.3 Vegetation and Landscape

The area of investigation is referred to as Bushmanland Arid Grassland. The landscape features are described as consisting of extensive to irregular plains on a slightly sloping plateau sparsely vegetated by grassland dominated by white grasses giving this vegetation type the character of semi-desert steppe. In places low shrubs change the vegetation structure. On site it was found that in the areas where natural vegetation is present it consists of a sparse stand of Acacia melliflora and prosopis glandulosa. Stands of aloe claviflora are present. A few examples of Acacia erioloba and Aloe hereroensis were encountered during the investigation.

3.4 Climatic Conditions

The area is located in a summer-rainfall region with mean annual precipitation between 70mm to 200mm ; mean maximum summer temperature of 38°C and mean minimum winter temperature of - 0,6°C. Frost incidence varies between 10 and 35 days per year. The development of whirl winds are common on hot summer days. The Thornthwaite moisture index is less than -40 ; and the Weinert N value approximately 35. The climate can thus be described as arid.

3.5 Existing Facilities

The area can be divided into two zones as follows :

3.5.1 Vacant Land

The portion of level land occupying the southern part of the property can be described as vacant. It may have been used historically for grazing.

3.5.2 Utilised Land

The northern part of the property can be described as utilised land. Several obsolete and active waste water pipes are present. The area is characterized by the present of stockpiles of waste, mostly construction material and excavated calcrete. Unused, apparently obsolete, oxidations ponds and a small grave yard were encountered during the investigation ; so too an active oxidation dam for waste water from the nearby abattoir and areas of sewerage disposal.

4 NATURE OF INVESTIGATION

4.1 Test Pitting

Fifty test pits were excavated with a Bell 315SK TLB on hire from ALS Plant Rentals. Generally test pits were excavated to refusal. Excavation through the aeolian sands were terminated if collapse of the sidewalls occurred. This happened often at depths as shallow as 400mm. The test pits were profiled by a professionally registered geotechnical engineer.

4.2 Materials Testing

Soil testing consisted of the following :

- Conductivity and pH determinations on ten samples of the in-situ materials to determine the corrosivity thereof.*
- Foundation indicator testing on 15 samples of the in-situ materials to determine possible conditions of heave or settlement.*
- CBR and road indicator testing on four samples to determine the suitability of the in-situ materials to be utilized as road layerworks.*

5 GEOLOGY, SOIL PROFILE AND GROUNDWATER

5.1 Geology

The available information shows that the area of investigation is located on a subduction zone dating approximately 1000 million years old. The zone is located between the lithology of the Kaapvaal Craton and the Namaqua-Natal mobile belt. The remains of the original geology in the area are referred to as the Kaaien Terrane and the site is located on the Groblershoop Formation of the Brulpan Group. Bedrock on site occurs as lineal bands of grey, micaceous quartzite associated with a wider distributed quartz-amphibole schist of the Groblershoop Formation, Brulpan Group. Occasionally the quartzite tends to be muscovite-rich.

5.2 Soil Profile

5.2.1 Gordonia Formation

Aeolian sand of the Gordonia Formation, Kalahari Group, was encountered in a reworked form in the southern area of the site and in a pure form in the northwestern part thereof. These deposits are light red in colour, very loose, fine sand with an intact matrix. The thickness of the horizon varied between 800mm and 1900mm in the test pits.

5.2.2 Colluvium

Gravelly colluvium as surface deposit was found over the entire site. Being older than the aeolian sand, it underlies the dunes where they were encountered. The colluvium is a homogenous material, consisting light brown fine sand and clasts of gravels and cobbles of quartz and some calcrete. The horizon of colluvium was between 600mm and 1400mm thick in the test pits.

5.2.3 Mokalanen Formation

Calcrete was encountered as the dominant lithic material on site, in virtually a continuous cover over the quartzite and schist, with the latter outcropping occasionally. The calcrete is present as very dense hardpan or boulder calcrete. The calcrete is present as outcrops ; or underlies the transported materials, occurring from depths between zero and 800mm minimum, extending to 100mm to 1200mm maximum. It is described as dirty white to dirty light yellow white, very fine grained, very dense calcrete. Some fine sand may occasionally be contained in voids in the matrix of the calcrete.

5.2.4 Residual Quartzite

On site residual quartzite was encountered as surface material or underlying the gravelly colluvium. It consists of cobbles and boulders of quartzite with diameter less than 500mm contained a matrix of dirty white, calcareous cemented sand. The soil matrix is medium dense. The horizon of residual quartzite extended to a depth of 700mm where encountered.

5.3 Groundwater

5.3.1 Perched Water

Perched groundwater was not encountered in any of the test pits excavated for this investigation. It is anticipated that perched water will generally not prove problematic on the site. However, seepage water may be encountered in the vicinity of the waste water disposal areas.

5.3.2 Permanent Groundwater

The probability for drilling successfully for water in the area is between 40% and 60%, and the probability that such a borehole will yield more than 2l/s is between 10% and 20%. Groundwater is expected to occur at depths less than 15 meters in compact, argillaceous strata.

6 SITE CLASS DESIGNATION

The area is regarded as suitable for residential development as follows :

6.1 Geotechnical Zone I(a)

The zone is classed as R, meaning that the proposed horizon for founding is stable and negligible soil movement is expected. The distribution thereof encompasses 28% of the proposed area for development. Slope across the land is less than 2%. Considering the limited slope and the favourable geotechnical site classification, two foundation design alternatives are applicable to the zone, namely conventional strip foundations or slab-on-the-ground foundations placed directly on bedrock or very dense pedoconcrete.

6.2 Geotechnical Zone I(b)

The zone is classed as R, meaning that the proposed horizon for founding is stable and negligible soil movement is expected. The distribution thereof encompasses 36% of the proposed area for development. Slope across the land is approximately between 2% and 6%. The use of slab-on-the-ground foundations will require additional works in the form of the construction of an engineered fill or cutting to establish a level platform for construction. The more viable foundation alternative therefore remains founding by conventional strip foundations.

6.3 Geotechnical Zone II(a)

The zone is classed as S, meaning that the proposed horizon for founding is stable and less than 10mm rapid compression settlement is expected. The distribution thereof encompasses 3% of the proposed area for development. Slope across the land is less than 2%. Considering the limited slope and the favourable geotechnical site classification, two foundation design alternatives are applicable to the zone, namely conventional strip foundations or slab-on-the-ground foundations placed directly on gravelly colluvium or aeolian sand. The latter option is regarded as the better solution of the two alternatives.

6.4 Geotechnical Zone II(b)

The zone is classed as S, meaning that the proposed horizon for founding is slightly compressible and rapid compression settlement less than 10mm is expected. The distribution thereof encompasses 17% of the proposed area for development. Slope across the land is between 2% and 6%. Considering the slope and the favourable geotechnical site classification, two foundation design alternatives are applicable to the zone, namely conventional strip foundations or slab-on-the-ground foundations placed directly on gravelly colluvium or aeolian sand. The more viable foundation alternative therefore remains founding by conventional strip foundations.

6.5 Geotechnical Zone III(a)

The zone is classed as S1, meaning that the proposed horizon for founding is fairly compressible and the foundation design need to incorporate measures to counter the effects of the geotechnical conditions. Between 10mm and 20mm rapid compression settlement is expected. The distribution thereof encompasses 3% of the proposed area for development. Slope across the land is less than 2%. Considering the limited slope and the intermediate geotechnical site classification, two foundation design alternatives are applicable to the zone, namely reinforced strip foundations or replacement of the in-situ soils underneath individual footings. From a geotechnical viewpoint both alternatives are regarded as suitable solutions for the founding conditions.

6.6 Geotechnical Zone III(b)

The zone is classed as S1, meaning that the proposed horizon for founding is fairly compressible and the foundation design need to incorporate measures to counter the effects of the geotechnical conditions. Between 10mm and 20mm rapid compression settlement is expected. The distribution thereof encompasses 7% of the proposed area for development. Slope across the land is between 2% and 6%. Considering the intermediate geotechnical site classification, two foundation design alternatives are applicable to the zone, namely reinforced strip foundations or replacement of the in-situ soils underneath individual footings. From a geotechnical viewpoint both alternatives are regarded as suitable solutions for the founding conditions.

6.7 Geotechnical Zone IV

The zone is classed as S2, meaning that the proposed horizon for founding is highly compressible and the foundation design need to incorporate measures to counter the effects of the geotechnical conditions. In excess of 20mm rapid compression settlement is expected. The distribution thereof encompasses 6% of the proposed area for development. Slope across the land is between 2% and 6%. Considering the intermediate geotechnical site classification, two foundation design alternatives are applicable to the zone, namely reinforced strip foundations or reinforced concrete rafts. From a geotechnical viewpoint both alternatives are regarded as suitable solutions for the founding conditions. However, the selection of which alternative to use must be made individually for each stand. All foundations to be designed by a suitably experienced professional engineer.

7 CONDITIONS OF EXCAVATION

7.1 Conditions of Hard Rock Excavation

On average over the entire site bedrock or refusal of excavation on very dense hardpan calcrete, bedrock of quartz-amphibole schist or quartzite was encountered at depths between 100mm minimum

and 1500mm maximum, averaging 700mm deep. The implication of this is that should trenches require excavated depths to 1000mm, 30% of the excavation may be classified as hard, requiring drilling and blasting. Should the required depth of excavation increase to 1500mm, 53% of the excavation may be classified as hard.

7.1.1 Geotechnical Zones I(a) and I(b)

These zones are classified as R. The average depth to bedrock or very dense pedocrete is 185mm. Refusal of excavation occurred at an average depth of 550mm. The implication of this is that should trenches require excavated depths to 1000mm, 45% of the excavation may be classified as hard, requiring drilling and blasting. Should the required depth of excavation increase to 1500mm, 63% of the excavation may be classified as hard.

7.1.1ii) Geotechnical Zones II(a) and II(b)

These zones are classified as S. The average depth to bedrock or very dense pedocrete is 620mm. Refusal of excavation occurred at an average depth of 850mm. The implication of this is that should trenches require excavated depths to 1000mm, 15% of the excavation may be classified as hard, requiring drilling and blasting. Should the required depth of excavation increase to 1500mm, 43% of the excavation may be classified as hard.

7.1.1(iii) Geotechnical Zones III(a and b)

These zones are classified as S1. The average depth to bedrock or very dense pedocrete is 780mm. Refusal of excavation occurred at an average depth of 1200mm. The implication of this is that should trenches require excavated depths to 1000mm, zero percent of the excavation may be classified as hard, requiring drilling and blasting. Should the required depth of excavation increase to 1500mm, 20% of the excavation may be classified as hard.

7.1.1(iv) Geotechnical Zone IV

This zones is classified as S2. The average depth to bedrock or very dense pedocrete is 1370mm. Refusal of excavation occurred at an average depth of 1470mm. The implication of this is that should trenches require excavated depths to 1000mm, zero percent of the excavation may be classified as hard, requiring drilling and blasting. Should the required depth of excavation increase to 1500mm, 2% of the excavation may be classified as hard.

7.2 Sidewall Stability

In all cases where aeolian sand or reworked aeolian sand may occur such material may be regarded

as potentially unstable and subject to collapse. However, especially in Geotechnical Zone S2 where deep, very loose sand is present, such conditions are dangerous and can prove fatal if collapses occur while workmen are occupied in trenches.

8 LAND SLOPE

The average slope across 66% of the land is between 2% and 6% and over 34% it is less than 2%.

The slope of less than 2% has a detrimental influence on especially the design of a stormwater disposal system depending on gravity to dissipate of the surface water due to downpours. The land slope also affects the design of the sewerage disposal but to a lesser extent as the gradient of the pipes can be adjusted according to design requirements.

9 MATERIALS UTILIZATION

- *Trench Backfilling : Only the aeolian sand can be regarded as suitable for selected fill or pipe bedding. With exception of the hardpan calcrete all materials can be used for normal backfill.*
- *Layerworks for Paved or Segmental Block Paving : The hardpan calcrete and colluvium are of G6 quality and hence suitable for the construction of layerworks up to subbase and base course level for lightly trafficked roads.*
- *Wearing Course for Gravel Roads in Urban Areas : None of the soil materials are 100% suitable for this purpose. The use of these materials will generally result in a road surface subject to raveling and corrugations.*

10 SPECIAL PRECAUTIONARY MEASURES

10.1 Soil and Water Contamination

Prior to development of the area possible conditions of soil and groundwater contamination due to the presence of the cemetery, obsolete oxidation dams, existing oxidation dam and sewer dumping area need to be resolved.

Even though no in-situ testing was conducted to determine whether these items are responsible for, or have historically been responsible for soil or water contamination, it can be stated that such conditions may have occurred. Due to the relative absence of groundwater of any sort close to the surface and an impermeable barrier formed by the calcrete and bedrock it is unlikely that groundwater contamination may have taken place, but contamination of surface water could have occurred. Similarly could bacterial contamination of the surface soils have taken place.

10.2 Dune Stability

Although the dunes in this area have been stable and not subject to movement over a very long time, it has been found that with the removal of vegetation the effects of wind result in the displacement of the sand. It is therefore important that any development of the dune area be done in conjunction with an environmental specialist who can provide guidance with regard to revegetating the dunes and development of infrastructure in these conditions.

11 OTHER CONSIDERATIONS

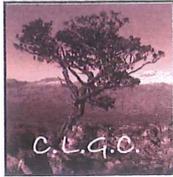
- *Undermining : The area is not subject to undermining.*
- *Seismic Activity : The Peak Ground Acceleration expected in 50 years is 0,05g. A low risk for the development of earth tremors therefore exist.*
- *Soil Corrosivity : The in-situ soils and pedocretes are not corrosive due to acidic properties. All soil materials can be regarded as corrosive due to high soluble salt contents.*
- *Dolomite : The area of investigation is not subject to any restrictions due to the presence of dolomite. Bedrock of dolomite does not occur in the area of investigation.*

GEOTECHNICAL CONDITIONS ON PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT 48: A REPORT FOR THE EXPANSION AND FORMALISATION OF GROBLERSHOOP COMMUNITY

2020/J09/MCP_01

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**GEOTECHNICAL CONDITIONS ON PORTION 16 OF THE FARM BOEGOEBERG
SETTLEMENT 48 : A REPORT FOR THE EXPANSION AND FORMALISATION OF
GROBLERSHOOP COMMUNITY**

1 INTRODUCTION

It is envisaged to develop some 95 hectare of land on Portion 16 of the farm Boegoeberg Settlement 48 as an expansion of the existing Groblershoop community. For this purpose Cedar Land Geotechnical Consult (Pty) Ltd was appointed as subconsultant to Macroplan as per the minutes of the start-up meeting of the project held in the offices of Macroplan on 20 May 2020 to conduct a geotechnical investigation on the property.

2 TERMS OF REFERENCE

The requirements of the following documents were adhered to in the conduct of the investigation and reporting of the project :

- The document *Geotechnical Site Investigations for Housing Developments (Generic Specification GFSH-2)*, issued by the National Department of Housing in September 2002.
- The document *SANS 634-1 : Geotechnical Investigations for Township Development*, issued by SABS in February 2012.

3 AVAILABLE INFORMATION

The following source of available information recording available data obtained in the larger Upington to Groblershoop area have been consulted for background information :

- *Breytenbach FJ* : Report on the Geotechnical Conditions on Erf 2785 Boegoeberg Settlement, issued by Soilkraft cc on behalf of KLK Petroleum on 25 April 2015.

Directors : FJ Breytenbach (Pr Eng) B Eng (Civ) NDT (Geology); M Breytenbach M Sc (Mathematical Statistics)

- *Breytenbach FJ* : Geotechnical Conditions on Erf 2790 Sternham : A Phase 3 Report for the Proposed Construction of a New Library, issued by Soilkraft cc on behalf of Ukhukhula Consulting Engineers on 18 October 2012.
- *Breytenbach FJ* : Contract NRA N010-110-2012/1F : Geotechnical Investigation for Four Bridge Widening on the National Route 10 Section 11 between Groblershoop (km 0,0) and Lambrechtsdrift (km 61,1), issued by Soilkraft cc on behalf of Bvi Engineers on 8 March 2012.
- *Breytenbach FJ* : Geotechnical Conditions on Five Areas of the Farm Buchuberg 48 : A Report for Extending the Existing Residential Area of Sternham near Groblershoop, issued by Soilkraft on behalf of Macroplan on 21 December 2011.

4 SITE DESCRIPTION

4.1 Site Location

The area of investigation for the extension of Groblershoop is located on the south western side of National Route N10 to Marydale, opposite of the existing Sternham ; but directly adjacent to the south east of the industrial area of Groblershoop. Access to the area is directly from National Route N10. It is some 120km southeast of Upington and located on Portion 16 of the farm Boegoeberg Settlement 48. The size of the property is 95 hectare.

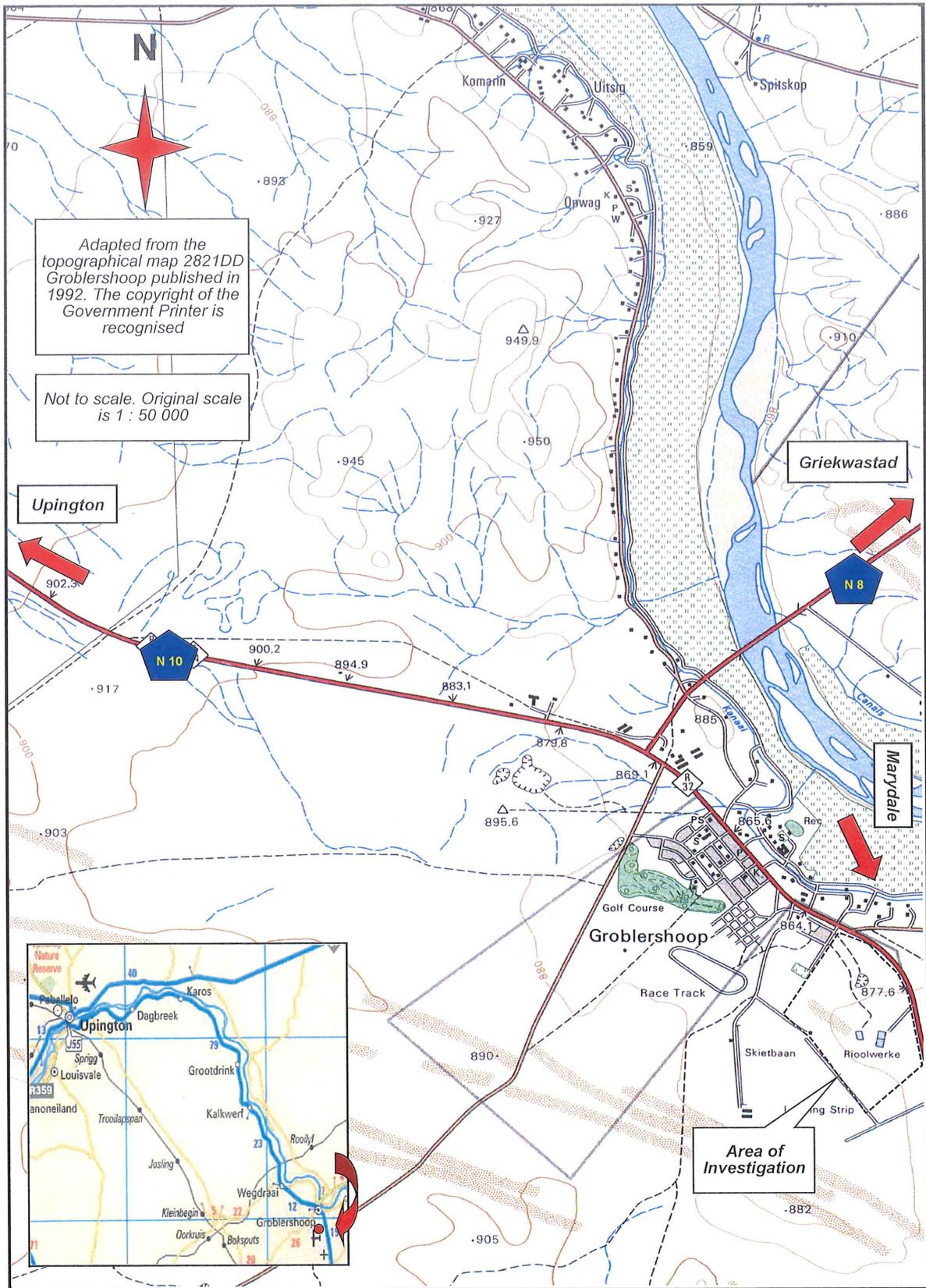
Refer to the attached Figure 1 : Locality Plan.

4.2 Topography and Drainage

The land investigated is located between 885,0mamsl and 868,0mamsl. Topographical it can be described as being located on the southern limit of undulating dunes encroaching from the north overlying level plain to the south. The dunes have been partially mechanically reworked and the slope of the dunes is variable up to approximately 4%.

The plain to the south has possibly in been exposed by erosive action of wind and the river. The slope across the plain is less than 2% and generally towards the south.

Drainage takes place by means of surface sheetwash. Two non-perennial streams originate from the dunes and drain towards the north. The drainage courses are contained in narrow, shallow sloping and well defined gullies.



LOCALITY PLAN

FIGURE 1

4.3 Vegetation and Landscape

Based on the work done by Mucina^{Reference 14.1} the area of investigation is referred to as Bushmanland Arid Grassland. The landscape features are described as consisting of extensive to irregular plains on a slightly sloping plateau sparsely vegetated by grassland dominated by white grasses giving this vegetation type the character of semi-desert steppe. In places low shrubs change the vegetation structure. In years of abundant rainfall rich displays of annual herbs can be expected. On site it was found that in the areas where natural vegetation is present it consists of a sparse stand of *Acacia melliflora* and *Prosopis glandulosa*. Stands of *Aloe claviflora* are present. A few examples of *Acacia erioloba* and *Aloe hereroensis* were encountered during the investigation.

4.4 Climatic Conditions

The area is located in a summer-rainfall region with mean annual precipitation between 70mm to 200mm ; mean maximum summer temperature of 38°C and mean minimum winter temperature of -0,6°C. Frost incidence varies between 10 and 35 days per year. The development of whirl winds are common on hot summer days. The Thornthwaite moisture index is less than -40 ; and the Weinert N value approximately 35. The climate can thus be described as arid. The importance of this is that mechanical breakdown of bedrock will take place rather than chemical decomposition, limiting the formation of secondary minerals such as expansive montmorillonite clay.

4.5 Existing Facilities

Site conditions are illustrated on Photo 1 : Site Conditions.

The area can be divided into two zones as follows :

4.5.1 Vacant Land

The portion of level land occupying the southern part of the property can be described as vacant. It may have been used historically for grazing, but no sign of recent human occupation or disturbance could be identified during the investigation.

4.5.2 Utilised Land

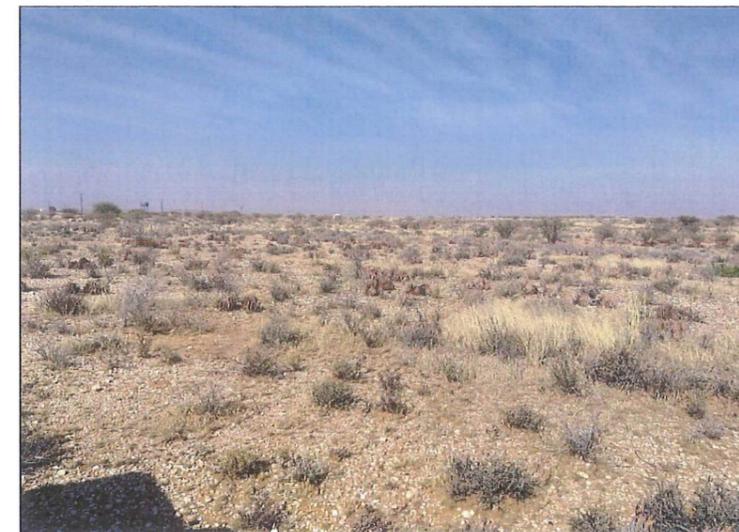
The northern part of the property, adjacent to the existing infrastructure of Groblershoop can be described as utilised land. Several obsolete and active waste water pipes are present. The area is characterized by the present of stockpiles of waste, mostly construction material and



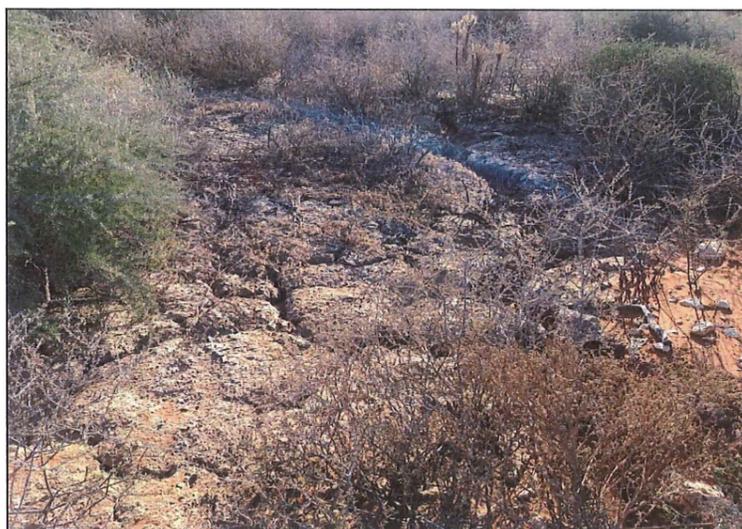
TILTED OUTCROPS OF QUARTZ-AMPHIBOLE SCHIST THROUGH AEOLIAN SAND



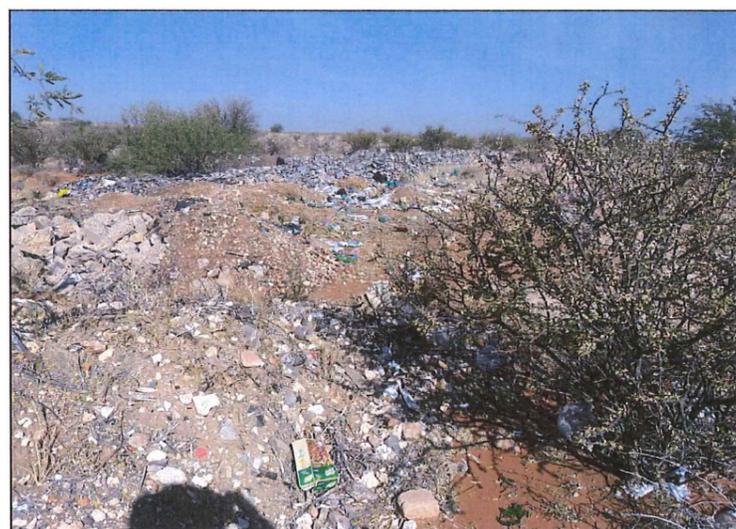
CONDITIONS OF HARD EXCAVATION IN CALCRETE



CONDITIONS IN UNDISTURBED VELD



DRIED SPILL OF SEWER WASTE



STOCKPILES OF MIXED WASTE MATERIAL



CONDITIONS OF HARD EXCAVATION IN QUARTZ-AMPHIBOLE SCHIST



excavated calcrete. Unused, apparently obsolete, oxidations ponds and a small grave yard were encountered during the investigation ; so too an active oxidation dam for waste water from the nearby abattoir and areas of sewerage disposal. These latter areas of sewerage disposal cannot be regarded as professionally designed oxidation dams or similar features.

5 NATURE OF INVESTIGATION

5.1 Test Pitting

In compliance with the requirements of SANS 634 and GFSH-2 test pitting was conducted to provide applicable geotechnical information. On 9 and 10 July 2020 50 test pits were excavated with a Bell 315SK TLB on hire from ALS Plant Rentals. The TLB was equipped with a 600mm wide bucket. Generally test pits were excavated to refusal. Excavation through the aeolian sands were terminated if collapse of the sidewalls occurred. This happened often at depths as shallow as 400mm.

The test pits were profiled by a professionally registered geotechnical engineer. For the benefit of the non-geotechnical reader of this document, the guidelines for test pit profiling are summarized in the attached Table 1 : Soil Profiling Parameters. The profiles of the test pits may be found in Addendum A to this report. The positions of the test pits are indicated on the attached Figure 2 : Site Plan. Provisional co-ordinates for property beacons A to U are indicated on this figure.

5.2 Materials Testing

Soil testing was undertaken by Roadlab in Upington. As a matter of quality control duplicate samples were sent to the Roadlab branch in Germiston for independent testing to verify the results. Due to general limited vertical extent of the soil profile and coarse nature thereof, it was not feasible to retrieve undisturbed samples to determine properties of settlement or collapse fairly accurately.

Soil testing consisted of the following :

- Conductivity and pH determinations on ten samples of the in-situ materials to determine the corrosivity thereof.
- Foundation indicator testing on 15 samples of the in-situ materials to determine possible conditions of heave or settlement.
- CBR and road indicator testing on four samples to determine the suitability of the in-situ materials to be utilized as road layerworks.

TABLE 1 : SOIL PROFILING PARAMETERS

CONSISTENCY : GRANULAR SOILS

CONSISTENCY : COHESIVE SOILS

SPT N	GRAVELS & SANDS Generally free draining soils			DRY DENSITY (kg/m ³)	SPT N	SILTS & CLAYS and combinations with SANDS Generally slow draining soils			UCS (kPa)
<4	Very loose	Crumbles very easily when scraped with geological pick. Requires power tools for excavation.		<1450	<2	Very soft	Pick point easily pushed in 100mm. Easily moulded by fingers.		<50
4-10	Loose	Small resistance to penetration by sharp pick point. Requires many blows by pick point.		1450-1600	2-4	Soft	Pick point easily pushed in 30mm to 40mm. Moulded by fingers with some pressure.		50-125
10-30	Medium dense	Considerable resistance to penetration by sharp pick point.		1600-1750	4-8	Firm	Pick point penetrates to 10mm. Very difficult to mould with fingers.		125-250
30-50	Dense	Very high resistance to penetration by sharp pick point. Requires many blows by pick point for excavation.		1750-1925	8-15	Stiff	Slight indentation by pick point. Cannot be moulded by fingers. Penetrated by thumb nail.		250-500
>50	Very dense	High resistance to repeated blows of geological pick. Requires power tools for excavation.		>1925	15-30	Very stiff	Slight indentation by blow of pick point. Requires power tools for excavation.		500-1000

SOIL TYPE

SOIL TYPE	PARTICLE SIZE (mm)
Clay	<0,002
Silt	0,002-0,06
Sand	0,06-2,0
Gravel	2,0-60,0
Cobbles	60,0-200,0
Boulders	>200,0

MOISTURE CONDITION

Dry	No water detectable
Slightly moist	Water just discernable
Moist	Water easily discernable
Very moist	Water can be squeezed out
Wet	Generally below water table

SOIL STRUCTURE

COLOUR		SOIL STRUCTURE	
Speckled	Very small patches of colour <2mm	Intact	No structure present.
Mottled	Irregular patches of colour 2-6mm	Fissured	Presence of discontinuities, possibly cemented.
Blotched	Large irregular patches 6-20mm	Slickensided	Very smooth, glossy, often striated discontinuity planes.
Banded	Approximately parallel bands of varying colours	Shattered	Presence of open fissures. Soil break into gravel size blocks.
Streaked	Randomly orientated streaks of colour	Micro shattered	Small scale shattering, very closely spaced open fissures. Soil breaks into sand size crumbs.
Stained	Local colour variations : Associated with discontinuity surfaces	Residual structures	Residual bedding, laminations, foliations etc.

ORIGIN

Transported	Alluvium, hillwash, talus etc.
Residual	Weathered from parent rock, eg residual granite
Pedocretes	Femcrete, silcrete, calcrete etc.

DEGREE OF CEMENTATION OF PEDOCRETES

TERM	DESCRIPTION	UCS (MPa)
Very weakly cemented	Some material can be crumbled between finger and thumb. Disintegrates under knife blade to a friable state.	0,1-0,5
Weakly cemented	Cannot be crumbled between strong fingers. Some material can be crumbled by strong pressure between thumb and hard surface. Under light hammer blows disintegrate to a friable state.	0,5-2,0
Cemented	Material crumbles under firm blows of sharp pick point. Grains can be dislodged with some difficulty by a knife blade.	2,0-5,0
Strongly cemented	Firm blows of sharp pick point on hand-held specimen show 1-3mm indentations. Grains cannot be dislodged by knife blade.	5,0-10,0
Very strongly cemented	Hand-held specimen can be broken by single firm blow of hammer head. Similar appearance to concrete.	10,0-25

The results of the soil testing may be found in Addendum B. However, for easy reference, these results are summarized in the attached Table 2 : Summary of Soil Testing. The data sheets contained in Addendum B are copies of the originals, which are available from Roadlab.

6 SITE GEOLOGY AND GEOHYDROLOGY

The geology of the area between Upington and Groblershoop appears to consist of granitoid rock in the north, grading into metamorphic rocks towards Groblershoop, but it is in fact highly complex and from a stratigraphical viewpoint provides complicated formation. As a background to the site geology an effort is made in this subparagraph to provide a simplified

TABLE 2 : SUMMARY OF SOIL TESTING

TEST PIT NO	SAMPLE NO (CLG)	DEPTH (mm)	SOIL ORIGIN	SOIL TYPE	GM	PI	LL	ACTIVITY	pH	CONDUCTIVITY (Sm ⁻¹)	% < 0,002mm	OMC	MDD	SOIL CLASS		
														COLTO	PRA	UNIFIED
2	U9309	200-600	Hardpan calcrete	Sandy gravel	2,20	2	20	Low	7,76	0,16	0,4			A-1-a(0)	GW-GC	
9	U9310	0-800	Rock fragments	Gravelly sand	1,70	2	16	Low	7,90	0,03	0,8	6,5	2179	G6	A-1-b(0)	SC
15	U9307	100-500	Boulder calcrete	Sandy gravel	2,50	1	19	Low	7,77	0,12	0,3				A-1-a(0)	GW-GC
17	U9308	0-300	Boulder calcrete	Sandy gravel	2,20	2	24	Low			0,8				A-1-b(0)	GM
22	U9304	0-700	Boulder calcrete	Gravelly sand	1,80	4	26	Low	7,52	0,11	0,4	7,7	2146	G6	A-1-b(0)	SM
23	U9306	0-400	Colluvium	Gravelly sand	1,70	2	18	Low			1,2				A-2-4(0)	SC
25	U9305	0-600	Aeolian sand	Fine sand	0,90	NP	16	Low	7,63	0,13	0,3				A-2-4(0)	SC
30	U9303	0-500	Aeolian sand	Fine sand	1,00	6	30	Low	7,56	0,15	0,3				A-2-4(0)	SM
33	U9299	300-500	Rock fragments	Sandy gravel	2,10	6	34	Low			0,5				A-1-b(0)	SM
37	U9298	0-600	Aeolian sand	Fine sand	1,0	NP	12	Low	7,50	0,18	0,5				A-2-4(0)	SC
38	U9293	300-500	Rock fragments	Sandy gravel	2,20	5	24	Low			0,3				A-1-a(0)	GM-GC
40	U9297	0-300	Colluvium	Sandy gravel	2,30	2	24	Low	7,73	0,05	0,5	5,7	2096	G6	A-1-a(0)	GM
44	U9296	0-500	Colluvium	Sandy gravel	1,50	3	28	Low			0,9				A-2-4(0)	SM
46	U9295	0-700	Aeolian sand	Fine sand	1,10	NP	12	Low	7,70	0,09	0,4				A-2-4(0)	SC
50	U9294	200-1000	Rock fragments	Sandy gravel	2,30	6	30	Low	7,78	0,06	0,4	11,3	1957	G6	A-1-a(0)	GW-GM

explanation of the regional geology of the area. For this purpose publications by McCarthy^{Reference 14.2}, Cornell^{Reference 14.3} and Moen^{Reference 14.4} were consulted. Of these three references, the latter two can be regarded as site specific. However, there is disagreement between the two sources regarding the stratigraphic classification of the major subdivisions of the Namaqua-Natal province. As the work produced by Cornell is regarded as the reference document, his approach is adopted for this report.

Some concepts must be identified :

- *Craton* : A craton is a block of ancient crust, formed 3000 million years ago and its rocks have essentially remained unchanged. Cratons form the larger parts of the land-building mass.
- *Province* : A tectono-stratigraphic province is defined as a large area of contiguous structural fabric with well-defined boundaries which formed during a particular, geochronologically defined, tectono-metamorphic event. A province is further subdivided in sub-provinces and sub-provinces into terranes.
- *Terrane* : A terrane is a term for a tectonostratigraphic unit, which is a fragment of crustal material formed on, or broken off from, one tectonic plate and accreted or "sutured" to crust lying on another plate. The crustal block or fragment preserves its own distinctive geologic history, which is different from that of the surrounding areas.

6.1 Regional Geology

The geological processes by which the area under consideration was shaped, initiated some 1000 million years ago with the formation of the supercontinent Rodinia. A mountain chain of global extent formed along the boundaries, underlain by metamorphic rocks that have since then been exposed due to erosion. Metamorphic rocks of this age formed across South Africa to the south and west of the Kaapvaal Craton, known as the Namaqua-Natal Province. The Namaqua-Natal Province can be divided into five tectonostratigraphic subprovinces and terranes, based on marked changes in the lithostratigraphy across structural discontinuities. The five domains so recognized are the Richtersveld Subprovince, the Bushmanland Terrane, Kakamas Terrane, Areachap Terrane and Kaaien Terrane. The tectonic subdivision as proposed on Figure 2 (Cornell) is reproduced in this document as Figure 3.

The process of landforming can be described as compatible to the modern concept of plate tectonics. In this case the Namaqua plate became buried beneath the Kaapvaal Craton in a subduction zone. Considering the forces involved it can be regarded as a violent process, resulting in the breaking up of the landmass into the five domains as described above, associated with the intrusion of recycled rock material from the subduction zone. What is

important for this report is that in the case of the Kaaien terrane, the formation of metaquartzites, deformed early Namaquan volcano-sedimentary rocks and deformed, but thermally metamorphosed bimodal volcanic rocks resulted, amongst others. These rocks are at present referred to amongst others as the Brulpan Group, on which Groblershoop is located. There is controversy about the age of the Brulpan Group, but is estimated between 1710Ma to 1780Ma, underlying the Wilgenhoutsdrif Group.

The regional geology is indicated on Figure 4 : Regional Geology.

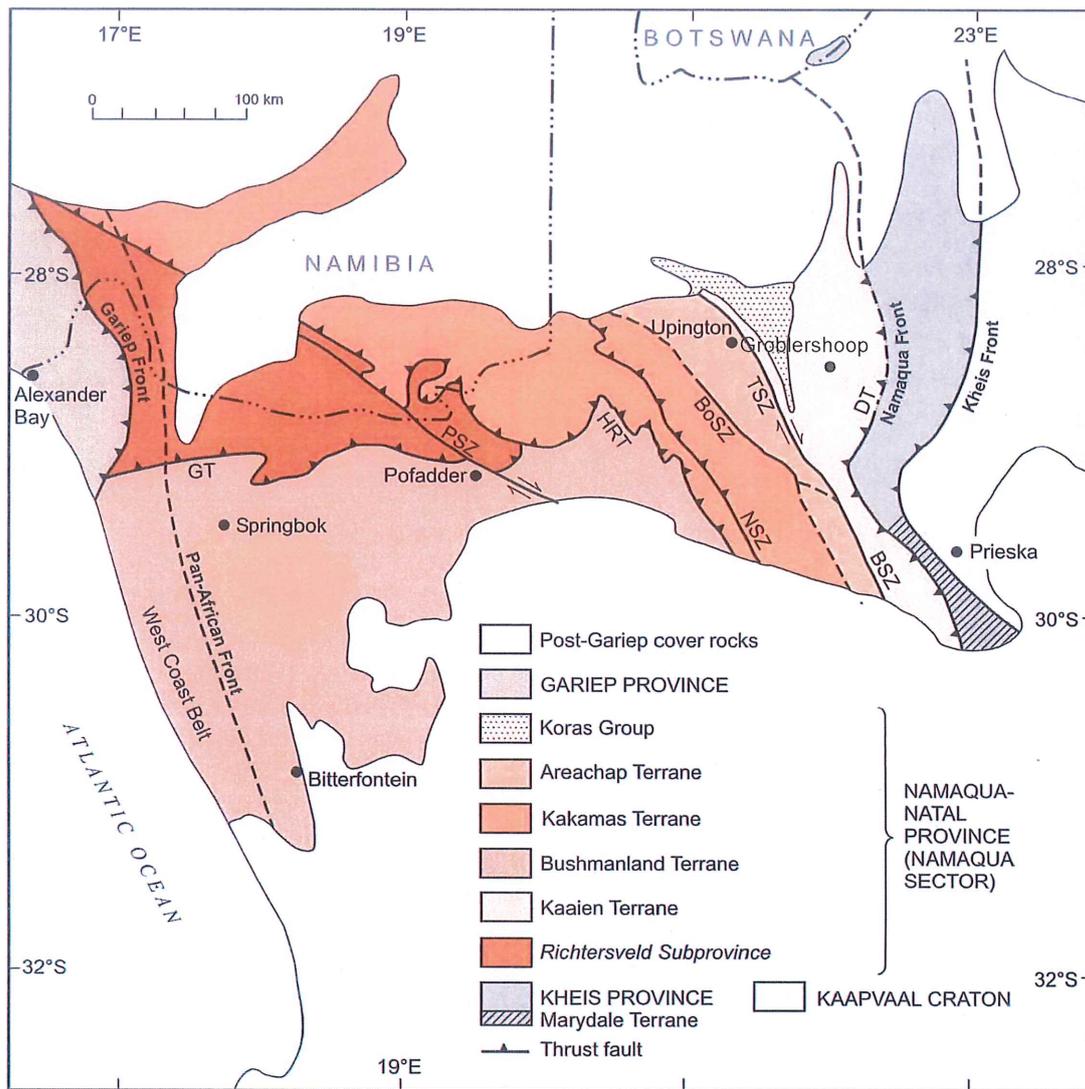
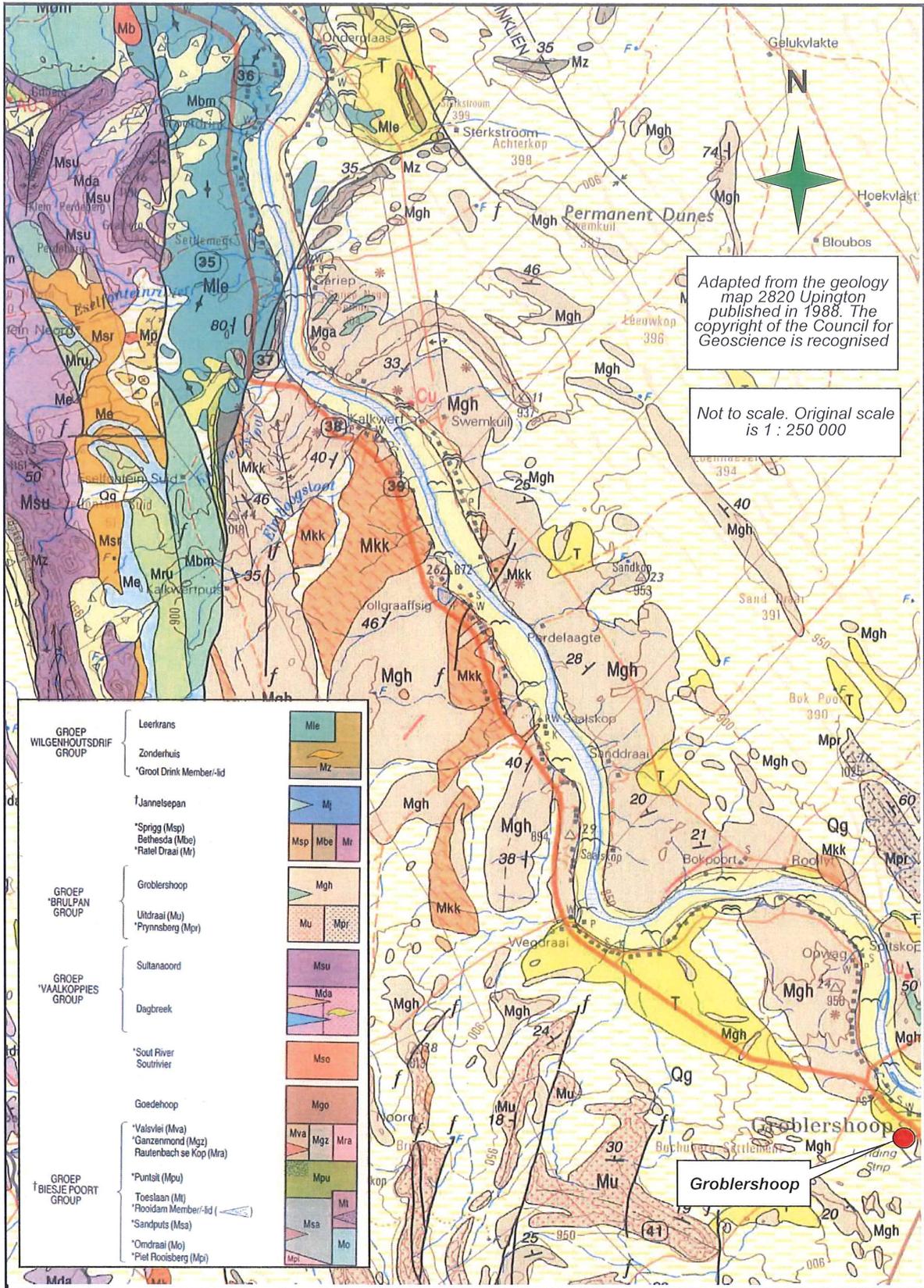


FIGURE 3 : TECTONIC SUBDIVISION OF THE NAMAQUA SECTOR

6.2 Site Geology

The site geology is illustrated on Figure 5. The soil and pedocretes are present as a very dense barrier over bedrock with exposures in areas of thin and less dense pedocrete deposits.



GROBLERSHOOP : REGIONAL GEOLOGY

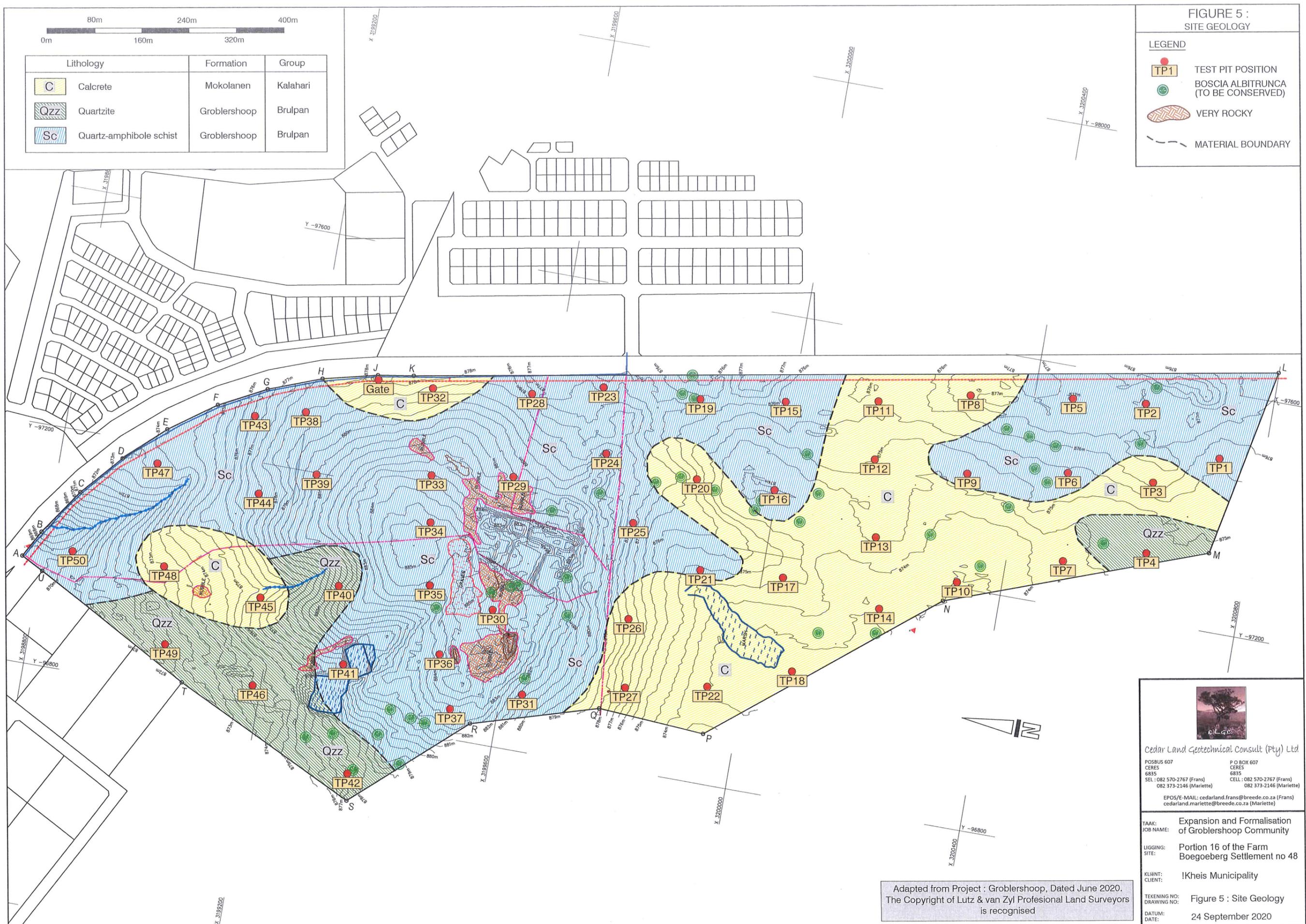
FIGURE 4

FIGURE 5 :
SITE GEOLOGY

LEGEND

- TP1 TEST PIT POSITION
- BOSCIA ALBITRUNCA (TO BE CONSERVED)
- VERY ROCKY
- MATERIAL BOUNDARY

Lithology	Formation	Group
C	Calcrete	Mokolanen Kalahari
QZZ	Quartzite	Groblershoop Brulpan
Sc	Quartz-amphibole schist	Groblershoop Brulpan





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TAASK:	Expansion and Formalisation of Groblershoop Community
JOB NAME:	Portion 16 of the Farm Boegoeberg Settlement no 48
LIGGING:	
SITE:	
KLIANT:	!Kheis Municipality
CLIENT:	
TEKENING NO:	Figure 5 : Site Geology
DATUM:	24 September 2020
DATE:	

Adapted from Project : Groblershoop, Dated June 2020.
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is recognised

Due to the irregular presence of pedocretes the inferred material boundaries must be accepted as indicative of the actual conditions only. Bedrock of the Groblershoop Formation of the Brulpan Group on site occurs as follows :

6.2.1 Quartzite

Quartzite was encountered in TP's 4, 40, 42, 46 and 49 only. It tends to be present in steeply dipping lineal bands of limited width rather than wide spread occurrences of rock. Due to its resistance to weathering it is present as easily identifiable outcrops of rock. It is generally described as light yellow grey speckled light brown or light grey, very fine grained, slightly weathered to unweathered, medium jointed to widely jointed, hard rock to very hard rock. The joints are smooth, closed and clean. The quartzite is sometimes muscovite rich.

6.2.2 Quartz-amphibole Schist

It was possible to penetrate the very dense calcrete into bedrock of quartz-amphibole schist in TP's 1, 2, 5, 6, 9, 15, 16, 19, 21, 23, 25, 28, 29, 31, 33 to 39, 41, 43, 44, 47 and 50. The quartz-amphibole schist is described as dull light grey green to yellow grey, speckled white or black, very closely jointed, very intensely laminated, unweathered to slightly weathered, hard rock to very hard rock. The joints in the rock matrices are usually open and filled with white calcareous sand, but the laminations are closed smooth and clean. Well-developed, needle like, black crystals of amphibole are present in the rock matrix. The crystals are up to 1mm thick and 2cm in length. The strata of quartz-amphibole schist dip at highly variable angles, estimated at between 30° and 75°.

6.3 Soil Profile

6.3.1 Aeolian Sand

The aeolian sand is described as light red, loose to very loose, intact, fine sand. It can be associated with the Gordonia Formation of the Kalahari Group. The sand consists of rounded quartz grains coloured red by a thin coating of haematite. The general consensus is that the aeolian sand is derived from local sources with some additional material transported over short distances.

Aeolian sand was encountered as surface deposits in TP's 1, 4, 7, 10, 16, 19, 20 and 22 as deposits most probably subjected to some previous alluvial rework action. The horizon of alluvial sand extended to depths varying between 300mm and 800mm in these test pits.

The deposits to the north of the imaginary line formed by TP's 23 to 27 can be regarded as true dune deposits. Under these conditions aeolian sand was encountered in TP's 24, 25, 30, 31, 36, 37, 42 and 46 extending to depths varying between 100mm and 1900mm.

6.3.2 Colluvium

On site colluvium was encountered as a surface horizon in test pits TP's 2, 3, 5, 6, 9, 11 to 15, 17, 18, 21,23, 26 to 29, 32 to 35, 38 to 41, 44, 45 and 47 to 48. It was present to depths varying between 100mm minimum to 700mm maximum, at which stage calcrete was usually encountered. The colluvium was also encountered underlying the younger aeolian sand in TP's 1, 7, 24, 30, 36 and 46, occurring from depths between 500mm and 1900mm minimum, extending to 700mm to 2100mm. In the latter case the vertical extent of the colluvium could not be determined reliably as the aeolian sand tended to collapse in the test pits.

The colluvium is a homogenous material, consisting light brown fine sand and clasts of gravels and cobbles of quartz and some calcrete. Isolated occurrences of banded ironstone prove that the colluvium may also be present as transported alluvial terrace gravel. The consistency of the colluvium is loose to medium dense and the soil matrix intact.

6.3.3 Mokalanen Formation

Calcrete of the Mokalanen Formation, Kalahari Group, is present as an ubiquitous surface duricrust on site. In the strictest sense calcrete cannot be regarded as either rock or soil, but as a duricrust with properties and a geological context all of its own. However, for purposes of discussion it is regarded as a soil due to the possibility of retrieving samples thereof for purposes of materials testing.

There is a difference in opinion between Moen (Reference 14.4 page147) and Partridge^{Reference 14.5} regarding the origin of the calcrete. Moen regards the calcrete as being of Tertiary age, but some doubt whether the outcrops are of the same age and in some localities it may still be in the process of forming. Partridge describes the age of the calcrete as straddling the boundary between the Pliocene and Quaternary, making it some 2,6 to 2,8 million years old. It was deposited under arid conditions and possibly reflects a climatic interval of global aridification.

The engineering properties of calcrete may differ widely for samples taken from the same locality. It is therefore important to provide some background in this regard to aid in the understanding of these conditions.

Brink^{Reference 14.6} states that during pedocrete development, clay and silt become flocculated and cemented into larger silt to gravel-sized complexes of varying strength and porosity. These particles and aggregations may or may not break down during laboratory testing and under compaction. The mineralogy of the cementing material and of the clay fraction is different from those of normal, temperate zone soils on which current specifications for soil testing and classification is based. Calcrete can therefore be expected to exhibit differences in behaviour from those of traditional soil materials.

Whereas in traditional soil mechanics it is assumed that all the water is outside the particles, calcrete aggregates retain moisture and this affects conventional moisture content and Atterberg limit determinations. Palygorskite which is the dominant clay in calcrete has approximately the same plasticity index as some smectites, which can be regarded as highly expansive. However, the palygorskite has a non-expansive lattice and a hollow, needle-like shape instead of the usual flaky particle shape of most other clays. It has the lowest shrinkage limit and dry density and the highest optimum moisture content and shear strength of all clays.

Be it as it may, calcrete was encountered as a widely distributed material on site, continuously covering the Groblershoop Formation, only to be covered in the high-lying parts of the land by aeolian sand of the Gordonia Formation, Kalahari Group. The calcrete was encountered in TP's 2, 3, 7, 8, 10 to 22 in the low-lying land mostly as very dense, boulder calcrete. In the high-lying part of the land it was encountered in TP's 25 to 30, 32 to 34, 37, 39, 40, 45 and 48 mostly as dense to very dense hardpan calcrete. The calcrete is present as outcrops ; or underlies the transported materials, occurring from depths between zero and 800mm minimum, extending to 100mm to 1200mm maximum, at which stage refusal of excavation occurred or bedrock was encountered. Moen reports the calcrete to be up to five meters thick in the area. Minor outcrops of calcrete are present randomly across the site. It is described as dirty white to dirty light yellow white, very fine grained, very dense calcrete. Some fine sand may occasionally be contained in voids in the matrix of the calcrete.

6.3.4 Residual Quartzite

On site residual quartzite was encountered in TP 49 only underlying the colluvium. It consists of cobbles and boulders of quartzite with diameter less than 500mm contained a matrix of dry, light brown sand. The soil matrix is medium dense and weakly calcareous cemented. The horizon of residual quartzite extended to a depth of 700mm in the test pit, prior to encountering bedrock of quartzite.

6.4 Groundwater

6.4.1 Perched Water

Perched groundwater was not encountered in any of the test pits excavated for this investigation. Considering the climate of the area and the nature of in situ materials, it is anticipated that perched water will generally not prove problematic on the site, except in the lesser drainage courses of the site after events of inundation. Even if it did occur, the grading of in-situ materials is such that dispersal will take place fairly rapidly. Furthermore, it is expected that perched water and/or surface seepage may occur shortly after precipitation events and in years of excessive rain only.

6.4.2 Permanent Groundwater

Vegter^{Reference 14.7} indicates the probability for drilling successfully for water in the area to be between 40% and 60%, and the probability that such a borehole will yield more than 2l/s is between 10% and 20%. Groundwater is expected to occur at depths less than 15 meters in compact, argillaceous strata.

7 GEOTECHNICAL EVALUATION

The engineering properties of the in-situ materials are summarized in Table 3 : Summary of Engineering Properties. The characterizations have been derived based on the Unified materials classifications as reported by literature studies.

7.1 Engineering and Material Characteristics

7.1.1 Properties of Heave

The results of the materials testing as reported in Table 2 indicate the in-situ materials are not expansive. Any future structures will thus not be subject to heave. The content of active clay, that is the material smaller than 0,002mm in diameter, was less than 1,2% for all the samples tested.

7.1.2 Properties of Settlement

7.1.2(i) *Aeolian Sand*

The aeolian sand is described as light red, loose to very loose, intact, fine sand. The sand is unconsolidated and consists of rounded quartz grains coloured red by a thin coating of

TABLE 3 : SUMMARY OF ENGINEERING PROPERTIES

TEST PIT NO	SAMPLE NO	DEPTH (mm)	SOIL ORIGIN	SOIL TYPE	SOIL CLASS		COHESION ¹ (kNm ⁻²)	FRICTION ANGLE (°) ¹	COMPRESSIBILITY ²	EROSION RESISTANCE ²⁺⁵	PERMEABILITY ² k (cms ⁻¹)	SPECIFICATIONS FOR UNPAVED ROADS ³					SUITABILITY FOR ROAD CONSTRUCTION ⁴	
					PRA	UNIFIED						MAXIMUM SIZE	OVERSIZE INDEX (I _o)	GRADING COEFFICIENT (G _o)	SHRINKAGE PRODUCT (S _p)	CBR @ 95% MOD	PAVED	UNPAVED
2	U9309	200-600	Hardpan calcrete	Sandy gravel	A-1-a(0)	GW-GC	0 to 20	28° to 40°	Negligible to very low	1 to 3	Highly variable	50,0	8	20,2	45,0			Ravels & corrugates
9	U9310	0-800	Rock fragments	Gravelly sand	A-1-b(0)	SC	5 to 10	30° to 35°	Low	5	(3±2)X10 ⁻⁷	63,0	8	11,8	50,0	28	Subbase & base	Ravels & corrugates
15	U9307	100-500	Boulder calcrete	Sandy gravel	A-1-a(0)	GW-GC	0 to 20	28° to 40°	Negligible to very low	1 to 3	Highly variable	63,0	4	10,3	19,0			Ravels & corrugates
17	U9308	0-300	Boulder calcrete	Sandy gravel	A-1-b(0)	GM	<5	30° to 40°	Negligible	4	>3X10 ⁻⁷	50,0	3	19,5	48,0			Ravels & corrugates
22	U9304	0-700	Boulder calcrete	Gravelly sand	A-1-b(0)	SM	20 to 22	32° to 35°	Low	8	(7,5±4,8)X10 ⁻⁶	75,0	7	9,9	90,0	28	Subbase & base	Ravels & corrugates
23	U9306	0-400	Colluvium	Gravelly sand	A-2-4(0)	SC	5 to 10	30° to 35°	Low	5	(3±2)X10 ⁻⁷	50,0	9	10,4	53,0			Ravels & corrugates
25	U9305	0-600	Aeolian sand	Fine sand	A-2-4(0)	SC	5 to 10	30° to 35°	Low	5	(3±2)X10 ⁻⁷	20,0	0	2,0	44,0			Ravels & corrugates
30	U9303	0-500	Aeolian sand	Fine sand	A-2-4(0)	SM	20 to 22	32° to 35°	Low	8	(7,5±4,8)X10 ⁻⁶	14,0	0	3,9	178,0			Erodible
33	U9299	300-500	Rock fragments	Sandy gravel	A-1-b(0)	SM	20 to 22	32° to 35°	Low	8	(7,5±4,8)X10 ⁻⁶	50,0	4	22,1	85,0			Ravels & corrugates
37	U9298	0-600	Aeolian sand	Fine sand	A-2-4(0)	SC	5 to 10	30° to 35°	Low	5	(3±2)X10 ⁻⁷	20,0	0	2,0	0,0			Ravels & corrugates
38	U9293	300-500	Rock fragments	Sandy gravel	A-1-a(0)	GM-GC	<5	28° to 40°	Negligible to very low	Highly variable	>3X10 ⁻⁷	50,0	0	21,4	75,0			Ravels & corrugates
40	U9297	0-300	Colluvium	Sandy gravel	A-1-a(0)	GM	<5	30° to 40°	Negligible	4	>3X10 ⁻⁷	50,0	10	12,8	43,5	42	Subbase & base	Ravels & corrugates
44	U9296	0-500	Colluvium	Sandy gravel	A-2-4(0)	SM	20 to 22	32° to 35°	Low	8	(7,5±4,8)X10 ⁻⁶	28,0	0	21,0	93,0			Ravels & corrugates
46	U9295	0-700	Aeolian sand	Fine sand	A-2-4(0)	SC	5 to 10	30° to 35°	Low	5	(3±2)X10 ⁻⁷	20,0	0	5,8	0,0			Ravels & corrugates
50	U9294	200-1000	Rock fragments	Sandy gravel	A-1-a(0)	GW-GM	<5	30° to 40°	Negligible	1 to 4	(2,7±1,3)X10 ⁻²	75,0	14,0	11,8	50,0	31	Subbase & base	Ravels & corrugates

1 Obrzud RF and Truty A : The Hardening Soil Model - A Practical Guidebook, 2018 edition, revised 21 October 2018.
 2 Brink ABA et al : Soil Survey for Engineering, published in 1982.
 3 The Structural Design, Construction and Maintenance of Unpaved Roads (Draft TRH 20), Committee of State Road Authorities 1990.
 4 Structural Design of Flexible Pavements for Interurban and Rural Roads (Draft TRH 4), Committee of State Road Authorities 1996.
 5 Erosion resistance : 1 is best 10 is poor.

haematite. Aeolian sand was encountered in TP's 1, 4, 7, 10, 16, 19, 20, 22, 24, 25, 30, 31, 36, 37, 42 and 46 extending to depths varying between 100mm and 1900mm. Due to its very loose consistency the aeolian sand can be considered as highly compressible.

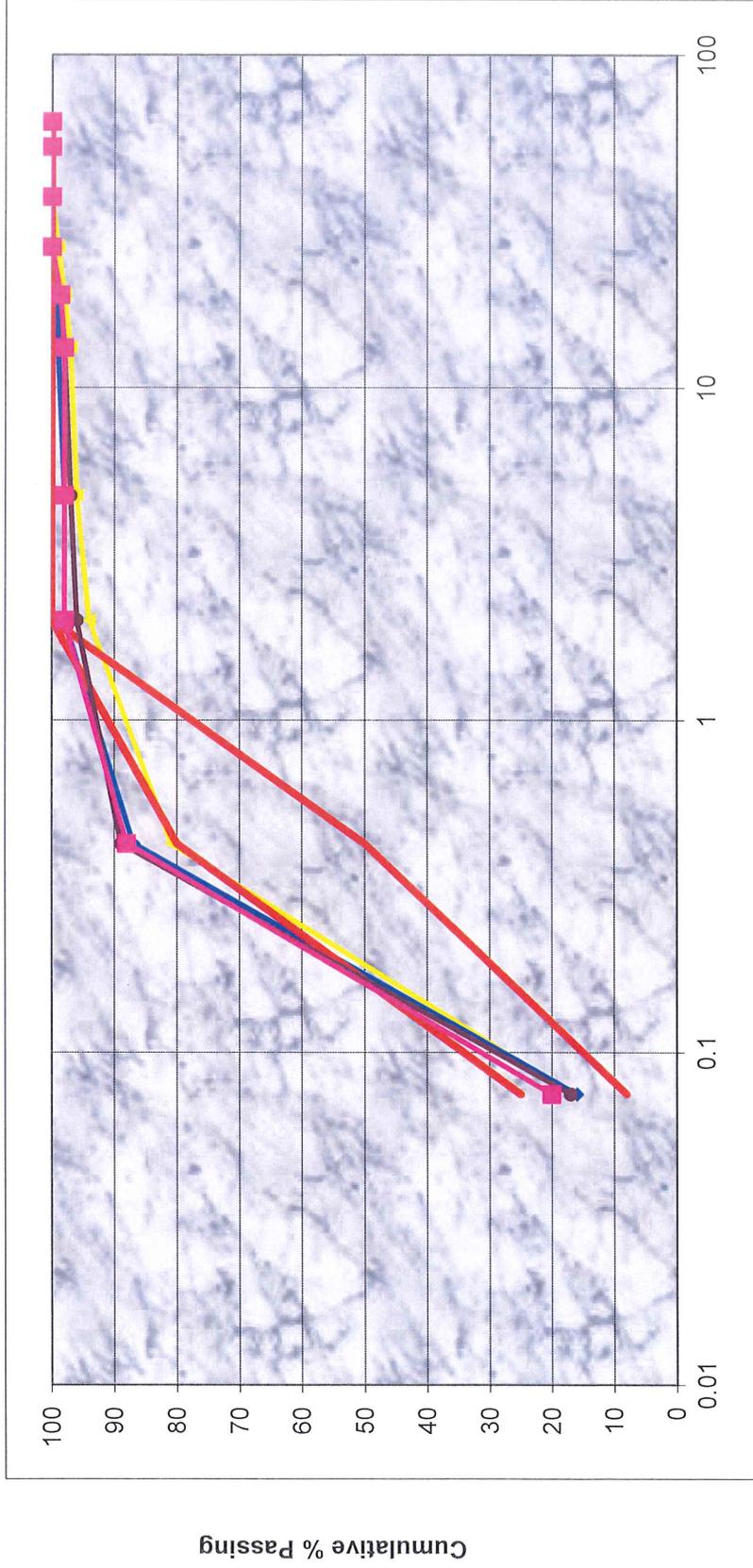
A case is often made for the collapsing properties of aeolian sand originating from the Gordonia Formation. The correct procedure to determine the collapse potential of a soil material is to conduct a collapse potential test on an undisturbed sample in the laboratory. In the case of this investigation it was not possible to retrieve an undisturbed sample from the aeolian sand due to its friable and very loose consistency. However, Errera^{Reference 14.8} proved specifically for the aeolian sand that potential properties of collapse can be determined on a parametric basis by plotting the grading curves of the sand. Should the grading curves fit into a so-called Errera envelope, the sand can be regarded as potentially collapsible. Figure 6 shows the grading curves of the various samples of aeolian sand retrieved during this investigation. Of these, only Sample U2995 fit partially into the envelope. The aeolian sand encountered during this investigation is therefore not regarded as collapsible.

7.1.2(ii) Colluvium

Colluvium was encountered as a surface horizon in test pits TP's 2, 3, 5, 6, 9, 11 to 15, 17, 18, 21, 23, 26 to 29, 32 to 35, 38 to 41, 44, 45 and 47 to 48. It was present to depths varying between 100mm minimum to 700mm maximum, at which stage calcrete was usually encountered. The colluvium was also encountered underlying the younger aeolian sand in TP's 1, 7, 24, 30, 36 and 46, occurring from depths between 500mm and 1900mm minimum, extending to 700mm to 2100mm. The colluvium is a homogenous material, consisting of light brown fine sand and clasts of gravels and cobbles of quartz and some calcrete. The consistency of the colluvium is loose to medium dense and the soil matrix intact. The properties of the gravelly colluvium are thus such that it does not tend to excessive settlement.

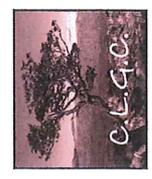
7.1.2(iii) Pedocretes

Calcrete was encountered as a widely distributed material on site in TP's 2, 3, 7, 8, 10 to 22 in the low-lying land mostly as very dense, boulder calcrete. In the high-lying part of the land it was encountered in TP's 25 to 30, 32 to 34, 37, 39, 40, 45 and 48 mostly as dense to very dense hardpan calcrete. The calcrete is present as outcrops ; or underlies the transported materials, occurring from depths between zero and 800mm minimum, extending to 100mm to 1200mm maximum, at which stage refusal of excavation occurred or bedrock was encountered. It can thus accommodate stresses imposed by conventional housing structures without undue settlement. Only limited – if any – settlement can thus be expected for structures such as single storey units of masonry construction.



Sieve sizes (To Log Scale)

- Errera envelope
- Sample U9305
- Sample U9303
- Sample U9298
- Sample U9295



ERRERA ENVELOPE FOR COLLAPSING SAND

FIGURE 6

7.1.2(iv) Residual Quartzite

Residual quartzite was encountered in TP 49 only underlying the colluvium. It consists of cobbles and boulders of quartzite with diameter less than 500mm contained a matrix of dry, light brown sand. The soil matrix is medium dense and weakly calcareous cemented. The horizon of residual quartzite extended to a depth of 700mm in the test pit, prior to encountering bedrock of quartzite. The properties of the residual quartzite are thus such that it does not tend to excessive settlement.

7.1.3 Corrosivity

When discussing soil corrosivity, it is applicable to consider the guidelines as proposed by Evans^{Reference 14.9}. The corrosivity of a soil towards buried, exposed, metallic surfaces is dependent on the following properties of the soil :

- Electrical conductivity.
- Chemical properties of the soil.
- Ability of the soil to support sulphate reducing bacteria.
- Heterogeneity of the soil.

The tests carried out for the compilation of this report must be considered as indicative of the corrosivity of the soils only. The pH of a soil gives an indication of potential acid related problems. Should the soil pH be less than 6,0, corrosion may take place ; and should the pH be less than 4,50, the problem of corrosion may be serious. If the conductivity of the soil is less than $0,01\text{Sm}^{-1}$, corrosiveness is generally not a problem. However, the potential for corrosivity of the soil increases with an increase in conductivity. Should the conductivity of the soil exceed $0,05\text{Sm}^{-1}$, the soil can be regarded as very corrosive. Should exposed metal pipes pass from argillaceous soils to arenaceous soils or vice versa, electrochemical cells are set up due to the different rates of oxygen diffusion of the soils. Sulphate reducing bacteria is usually present under anaerobic conditions, that is, typically saturated or waterlogged clays.

The results of the chemical testing carried out for this report indicate the following :

- *Acidity* : The pH of the samples of material tested varied between 7,58 and 7,87. The soils are thus regarded as not corrosive due to the acidity there of.
- *Water Soluble Salts Content* : The conductivity of the samples of material tested varied between $0,03\text{Sm}^{-1}$ for the fragments of quartz-amphibole schist to $0,18\text{Sm}^{-1}$ for the aeolian sand. However, for all materials tested a wide scatter of results occur, from non-corrosive to highly corrosive. One therefore has to accept that all residual materials can be regarded as corrosive due to their high soluble salt contents.

Other considerations are :

- *Heterogeneity of the Soil* : Conditions of corrosive soils due to a heterogeneous soil profile do not occur on the property.
- *Water Logged Soils* : Conditions of water logged soils do not naturally occur on site, but may be present as a result of dumping of waste water.

7.1.4 Materials Utilisation

7.1.4(i) Backfilling of Service Trenches

The hardpan calcrete is not suitable to be used for any type of backfill due to its tendency to break into boulder and cobble sized fragments on excavation. Such fragments cannot be compacted properly on backfilling.

The colluvium can be used for normal backfilling of services trenches. However, due to the coarse granular composition thereof, these materials are not suitable for pipe bedding or selected backfill around pipes.

The aeolian sand does not contain any coarse materials nor any significant clay particles. It may thus be used for selected backfill and pipe bedding.

7.1.4(ii) Construction of Paved or Segmental Block Streets

Only provisional indicators for future guidance of development are provided as far as material quality for road construction is concerned, complying with the requirements applicable to the level of investigation.

The results of the compaction testing on soil samples show the fragments of quartz-amphibole schist, calcrete and colluvium to be of G6 quality. These materials are thus suitable for purposes of paved road or segmental block paving construction. This type of construction is applicable to access roads to townships. The soil materials are therefore suitable for the construction of base and subbase course construction of lightly trafficked roads. The aeolian sand was not tested for this purpose, but can be regarded as suitable for an in-situ roadbed only.

7.1.4(iii) Wearing Course for Urban Gravel Roads

The properties to provide guidance for the use of soil materials for the structural design of a wearing course for urban gravel roads are contained in the various sub-columns of the

column "Specifications for Unpaved Roads" in Table 3. The various parameters are colour-coded : Green = suitable ; red = unsuitable. The two sub-columns with a light yellow-brown background contain the parameters on which the physical behaviour of the wearing is course is determined.

From the table it is clear that none of the in-situ materials comply in all aspects to the requirements for a gravel wearing course. In most cases the use of these materials will result in a wearing course subject to raveling and corrugations. This can be attributed the non-cohesive character of most of the materials. In contradiction to the construction of paved roads, calcrete appears to be the material more suitable for gravel wearing course construction, although experience has taught that if a calcrete with a high PI is used for this purpose, the road surface can become slippery in wet conditions.

7.1.5 Other Considerations

The properties discussed in this subsection of the report were obtained from literature reported values based on studies done by the US Army Corps of Engineers as reported by Brink^{Reference 14.10} for compacted material. This approach is followed as the arenaceous character of the in-situ materials that did not allow the retrieval of undisturbed sampling. The typical soil properties associated with the Unified classifications of the materials are thus reported.

7.1.5(i) Compressibility

The compressibility of the material can be regarded as a necessary input to pavement design as well as lesser important supporting information for geotechnical classification for site class designation.

- *Colluvium* : The colluvium is regarded as low to negligible compressible with cohesion (c_0) of less than $5,0\text{kNm}^{-2}$ to 22kNm^{-2} and the effective stress envelope approximately 30° to 40° .
- *Calcrete* : The calcrete is regarded as negligible to very low compressible with cohesion (c_0) of less than $5,0\text{kNm}^{-2}$ to 22kNm^{-2} and the effective stress envelope approximately 28° to 40° .
- *Aeolian Sand* : The aeolian sand is regarded as low compressible with cohesion (c_0) of $5,0\text{kNm}^{-2}$ to 22kNm^{-2} and the effective stress envelope approximately 30° to 35° .

7.1.5(ii) Permeability

Permeability is an important parameter in the design of surface drainage and seepage drains.

As such indicators in this regard are provided.

- *Colluvium* : The colluvium is regarded as semi-pervious to impervious. The soil permeability coefficient varies between $2,7 \times 10^{-6} \text{cms}^{-1}$ to $>3,0 \times 10^{-7} \text{cms}^{-1}$.
- *Hardpan Calcrete* : The permeability of the hardpan calcrete is highly variable depending on the mode of deposition and regarded as pervious to impervious. The soil permeability coefficient varies between more permeable than $1,5 \times 10^{-2} \text{cms}^{-1}$ to $>3,0 \times 10^{-7} \text{cms}^{-1}$.
- *Aeolian Sand* : The aeolian sand is regarded as impervious. The soil permeability coefficient varies between $2,7 \times 10^{-6} \text{cms}^{-1}$ to $3 \times 10^{-7} \text{cms}^{-1}$.

7.1.5(iii) Erosion Potential

The colluvium and calcrete can be regarded as moderately to slightly erodible. The aeolian sand can be regarded as moderately to highly erodible.

7.2 Properties of Bedrock

The TLB used to excavate the test pits did not penetrate the calcrete or bedrock of quartzite or schist to any significant extent and refusal of excavation occurred within millimeters after encountering these materials. It is not customary to penetrate bedrock in the case of a geotechnical investigation for purposes of a residential development. Refusal of excavation on hard rock is accepted as suitable. One can thus accept bedrock to be hard tending to very hard once refusal of excavation was encountered.

7.2.1 Calcrete

Voided matrices were not encountered in the hardpan calcrete during the investigation. The results of the materials testing on samples of the calcrete approach that of sandy gravel. However, it must be borne in mind that in in-situ conditions the properties of hardpan calcrete approach that of hard rock rather than a gravelly sand. The grading modulus of the samples of calcrete fragments tested as 1,80 to 2,50 ; plasticity index as one to four ; and clay content less than 1,0%. The activity of the calcrete is described as low. The PRA classification of the calcrete is A-1-a(0) to A-1-b(0) ; and the Unified classification is GW to SM. Based on these properties and material classification the calcrete is regarded as non-expansive and no consolidation settlement and no collapse settlement can thus be expected for structures such as single storey units of masonry construction.

The test results of the samples of the calcrete reflect the properties of excavated fragments of material and not the intact mass of calcrete. It is therefore accepted that the properties of the very dense calcrete can be considered as tending towards soft rock to hard rock, limestone.

Brink (Reference 14.6) reports an average UCS of 32MPa for intact samples of hardpan calcrete from the Kalahari region. Using this as input to parametric calculations with Roclab software results for very dense calcrete tending to widely jointed, slightly weathered, medium hard rock, limestone result in the following properties :

- Cohesion : 1,08MPa
- Friction Angle : 24°
- Tensile Strength : 0,018MPa
- Uni-axle Compressive Strength : 550kPa
- Young's Modulus : 2340MPa

All which show a sound pedocrete, not compressible, not permeable nor subject to erosion.

7.2.2 Quartzite

Parametric calculations with Roclab software results for unweathered, jointed, very hard rock result in the following properties :

- Cohesion : 11,0MPa
- Friction Angle : 36,6°
- Tensile Strength : 0,35MPa
- Uni-axle Compressive Strength : 14,1MPa
- Young's Modulus : 21435MPa

All which show a sound, very hard and durable rock.

7.2.3 Quartz-amphibole Schist

Parametric calculations with Roclab software results for slightly weathered, very closely jointed, very intensely laminated, hard rock result in the following properties :

- Cohesion : 3,4MPa
- Friction Angle : 29,0°
- Tensile Strength : 0,07MPa
- Uni-axle Compressive Strength : 2,5MPa
- Young's Modulus : 8082,4MPa

The above calculations are for schists dipping at 90° with the horizontal plane. Should the angle of dip change the tensile strength, UCS and Young's modulus may change accordingly.

7.3 Excavation Classification with Respect to Services

7.3.1 Hand Excavation

7.3.1(i) *Aeolian Sand*

The aeolian sand can be considered as suitable to be excavated by swing tools. However, due to its very loose consistency the side walls of excavations tend to collapse – even in shallow excavations.

7.3.1(ii) *Colluvium*

The colluvium can be considered as suitable to be excavated by swing tools.

7.3.1(iii) *Pedogenic Deposits*

The boulder and hardpan calcrete are of dense to very dense consistency. Such material cannot be considered as suitable to be manually excavated and may as minimum require the use of a 55kW TLB, but preferably a 30 ton excavator to remove it on an economical basis.

7.3.1(iv) *Residual Quartzite*

The residual quartzite is of dense to very dense consistency containing boulders of quartzite. Such material cannot be considered as suitable to be manually excavated and may as minimum require the use of a 55kW TLB, but preferably a 30 ton excavator to remove it on an economical basis.

7.3.1(v) *Bedrock*

Bedrock of quartzite or quartz-amphibole schist cannot be excavated manually successfully.

7.3.2 Classification of Material for Machine Excavation

In terms of Table 5 of SANS 634 : 2012 the following is applicable :

7.3.2(i) *Restricted Excavation*

- *Soft Excavation* : The colluvium, aeolian sand and residual quartzite can be regarded as soft excavation. The thickness of these strata varied between 100mm and 2100mm in the

test pits, averaging 410mm prior to encountering conditions of intermediate or hard rock excavation.

- *Intermediate Excavation* : Refusal of excavation with a TLB occurred in most cases once very dense, hardpan calcrete or slightly weathered to unweathered rock was encountered. However, some penetration into the hardpan calcrete or bedrock was possible and can be regarded as intermediate excavation. It was possible to penetrate between 100mm and 900mm into the hardpan calcrete and bedrock, averaging 330mm thick, prior to encountering hard rock excavation.
- *Boulder Class A Excavation* : Conditions of Boulder Class A excavation may be encountered in the residual quartzite. However in TP 49 the consistency of such material was medium dense only and the presence of cobbles and boulders did not impede the removal of the material with the TLB.
- *Hard Rock Excavation* : Refusal of excavation occurred on conditions of hard rock excavation in all the test pits at depths varying between 100mm and 1500mm, averaging 700mm.

7.3.2(ii) Non-restricted Excavation

The classification as per subparagraph 7.3.2(i) : Restricted Excavation as above is also applicable for non-restricted excavation.

7.4 Seismicity

A 10% probability of an event with magnitude less than 100cms⁻² to take place once in 50 years is regarded as favourable ; and a natural seismic activity with magnitude exceeding 100cms⁻² is regarded as unfavourable. Based on a report compiled by Kijko^{Reference 14.11} a 10% probability exists that an earthquake with Peak Ground Acceleration exceeding of 0,05g may take place once in 50 years in Groblershoop.

The closest source of seismic measurements to Opwag under control of the Council for Geoscience is Tontelbos at 31° 10' 12"S and 20' 30' 00"E.

- The annual probability for an earthquake with intensity of 4,5 on the Modified Mercalli Scale to occur in the area is less than 10^{-0,7} ; and with an intensity of 8,5 to occur the probability is 10^{-3,8}.
- The annual probability for an earthquake with an acceleration of 10^{-1,9}g to occur in the area is less than 10^{-0,7} ; and with an acceleration of 10^{-0,75}g to occur in the area is less than 10^{-3,8}.

To put the above information into perspective, Table 4 : Earthquake and Magnitude and Intensity, is attached to this report.

TABLE 4 : EARTHQUAKE MAGNITUDE AND INTENSITY

MODIFIED MERCALLI INTENSITY SCALE	INTENSITY	DESCRIPTION	RICHTER SCALE MAGNITUDE	RADIUS OF PERCEPTIBILITY (km)
I	Instrumental	Detected only by seismography		
II	Feeble	Noted only by sensitive people	3.5 to 4.2	3 to 24
III	Slight	Like the vibrations due to a passing lorry. Felt by people at rest, especially on upper floors		
IV	Moderate	Felt by people while walking. Rocking of loose objects, including vehicles	4.3 to 4.8	24 to 48
V	Rather strong	Felt generally ; most sleepers are awakened and bells ring		
VI	Strong	Trees sway and suspended objects swing ; damage by overturning and fling of loose objects	4.9 to 5.4	48 to 112
VII	Very strong	General public alarm ; walls crack ; plaster falls	5.5 to 6.1	110 to 200
VIII	Destructive	Car drivers seriously disturbed; masonry fissured ; buildings damaged	6.2 to 6.9	200 to 400
IX	Ruinous	Houses collapse ; pipes break		
X	Disasterous	Ground cracks badly ; buildings destroyed ; railway lines bent ; landslides on steep slopes	7.0 to 7.3	400 to 700
XI	Very disasterous	Few buildings remain standing; bridges destroyed ; all services out of action ; great landslides and floods	7.4 to 8.1	400 to 700
XII	Catastrophic	Total destruction ; objects thrown into the air; ground rises and falls in waves	>8.1	400 to 700

7.5 Undermining

The area of investigation is not undermined.

7.6 Dolomite Stability

The area of investigation is not subject to dolomite related instabilities.

8 SITE CLASS DESIGNATIONS

Based on the above discussions the property can be divided into five zones as per the guidelines posted by SANS 10400 : Section H^{Reference 14.12} . The zonation is indicated on Figure 7 : Site Class Designation.

8.1 Geotechnical Zone I

The zone can be divided into two parts. The geotechnical conditions are similar in both parts and characterized by the presence of rock and very dense calcrete at depths less than 400mm, but distinction can be made on land slope and previous land use as follows :

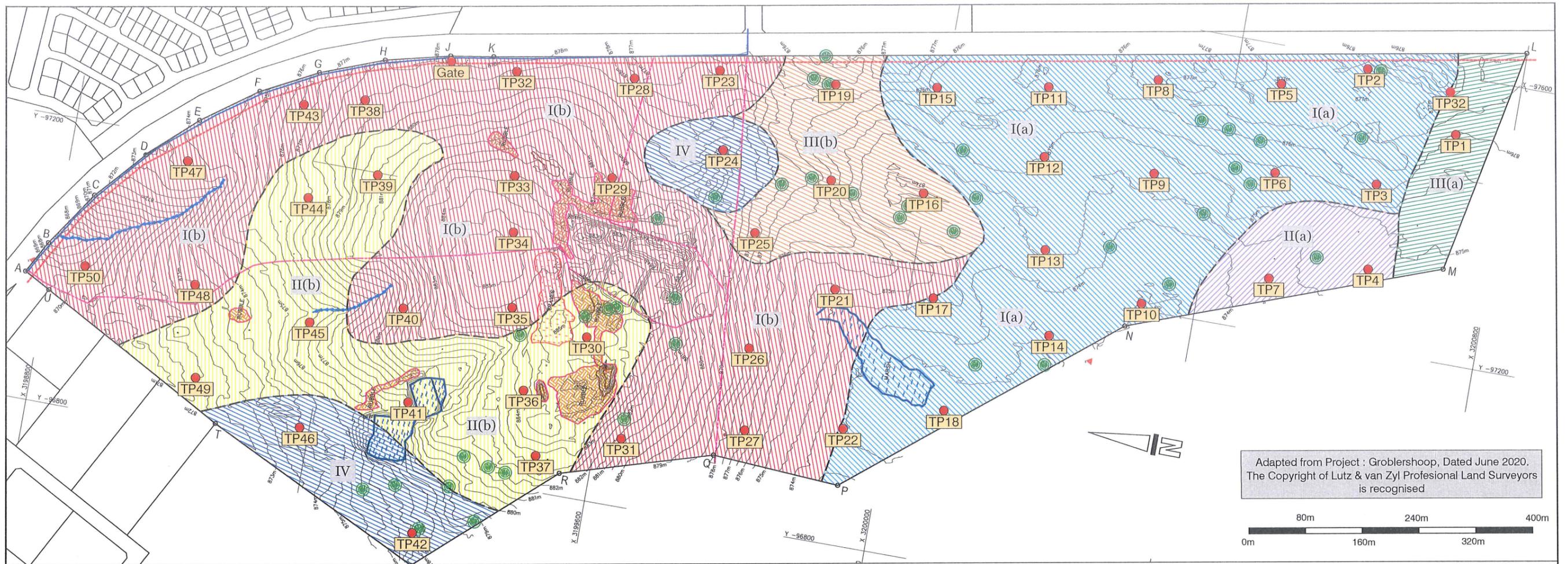
8.1.1 Geotechnical Zone I(a)

This zone comprises 28% of the area investigated. It is characterized by the materials profiles of TP's 2, 3, 5, 6, 8 to 15, 17 and 18. It covers the larger part of the southern low-lying land on a continuous basis. It consists of a superficial horizon less than 400mm thick comprising of colluvium, reworked aeolian sand and very dense calcrete overlying bedrock of quartzite and quartz-amphibole schist. Several outcrops of calcrete, quartzite and schist occur in the area. Slope across the land is less than 2%. Foundation stresses induced by conventional strip foundations for single and double storey structures will result in almost negligible settlement if founded directly on the slightly weathered and unweathered hard rock to very hard rock, or on the very dense calcrete. The area is thus zoned as "R" and regarded as stable.

The development potential of the land is detrimentally influenced by the slope of the land being less than 2%, conditions of hard rock excavation and presence of active waste water dumping in the area of TP's 17, 18 and 22.

8.1.2 Geotechnical Zone I(b)

This zone comprises 36% of the area investigated. It is characterized by the materials profiles of TP's 21, 23, 26 to 29, 32 to 35, 38, 40, 43, 47, 48 and 50. It is present along the north eastern boundary of the site extending through centrally to the west and includes the two drainage courses. It consists of a superficial horizon less than 400mm thick comprising of colluvium and reworked aeolian sand less than 400mm thick overlying very dense hardpan



FOUNDATION DESIGN, BUILDING PROCEDURES AND PRECAUTIONARY MEASURES

AREA	AREA OF PROPERTY (%)	GEOTECHNICAL CLASS	ESTIMATED SOIL MOVEMENT(mm)	SOIL PROFILE	CONSTRUCTION TYPE	FOUNDATION DESIGN	ASSOCIATED PROBLEMS	DEVELOPMENT POTENTIAL	FIGURE 7 : SITE CLASS DESIGNATION
I(a)	27,54	R	Negligible	Less than 400mm of colluvium and residual soil overlying bedrock and pedogenic deposits	Normal	Normal construction (strip footing or slab-on-the-ground) foundation. Founding to take place on very dense pedocretes or bedrock	Conditions of hard rock excavation. Landslope less than 2% favours slab-on-the-ground foundations	Intermediate	LEGEND TEST PIT POSITION BOSCIA ALBITRUNCA (TO BE CONSERVED) VERY ROCKY MATERIAL BOUNDARY Cedar Land Geotechnical Consult (Pty) Ltd POSBUS 607 CERES 6835 SEL : 082 570-2767 (Frans) 082 373-2146 (Mariette) P O BOX 607 CERES 6835 CELL : 082 570-2767 (Frans) 082 373-2146 (Mariette) EPOS/E-MAIL: cedarland.frans@breede.co.za (Frans) cedarland.mariette@breede.co.za (Mariette)
I(b)	36,22	R	Negligible	Less than 400mm of colluvium and residual soil overlying bedrock and pedogenic deposits	Normal	Normal construction (strip footing or slab-on-the-ground) foundation. Founding to take place on very dense pedocretes or bedrock.	Conditions of hard rock excavation. Landslope between 2% and 6%. Presence of stockpiles of waste and obsolete sewerage oxidation ponds	Intermediate	
II(a)	3,12	S	0mm to 10mm compression settlement	Surface horizon of colluvial or aeolian sand, 400mm to 700mm thick overlying medium dense residual soil and very dense pedogenic deposits and bedrock	Normal	Normal construction (strip footing or slab-on-the-ground) foundation. Founding to take place on medium dense gravelly colluvium or aeolian sand. Foundation bearing pressure not to exceed 50kPa. Good site drainage.	Conditions of hard rock excavation. Landslope less than 2% favours slab-on-the-ground foundations.	Intermediate	
II(b)	16,82	S	0mm to 10mm compression settlement	Surface horizon of colluvial or aeolian sand, 400mm to 700mm thick overlying medium dense residual soil and very dense pedogenic deposits and bedrock	Normal	Normal construction (strip footing or slab-on-the-ground) foundation. Founding to take place on medium dense gravelly colluvium or aeolian sand. Foundation bearing pressure not to exceed 50kPa. Good site drainage.	Conditions of hard rock excavation. Landslope between 2% and 6%. Presence of stockpiles of waste and existing oxidation ponds from abattoir	Intermediate	
III(a)	2,87	S1	10mm to 20mm compression settlement	Surface horizon of reworked aeolian sand overlying dense calcareous cemented colluvium to depths exceeding 700mm.	Modified Normal	Reinforced strip foundations with articulation joints at some internal doors and all external doors and light reinforcement in masonry. Site drainage and service and plumbing precautions. Foundation bearing pressure not to exceed 50kPa	Landslope less than 2%	Intermediate	
					Replacement of in-situ soils below individual footings	Remove in-situ material below foundations to a depth and width of 1,5 times the foundation width or to a suitable soil horizon and replace with material compacted to 93% MOD AASHTO density at -1% to +2% of optimum moisture content. Normal construction with lightly reinforced strip foundation and light reinforcement in masonry			
III(b)	7,09	S1	10mm to 20mm compression settlement	Surface horizon of aeolian sand 600mm to 800mm thick overlying boulder calcrete and bedrock at depth.	Modified Normal	Reinforced strip foundations with articulation joints at some internal doors and all external doors and light reinforcement in masonry. Site drainage and service and plumbing precautions. Foundation bearing pressure not to exceed 50kPa	Presence of stockpiles of waste Landslope between 2% and 6%	Intermediate	
					Replacement of in-situ soils below individual footings	Remove in-situ material below foundations to a depth and width of 1,5 times the foundation width or to a suitable soil horizon and replace with material compacted to 93% MOD AASHTO density at -1% to +2% of optimum moisture content. Normal construction with lightly reinforced strip foundations and light reinforcement in masonry			
IV	6,34	S2	>20mm compression settlement	Surface horizon of very loose aeolian sand, >1000mm thick overlying cemented colluvium and bedrock at depth	Modified Normal	Reinforced strip footings or reinforced concrete raft placed on engineered fill. Foundation system to be designed by engineer. Foundation bearing pressure not to exceed 50kPa. Good site drainage.	Landslope between 2% and 6% Presence of stockpiles of waste and existing oxidation ponds from abattoir. Collapsing sidewalls in excavations Metastable dunes	Intermediate	

TAASK: Expansion and Formalisation of Groblershoop Community
 JOB NAME: Portion 16 of the Farm Boegoeberg Settlement no 48
 KLIENT: IKheis Municipality
 CLIENT: Figure 7 : Site Class Designation
 TEKENING NO: DATUM: 24 September 2020
 DRAWING NO:

calcrete and bedrock of quartzite and schist. Slope across the land is approximately between 2% and 6%. Foundation stresses induced by conventional strip foundations for single and double storey structures will result in almost negligible settlement if founded directly on the slightly weathered and unweathered hard rock to very hard rock, or on the very dense calcrete. The area is thus zoned as "R" and regarded as stable.

The development potential of the land is detrimentally influenced by the conditions of hard rock excavation and presence of active waste water dumping in the area of TP 21 ; obsolete oxidation ponds between TP's 26 and 29 ; cemetery near TP 35 and wide spread occurrences of stockpiles of waste.

8.2 Geotechnical Zone II

The zone can be divided into two parts. The geotechnical conditions are similar in both parts and characterized by the presence of rock and very dense calcrete at depths exceeding 400mm, but usually less than 700mm. Distinction can be made on land slope and previous land use as follows :

8.2.1 Geotechnical Zone II(a)

This zone comprises 3% of the area investigated and is characterized by the materials profiles of TP's 4 and 7. It is present in an area on the southwestern perimeter of the area of investigation. The soil profile consists of a surface horizon of reworked aeolian deposits and colluvium. The combined thickness of the horizon is between 400mm and 700mm in the test pits and it overlies very dense calcrete and bedrock of quartz-amphibole schist at depth. Slope across the land is less than 2%. Foundation stresses induced by conventional strip foundations for single and double storey structures will result in limited compression settlement less than 10mm if founded directly on the reworked aeolian sand or medium dense gravelly colluvium. As per the materials profile encountered in the test pits the thickness of the horizon of competent material is sufficient to dissipate the stresses induced by the foundations effectively. The area is thus zoned as "S" and the materials strata can be regarded as compressible to a maximum of 10mm.

The development potential of the land is detrimentally influenced by the slope of the land being less than 2% and conditions of hard rock excavation.

8.2.2 Geotechnical Zone II(b)

This zone comprises 217% of the area investigated and is characterized by the materials profiles of TP's 30, 36, 37, 39, 41, 44, 45 and 49. It is present in an area on the northwestern

perimeter of the area of investigation. The soil profile consists of a surface horizon of aeolian deposits and colluvium. The thickness of the strata is between 400mm and 700mm in the test pits and it overlies very dense calcrete and bedrock of quartzite and quartz-amphibole schist at depth. Slope across the land is between 2% and 6%. Foundation stresses induced by conventional strip foundations for single and double storey structures will result in limited compression settlement less than 10mm if founded directly on the aeolian sand or medium dense gravelly colluvium. As per the materials profile encountered in the test pits the thickness of the horizon of competent material is sufficient to dissipate the stresses induced by the foundations effectively. The area is thus zoned as "S" and the materials strata can be regarded as compressible to a maximum of 10mm.

The development potential of the land is detrimentally influenced by the conditions of hard rock excavation ; presence of active waste water dumping in the area of TP 41 and wide spread occurrences of stockpiles of waste.

8.3 Geotechnical Zone III

The zone can be divided into two parts. The geotechnical conditions are similar in both parts and characterized by the presence of competent material exceeding depths of 700mm. Distinction can be made on land slope and previous land use as follows :

8.3.1 Geotechnical Zone III(a)

This zone comprises 3% of the area investigated and is characterized by the materials profiles of TP 1. It is present in an area on the southern perimeter of the area of investigation. The soil profile consists of a surface horizon of aeolian deposits and colluvium. The combined thickness of the horizon exceeds 700mm in the test pit and it overlies bedrock of quartz-amphibole schist at depth. Slope across the land is less than 2%. Foundation stresses induced by conventional strip foundations for single and double storey structures will result in compression settlement between 10mm and 20mm if founded directly on the aeolian deposits. The area is thus zoned as "S1" and the materials strata can be regarded as compressible to a maximum of 20mm.

The development potential of the land is detrimentally influenced by the slope of the land being less than 2%.

8.3.2 Geotechnical Zone III(b)

This zone comprises 7% of the area investigated and is characterized by the materials profiles of TP's 16, 19, 20 and 25. It is present in a central area on the eastern perimeter of

the area of investigation. The soil profile consists of a surface horizon of very loose aeolian deposits. The combined thickness of the horizon is between 600mm and 800mm in the test pits and it overlies very dense calcrete and bedrock of quartzite and quartz-amphibole schist at depth. Slope across the land is between 2% and 6%. Foundation stresses induced by conventional strip foundations for single and double storey structures will result in compression settlement between 10mm and 20mm if founded directly on the very loose aeolian deposits. The area is thus zoned as "S1" and the materials strata can be regarded as compressible to a maximum of 20mm.

8.4 Geotechnical Zone IV

This zone comprises 6% of the area investigated and is characterized by the materials profiles of TP's 22, 42 and 46. It is present in two areas on site and located on the extreme limit of the regional presence of sand dunes. The soil profile consists of a surface horizon of very loose aeolian deposits. The combined thickness of the horizon exceeds 1000mm and may extend to more than 2000mm deep. It overlies colluvium and bedrock of quartz-amphibole schist or quartzite at depth. Slope across the land is between 2% and 6%. Foundation stresses induced by conventional strip foundations for single and double storey structures will result in compression settlement exceeding 20mm, mainly due to the very loose consistency of the aeolian sand. The area is thus zoned as "S2" and the materials strata can be regarded as compressible to a maximum exceeding 20mm.

The development potential of the land is detrimentally influenced by the conditions of instable sand and presence of active waste water dumping in the area of TP 41. Moen (Reference 14.4 page 149) reports that these dunes are stable by virtue of vegetation cover, but removal of the vegetation soon reveals that the dunes are metastable and may begin to readjust according to current wind patterns.

8.5 Other Considerations

The contents of this subparagraph 8.5 largely fall outside the scope of a geotechnical investigation. However, it is given in good faith in an effort to find a solution to the presence of waste in the area. Three issues need to be addressed, namely :

- *Construction Waste* : The construction waste can be crushed and used as fill material during construction. Such material may also be used as successfully as a gravel wearing course for streets in Groblershoop.
- *Disposal of Waste Water* : It is not known whether the historic and present dumping of waste water on site is legal or not. However, such actions have a detrimental influence on

site development and can greatly reduced the development potential of areas close to the activities.

- *Cemetery* : It appears as if the cemetery is not in use any more. Present guidelines require some safe distance between residential development and cemetery sites, which can can greatly reduced the development potential of areas close to the activities.

9 FOUNDATION RECOMMENDATIONS AND SOLUTIONS

The foundation design alternatives and ancillary issues as discussed in subparagraphs 9.1 and 9.7 below are summarized in Table 5 : Foundation Design, Building Procedures and Precautionary Measures. In some cases more than one foundation solution is offered in the discussion below. Whichever option is used, the design must adhere strictly on the proposals of SANS 10400H, which allows more options than those indicated in this report. As geotechnical conditions favour the use of several alternatives, the decision of which option to use must be based on financial and practical considerations. In all cases service trenches shall not be excavated parallel to buildings within 1500mm of the building perimeter.

9.1 Geotechnical Zone I(a)

The zone is classed as R, meaning that the proposed horizon for founding is stable and negligible soil movement is expected. Considering the limited slope across the land of less than 2% only and the favourable geotechnical site classification as per Section 8 above, two foundation design alternatives are applicable to the zone.

The two options can be discussed as follows :

9.1.1 Strip Foundations

Foundations of 400mm wide placed directly on the very dense hardpan calcrete may be used. Should the areas of the proposed dwellings not exceed 200m² foundations for internal non-loadbearing walls may consist of thickened floorslabs. Should this option be adopted the floorslabs shall be reinforced steel mesh.

9.1.2 Slab-on-the-ground Foundations

This is the preferred method of founding. The solution of slab-on-the-ground foundations may only be used for dwellings less than 200m² in area. Edge beams shall be placed directly on the very dense hardpan calcrete. Foundations for internal non-loadbearing walls shall consist of thickened floorslabs. The foundations shall not contain any changes in surface levels with

TABLE 5 : FOUNDATION DESIGN, BUILDING PROCEDURES AND PRECAUTIONARY MEASURES

AREA	AREA OF PROPERTY (%)	GEOTECHNICAL CLASS	ESTIMATED SOIL MOVEMENT (mm)	SOIL PROFILE	CONSTRUCTION TYPE	FOUNDATION DESIGN AND BUILDING PROCEDURES	ASSOCIATED PROBLEMS	DEVELOPMENT POTENTIAL
I(a)	28	R	Negligible	Less than 400mm of colluvium and residual soil overlying bedrock and pedogenic deposits	Normal	Normal construction (strip footing or slab-on-the-ground) foundation. Founding to take place on very dense pedocretes or bedrock	Conditions of hard rock excavation Landslope less than 2% favours slab-on-the-ground foundations.	Intermediate
I(b)	36	R	Negligible	Less than 400mm of colluvium and residual soil overlying bedrock and pedogenic deposits	Normal	Normal construction (strip footing or slab-on-the-ground) foundation. Founding to take place on very dense pedocretes or bedrock	Conditions of hard rock excavation. Landslope between 2% and 6% Presence of stockpiles of waste and obsolete sewerage oxidation ponds	Intermediate
II(a)	3	S	0mm to 10mm compression settlement	Surface horizon of colluvial or aeolian sand, 400mm to 700mm thick overlying medium dense residual soil and very dense pedogenic deposits and bedrock	Normal	Normal construction (strip footing or slab-on-the-ground) foundation. Founding to take place on medium dense gravelly colluvium or aeolian sand Foundation bearing pressure not to exceed 50kPa Good site drainage	Conditions of hard rock excavation Landslope less than 2% favours slab-on-the-ground foundations.	Intermediate
II(b)	17	S	0mm to 10mm compression settlement	Surface horizon of colluvial or aeolian sand, 400mm to 700mm thick overlying medium dense residual soil and very dense pedogenic deposits and bedrock	Normal	Normal construction (strip footing or slab-on-the-ground) foundation. Founding to take place on medium dense gravelly colluvium or aeolian sand Foundation bearing pressure not to exceed 50kPa Good site drainage	Conditions of hard rock excavation. Landslope between 2% and 6% Presence of stockpiles of waste and existing oxidation ponds from abattoir	Intermediate
III(a)	3	S1	10mm to 20mm compression settlement	Surface horizon of reworked aeolian sand overlying dense calcareous cemented colluvium to depths exceeding 700mm.	Modified normal	Reinforced strip foundations with articulation joints at some internal doors and all external doors and light reinforcement in masonry. Site drainage and service and plumbing precautions. Foundation bearing pressure not to exceed 50kPa	Landslope less than 2%	Intermediate
					Replacement of in-situ soils below individual footings	Remove in-situ material below foundations to a depth and width of 1,5 times the foundation width or to a suitable soil horizon and replace with material compacted to 93% MOD AASHTO density at -1% to +2% of optimum moisture content. Normal construction with lightly reinforced strip foundations and light reinforcement in masonry.		
III(b)	7	S1	10mm to 20mm compression settlement	Surface horizon of aeolian sand 600mm to 800mm thick overlying boulder calcrete and bedrock at depth	Modified normal	Reinforced strip foundations with articulation joints at some internal doors and all external doors and light reinforcement in masonry. Site drainage and service and plumbing precautions. Foundation bearing pressure not to exceed 50kPa	Presence of stockpiles of waste Landslope between 2% and 6%	Intermediate
					Replacement of in-situ soils below individual footings	Remove in-situ material below foundations to a depth and width of 1,5 times the foundation width or to a suitable soil horizon and replace with material compacted to 93% MOD AASHTO density at -1% to +2% of optimum moisture content. Normal construction with lightly reinforced strip foundations and light reinforcement in masonry.		
IV	6	S2	>20mm compression settlement	Surface horizon of very loose aeolian sand, >1000mm thick overlying cemented colluvium and bedrock at depth	Modified normal	Reinforced strip footings or reinforced concrete raft placed on engineered fill. Foundation system to be designed by engineer. Foundation bearing pressure not to exceed 50kPa Good site drainage	Landslope between 2% and 6% Presence of stockpiles of waste and existing oxidation ponds from abattoir Collapsing sidewalls in excavations Metastable dunes	Intermediate

steps exceeding 400mm and do not support any chimneys or walls which support concrete roofs.

9.2 Geotechnical Zone I(b)

The zone is classed as R, meaning that the proposed horizon for founding is stable and negligible soil movement is expected. The slope across the land varies between approximately 2% and 6%. Two founding alternatives can be considered :

9.2.1 Strip Foundations

The preferable founding alternative is foundations of 400mm wide strip footings placed directly on very dense hardpan calcrete or bedrock. Should the areas of the proposed dwellings not exceed 200m² foundations for internal non-loadbearing walls may consist of thickened floorslabs. Should this option be adopted the floorslabs shall be reinforced steel mesh.

9.2.2 Slab-on-the-ground Foundations

Considering the slope across the land of approximately 2% to 6% the use of slab-on-the-ground foundations may require additional works in the form of the construction of an engineered fill or cutting to establish a level platform for construction, but it still remains a viable alternative. This latter option of additional earthworks may be costly and hence is regarded as less attractive than conventional strip footings.

9.3 Geotechnical Zone II(a)

The zone is classed as S, meaning that the proposed horizon for founding is stable and less than 10mm compression settlement is expected. Considering the limited slope across the land of less than 2% only and the favourable geotechnical site classification as per Section 8 above, two foundation design alternatives are applicable to the zone.

The two options can be discussed as follows :

9.3.1 Strip Foundations

Foundations of 400mm wide placed directly on the very dense hardpan calcrete or medium dense in-situ soil may be used. Should the areas of the proposed dwellings not exceed 200m² foundations for internal non-loadbearing walls may consist of thickened floorslabs. Should this option be adopted the floorslabs shall be reinforced steel mesh.

9.3.2 Slab-on-the-ground Foundations

This is the preferred method of founding. The solution of slab-on-the-ground foundations may only be used for dwellings less than 200m² in area. Edge beams shall be placed directly on the very dense hardpan calcrete or medium dense in-situ soils. Foundations for internal non-loadbearing walls shall consist of thickened floorslabs. The foundations shall not contain any changes in surface levels with steps exceeding 400mm and do not support any chimneys or walls which support concrete roofs.

9.4 Geotechnical Zone II(b)

The zone is classed as S, meaning that less than 10mm of compression settlement may occur. Considering the slope across the land of approximately 2% to 6% and the stable geotechnical site classification as per Section 8 above, two foundation design alternatives are applicable to the zone.

9.4.1 Strip Foundations

This is the preferred method of founding. Foundations of 400mm wide placed directly on the medium dense in-situ soil or very dense calcrete or bedrock. Should the areas of the proposed dwellings not exceed 200m² foundations for internal non-loadbearing walls may consist of thickened floorslabs. Should this option be adopted the floorslabs shall be reinforced steel mesh.

9.4.2 Slab-on-the-ground Foundations

The solution of slab-on-the-ground foundations may only be used for dwellings less than 200m² in area. Edge beams shall be placed directly on the medium dense in-situ soil, very dense calcrete or bedrock. Foundations for internal non-loadbearing walls shall consist of thickened floorslabs. The foundations shall not contain any changes in surface levels with steps exceeding 400mm and do not support any chimneys or walls which support concrete roofs.

9.5 Geotechnical Zone III(a)

The zone is classed as S1, meaning that between 10mm and 20mm compression settlement may occur. The land slopes at less than 2% and the soil profile consists of very loose aeolian sand overlying dense colluvium and bedrock at depth. Two foundation design alternatives are applicable to the zone :

9.5.1 Modified Normal Construction

The implementation of reinforced strip foundations, will require foundations of 400mm wide placed within the aeolian sand. The sand shall be compacted prior to casting of the foundations. The foundations shall be suitably steel reinforced and articulation joints at internal and external doors with light reinforcement in the masonry. Site drainage, wet services and plumbing precautions to prevent leaks shall be provided. Foundation pressures shall be limited to less than 50kPa.

9.5.2 Replacement of In-situ Soils

Remove in-situ soils below foundations to a depth of 1,5 times the foundation width or to a suitable soil horizon and replace with granular material compacted to 93% MOD AASHTO density at -1% to +2% of optimum moisture content. Normal construction of the superstructure can take place with lightly reinforced strip foundations and light reinforcement in the masonry.

9.6 Geotechnical Zone III(b)

The zone is classed as S1, meaning that between 10mm and 20mm compression settlement may occur. The land slopes between 2% to 6% and the soil profile consists of very loose aeolian sand overlying dense colluvium and very dense calcrete and bedrock at depth. Two foundation design alternatives are applicable to the zone :

9.6.1 Modified Normal Construction

The implementation of reinforced strip foundations, will require foundations of 400mm wide placed within the aeolian sand. The sand shall be compacted prior to casting of the foundations. The foundations shall be suitably steel reinforced and articulation joints at internal and external doors with light reinforcement in the masonry. Site drainage, wet services and plumbing precautions to prevent leaks shall be provided. Foundation pressures shall be limited to less than 50kPa.

9.6.2 Replacement of In-situ Soils

Remove in-situ soils below foundations to a depth of 1,5 times the foundation width or to a suitable soil horizon and replace with granular material compacted to 93% MOD AASHTO density at -1% to +2% of optimum moisture content. Normal construction of the superstructure can take place with lightly reinforced strip foundations and light reinforcement in the masonry.

9.7 Geotechnical Zone IV

The zone is classed as S2. The slope of the land is between 2% and 6%. The soil profile consists of deeper than 1000mm very loose aeolian sand overlying colluvium and bedrock at depth. Founding in this zone can be a source of some challenges. Due to the very loose consistency of the aeolian deposits, collapse of excavation sidewalls, even less than 1000mm deep will result in conditions difficult to excavate for construction of reinforced strip footings. It thus appears as if a reinforced raft is the better solution. However, due to the slope across the land it will require additional groundworks to provide a level platform for the construction of a reinforced concrete raft. The use of mini piles placed at depth on bedrock is an expensive option and not suitable for the development of low cost housing. The problem of dunes that may remobilize if vegetation is removed must also be considered.

It is thus recommended that the conditions at each individual stand be considered on its own merits and that all foundations be designed by a professional engineer to suit the conditions. Site drainage, wet services and plumbing precautions to prevent leaks shall be provided. Foundation pressures shall be limited to less than 50kPa. Such foundations may consist of the following :

- *Reinforced Strip Foundations* : The foundations shall be suitably steel reinforced and articulation joints at internal and external doors with light reinforcement in the masonry. Site drainage, wet services and plumbing precautions to prevent leaks shall be provided. Foundation pressures shall be limited to less than 50kPa.
- *Reinforced Concrete Raft* : Alternatively structures may be founded by means on a suitably reinforced concrete raft. The raft may be placed on an engineered fill to reduce excavating into the very loose sand.

10 DRAINAGE

The water courses on site are contained in narrow and well-defined gullies of such extent that they do not influence the various geotechnical site class designations. They are therefore not zoned separately. However, the presence of these water courses must be taken into account and infrastructure established only in a safe distance from these features.

The slope of less than 2% in certain areas of the land is regarded as marginal and may result in problems with the design of stormwater and sewerage disposal systems depending on dissipation by gravity.

11 SPECIAL PRECAUTIONARY MEASURES

11.1 Soil and Water Contamination

Some issues need to be resolved prior to residential development may take place on the land. The Cedar Land Geotechnical Consult appointment excludes the investigation of possible soil and groundwater contamination due to the presence of the cemetery, obsolete oxidation dams, existing oxidation dam and sewer dumping area. However, as a matter of due diligence these issues need to be considered in a geotechnical report.

Even though no in-situ testing was conducted to determine whether these items are responsible for, or have historically been responsible for soil or water contamination, it can be stated that such conditions may have occurred. Due to the relative absence of groundwater of any sort close to the surface and an impermeable barrier formed by the calcrete and bedrock it is unlikely that groundwater contamination may have taken place, but contamination of surface water could have occurred. Similarly could bacterial contamination of the surface soils have taken place.

It is thus essential that the developer ensure that the areas surrounding the features concerned be investigated by a suitably qualified professional practitioner to determine the absence/presence of contamination. Should the habit of waste water dumping be terminated, these features may be rehabilitated and the environment declared contamination free, the entire area can be developed as per the guidelines proposed by the investigating professional. Should it be found that contamination exists and that the culture of dumping waste water be continued, the facilities shall be upgraded to comply to modern legal requirements and applicable minimum distances between the facilities and residential developments maintained as per legal requirements and complying to the proposals of the investigating professional.

11.2 Dune Stability

The effects and damage that may occur due to moving dunes are amply illustrated by old mine villages in desert areas. Although the dunes in this area have been stable and not subject to movement over a very long time, it has been found that with the removal of vegetation the effects of wind result in the displacement of the sand. It is therefore important that any development of the dune area be done in conjunction with an environmental specialist who can provide guidance with regard to revegetating the dunes and development of infrastructure in these conditions.

12 CONCLUSIONS

The property is regarded as being of intermediate suitability for residential development. Founding conditions can be defined as R and S, S1 and S2. The factors that reduce the suitability of the land for development are :

- The presence of hard rock and very dense hardpan calcrete close to the surface in areas zoned as S and R. The presence thereof will result in conditions of hard excavation. On the other hand it provides conditions favouring conventional methods of founding.
- The limited slope of less than 2% in Geotechnical Zones I(a), II(a) and III(a) will have a detrimental influence on the design of stormwater disposal systems and sewerage reticulation.
- The presence of waste material need to be addressed.
- The issue of the presence of a cemetery and past and present waste water disposal need to be addressed.
- The possibility that dunes may be mobilized with the removal of vegetation need to be addressed.

The conclusions as based on the site conditions are summarized in Table 6 : Influence of Constraints per Geotechnical Zoning. This classification is based on the proposals of the document *Geotechnical Site Investigations for Housing Developments (Generic Specification GFSH-2)*, issued by the National Department of Housing in September 2002.

12.1 Stratigraphy

The available information shows that the area of investigation is located on a subduction zone dating approximately 1000 million years old. The zone is located between the lithology of the Kaapvaal Craton and the Namaqua-Natal mobile belt. The remains of the original geology in the area are referred to as the Kaaien Terrane and the site is located on the Groblershoop Formation of the Brulpan Group. Bedrock on site occurs as lineal bands of grey, micaceous quartzite associated with a wider distributed quartz-amphibole schist of the Groblershoop Formation, Brulpan Group. Occasionally the quartzite tends to be muscovite-rich.

12.2 Soil Profile

12.2.1 Gordonia Formation

Aeolian sand was encountered in a reworked form in the southern area of the site and in a pure form in the northwestern part thereof. These deposits are light red in colour, very loose, fine sand with an intact matrix. The aeolian sand can be associated with the Gordonia

TABLE 6 : INFLUENCE OF CONSTRAINTS PER GEOTECHNICAL ZONING

CONSTRAINT	KEY TO CLASSIFICATION			CLASSIFICATION PER GEOTECHNICAL ZONE						
	MOST FAVOURABLE (1)	INTERMEDIATE (2)	LEAST FAVOURABLE (3)	I(a)	I(b)	II(a)	II(b)	III(a)	III(b)	IV
Collapsible soil	Any collapsible horizon or consecutive horizons totalling a depth of less than 750mm in thickness	Any collapsible horizon or consecutive horizons with a depth of more than 750mm in thickness	A least favourable situation for this constraint does not occur							
Seepage	Permanent or perched water table more than 1,5m below ground surface	Permanent or perched water table less than 1,5m below ground surface	Swamps and marshes							
Active soil	Low soil heave potential anticipated	Moderate soil heave potential anticipated	High soil heave potential anticipated							
Highly compressible soil	Low soil compressibility anticipated	Moderate soil compressibility anticipated	High soil compressibility anticipated							
Erodibility of Soil	Low	Intermediate	High							
Difficulty of excavation to 1,5m depth	Scattered or occasional boulders less than 10% of the total volume	Rock or hardpan pedocretes between 10% and 40% of the total volume	Rock or hardpan pedocretes more than 40% of the total volume							
Undermined ground	Undermining at a depth greater than 240m below surface, except where total extraction mining has not occurred	Old undermined areas to a depth of 90m to 240m below surface where stope closure has ceased	Mining within less than 90m to 240m of surface or where total extraction mining has taken place							
Dolomite and limestone stability	Possibly stable. Areas of dolomite overlain by Karroo rocks or intruded by sills. Areas of Black Reef rocks. Anticipated Inherent Risk Class 1	Potentially characterised by instability. Anticipated Inherent Risk Classes 2 to 5	Known sinkholes and dolines. Anticipated Inherent Risk Classes 6 to 8							
Steep slopes*	Between 2° and 6° in all regions	Slopes between 6° and 18° and less than 2° (Natal and Western Cape) Slopes between 6° and 12° and less than 2° (all other regions)	More than 18° (Natal and Western Cape). More than 12° (all other regions)							
Areas of unstable natural slopes*	Low risk	Intermediate risk	High risk (Especially in areas subject to seismic activity)							
Areas subject to seismic activity	10% probability of an event less than 100cms ⁻² within 50 years	Mining induced seismic activity more than 100cms ⁻²	Natural seismic activity more than 100cms ⁻²							
Areas subject to flooding	A "most favourable" situation for this constraint does not occur	Areas adjacent to a known drainage channel or floodplain with slope less than 1%	Areas with a known drainage channel or floodplain							

Formation of the Kalahari Group. The thickness of the horizon varied between 800mm and 1900mm in the test pits.

12.2.2 Colluvium

Gravelly colluvium as surface deposit was found over the entire site. Being older than the aeolian sand, it underlies the dunes where they were encountered. The colluvium is a homogenous material, consisting light brown fine sand and clasts of gravels and cobbles of quartz and some calcrete. The consistency of the gravelly colluvium is medium dense and the soil matrix intact. The horizon of colluvium was between 600mm and 1400mm thick in the test pits.

12.2.3 Mokalanen Formation

Calcrete was encountered as the dominant lithic material on site, in virtually a continuous cover over the quartzite and schist, with the latter outcropping occasionally. The calcrete is present as very dense hardpan or boulder calcrete. The calcrete is present as outcrops ; or underlies the transported materials, occurring from depths between zero and 800mm minimum, extending to 100mm to 1200mm maximum, at which stage refusal of excavation occurred or bedrock was encountered. It is described as dirty white to dirty light yellow white, very fine grained, very dense calcrete. Some fine sand may occasionally be contained in voids in the matrix of the calcrete.

12.2.4 Residual Quartzite

On site residual quartzite was encountered as surface material or underlying the gravelly colluvium. It consists of cobbles and boulders of quartzite with diameter less than 500mm contained a matrix of dirty white, calcareous cemented sand. The soil matrix is medium dense. The horizon of residual quartzite extended to a depth of 700mm where encountered.

12.3 Groundwater

12.3.1 Perched Water

Perched groundwater was not encountered in any of the test pits excavated for this investigation. It is anticipated that perched water will generally not prove problematic on the site. However, seepage water may be encountered in the vicinity of the waste water disposal areas.

12.3.2 Permanent Groundwater

The probability for drilling successfully for water in the area is between 40% and 60%, and the probability that such a borehole will yield more than 2l/s is between 10% and 20%. Groundwater is expected to occur at depths less than 15 meters in compact, argillaceous strata.

12.4 Conditions of Excavation

12.4.1 Conditions of Hard Rock Excavation

On average over the entire site bedrock or refusal of excavation on very dense hardpan calcrete, bedrock of quartz-amphibole schist or quartzite was encountered at depths between 100mm minimum and 1500mm maximum, averaging 700mm deep. The implication of this is that should trenches require excavated depths to 1000mm, 30% of the excavation may be classified as hard, requiring drilling and blasting. Should the required depth of excavation increase to 1500mm, 53% of the excavation may be classified as hard.

Irrespective of which method of excavation is considered, the most important issue is that across the entire site the depth to bedrock and hardpan calcrete that can be regarded as hard rock excavation is highly variable as follows :

12.4.1(i) Geotechnical Zones I(a) and I(b)

These zones are classified as R. The average depth to bedrock or very dense pedocrete is 185mm. Refusal of excavation occurred at an average depth of 550mm. The implication of this is that should trenches require excavated depths to 1000mm, 45% of the excavation may be classified as hard, requiring drilling and blasting. Should the required depth of excavation increase to 1500mm, 63% of the excavation may be classified as hard.

12.4.1(ii) Geotechnical Zones II(a) and II(b)

These zones are classified as S. The average depth to bedrock or very dense pedocrete is 620mm. Refusal of excavation occurred at an average depth of 850mm. The implication of this is that should trenches require excavated depths to 1000mm, 15% of the excavation may be classified as hard, requiring drilling and blasting. Should the required depth of excavation increase to 1500mm, 43% of the excavation may be classified as hard.

12.4.1(iii) Geotechnical Zones III(a and b)

These zones are classified as S1. The average depth to bedrock or very dense pedocrete is 780mm. Refusal of excavation occurred at an average depth of 1200mm. The implication of this is that should trenches require excavated depths to 1000mm, zero percent of the excavation may be classified as hard, requiring drilling and blasting. Should the required depth of excavation increase to 1500mm, 20% of the excavation may be classified as hard.

12.4.1(iv) Geotechnical Zone IV

This zones is classified as S2. The average depth to bedrock or very dense pedocrete is 1370mm. Refusal of excavation occurred at an average depth of 1470mm. The implication of this is that should trenches require excavated depths to 1000mm, zero percent of the excavation may be classified as hard, requiring drilling and blasting. Should the required depth of excavation increase to 1500mm, 2% of the excavation may be classified as hard.

12.4.2 Sidewall Stability

In all cases where aeolian sand or reworked aeolian sand may occur such material may be regarded as potentially unstable and subject to collapse. However, especially in Geotechnical Zone S2 where deep, very loose sand is present, such conditions are dangerous and can prove fatal if collapses occur while workmen are occupied in trenches.

12.5 Site Class Designation

It is concluded that the area is regarded as suitable for residential development as follows :

12.5.1 Geotechnical Zone I(a)

The zone is classed as R, meaning that the proposed horizon for founding is stable and negligible soil movement is expected. The distribution thereof encompasses 28% of the proposed area for development. Slope across the land is less than 2%. Considering the limited slope and the favourable geotechnical site classification, two foundation design alternatives are applicable to the zone, namely conventional strip foundations or slab-on-the-ground foundations placed directly on bedrock or very dense pedocrete. The latter option is regarded as the better solution of the two alternatives.

Geotechnical conditions related to foundation design can be regarded as favourable, but the conditions of hard rock excavation close to the surface and slope less than 2% detract from

the ease suitability of establishing services and overall the development potential is regarded as intermediate only.

12.5.2 Geotechnical Zone I(b)

The zone is classed as R, meaning that the proposed horizon for founding is stable and negligible soil movement is expected. The distribution thereof encompasses 36% of the proposed area for development. Slope across the land is approximately between 2% and 6%. The use of slab-on-the-ground foundations will require additional works in the form of the construction of an engineered fill or cutting to establish a level platform for construction. The more viable foundation alternative therefore remains founding by conventional strip foundations.

Geotechnical conditions related to foundation design can be regarded as favourable, but the conditions of hard rock excavation close to the surface detracts from the ease suitability of establishing services and overall the development potential is regarded as intermediate only.

12.5.3 Geotechnical Zone II(a)

The zone is classed as S, meaning that the proposed horizon for founding is stable and less than 10mm rapid compression settlement is expected. The distribution thereof encompasses 3% of the proposed area for development. Slope across the land is less than 2%. Considering the limited slope and the favourable geotechnical site classification, two foundation design alternatives are applicable to the zone, namely conventional strip foundations or slab-on-the-ground foundations placed directly on gravelly colluvium or aeolian sand. The latter option is regarded as the better solution of the two alternatives.

Geotechnical conditions related to foundation design can be regarded as favourable, but the conditions of hard rock excavation close to the surface and slope less than 2% detract from the ease suitability of establishing services and overall the development potential is regarded as intermediate only.

12.5.4 Geotechnical Zone II(b)

The zone is classed as S, meaning that the proposed horizon for founding is slightly compressible and rapid compression settlement less than 10mm is expected. The distribution thereof encompasses 17% of the proposed area for development. Slope across the land is between 2% and 6%. Considering the slope and the favourable geotechnical site classification, two foundation design alternatives are applicable to the zone, namely conventional strip foundations or slab-on-the-ground foundations placed directly on gravelly

colluvium or aeolian sand. The more viable foundation alternative therefore remains founding by conventional strip foundations.

Geotechnical conditions related to foundation design can be regarded as favourable, but the conditions of hard rock excavation close to the surface detracts from the ease suitability of establishing services and overall the development potential is regarded as intermediate only.

12.5.5 Geotechnical Zone III(a)

The zone is classed as S1, meaning that the proposed horizon for founding is fairly compressible and the foundation design need to incorporate measures to counter the effects of the geotechnical conditions. Between 10mm and 20mm rapid compression settlement is expected. The distribution thereof encompasses 3% of the proposed area for development. Slope across the land is less than 2%. Considering the limited slope and the intermediate geotechnical site classification, two foundation design alternatives are applicable to the zone, namely reinforced strip foundations or replacement of the in-situ soils underneath individual footings. From a geotechnical viewpoint both alternatives are regarded as suitable solutions for the founding conditions. The developer must base is choice on financial constraints.

Geotechnical conditions related to foundation design can be regarded as intermediate, and slope less than 2% detract from the ease suitability of establishing services and overall the development potential is regarded as intermediate only.

12.5.6 Geotechnical Zone III(b)

The zone is classed as S1, meaning that the proposed horizon for founding is fairly compressible and the foundation design need to incorporate measures to counter the effects of the geotechnical conditions. Between 10mm and 20mm rapid compression settlement is expected. The distribution thereof encompasses 7% of the proposed area for development. Slope across the land is between 2% and 6%. Considering the intermediate geotechnical site classification, two foundation design alternatives are applicable to the zone, namely reinforced strip foundations or replacement of the in-situ soils underneath individual footings. From a geotechnical viewpoint both alternatives are regarded as suitable solutions for the founding conditions. The developer must base is choice on financial constraints.

Geotechnical conditions related to foundation design can be regarded as intermediate, and overall the development potential is regarded as intermediate only.

12.5.7 Geotechnical Zone IV

The zone is classed as S2, meaning that the proposed horizon for founding is highly compressible and the foundation design need to incorporate measures to counter the effects of the geotechnical conditions. In excess of 20mm rapid compression settlement is expected. The distribution thereof encompasses 6% of the proposed area for development. Slope across the land is between 2% and 6%. Considering the intermediate geotechnical site classification, two foundation design alternatives are applicable to the zone, namely reinforced strip foundations or reinforced concrete rafts. From a geotechnical viewpoint both alternatives are regarded as suitable solutions for the founding conditions. However, the selection of which alternative to use must be made individually for each stand. All foundations to be designed by a suitably experienced professional engineer.

Geotechnical conditions related to foundation design can be regarded as intermediate, and overall the development potential is regarded as intermediate only.

12.6 Land Slope

The average slope across 66% of the land is between 2% and 6% and over 34% it is less than 2%.

The slope of less than 2% has a detrimental influence on especially the design of a stormwater disposal system depending on gravity to dissipate of the surface water due to downpours. The land slope also affects the design of the sewerage disposal but to a lesser extent as the gradient of the pipes can be adjusted according to design requirements.

12.7 Areas Subject to Flooding

The non-perennial water courses on site are contained in well-defined, narrow gullies and may be regarded as being of lesser importance, requiring no additional precautionary measures to ensure the safety of the population against flooding.

12.8 Materials Utilization

- *Trench Backfilling* : Only the aeolian sand can be regarded as suitable for selected fill or pipe bedding. With exception of the hardpan calcrete all materials can be used for normal backfill.
- *Layerworks for Paved or Segmental Block Paving* : The hardpan calcrete and colluvium are of G6 quality and hence suitable for the construction of layerworks up to subbase and base course level for lightly trafficked roads.

- *Wearing Course for Gravel Roads in Urban Areas* : None of the soil materials are 100% suitable for this purpose. The use of these materials will generally result in a road surface subject to raveling and corrugations.

12.9 Other Considerations

- *Undermining* : The area is not subject to undermining.
- *Seismic Activity* : The Peak Ground Acceleration expected in 50 years is 0,05g. A low risk for the development of earth tremors therefore exist.
- *Soil Corrosivity* : The in-situ soils and pedocretes are not corrosive due to acidic properties. All soil materials can be regarded as corrosive due to high soluble salt contents.
- *Dolomite* : The area of investigation is not subject to any restrictions due to the presence of dolomite. Bedrock of dolomite does not occur in the area of investigation.

13 RECOMMENDATIONS

13.1 Foundation and Structural Design

Section 9 of this document provides guidelines for foundation and structural design. These guidelines are based strictly on the contents of SANS 10400H and the NHBRC Home Owners Manual published in 2015. It is recommended that development take place strictly according to these guidelines. More than one founding solution is applicable on the site, and the property developer can base his choice on financial constraints.

13.2 Materials Utilization

- *Trench Backfill* : With exception of the hardpan calcrete, the in-situ materials may be used for normal backfill of trenches. The hardpan calcrete shall be spoilt and not used at all for this purpose. Material for pipe bedding and selected backfill may be obtained from the aeolian sand or commercial sources.
- *Layerworks for Paved or Segmental Block Paving* : The hardpan calcrete and colluvium are of G6 quality and hence suitable for the construction of layerworks up to subbase and base course level for lightly trafficked roads. It is recommended that a centerline investigation consisting of test pitting and soil sampling be conducted to allow the consulting engineer to produce suitable pavement designs for the project.
- *Wearing Course for Gravel Roads in Urban Areas* : Material for the construction of a gravel wearing course shall be obtained from stockpiled or calcrete from a licensed borrow pit.

13.4 Conditions of Excavation

Although manual excavation is possible through the colluvium, aeolian sand and residual soil and to some extent through the calcrete, it is considered as not an economic proposition, mostly due to the consistency and composition of the soil. Excavation through these soils shall require the use of a TLB rated at 55kW minimum, or preferably a 30 ton excavator of the very dense pedocretes need to be removed. It is recommended that adequate provision be made for hard rock excavation.

The sidewalls of excavations through the aeolian sand may be subject to collapse. It is recommended that precautionary measures be provided to protect workmen in these excavations. Such precautionary measures can consist of either shoring the excavations or sloping the sides to flatter than 1(V) : 2(H).

13.5 Land Slope

The average slope across 66% of the land is between 2% and 6%, which is regarded as favourable for residential development. Over 34% it is less than 2%, which will require careful consideration of the design of wet services due to possible reduced flow rates of liquids.

13.6 Presence of the Cemetery Site and Waste Water Facilities

It is recommended that the effects of these facilities on the proposed development be investigated. The future development must comply to legal requirements to mitigate any negative effects that these facilities may have on the development of the site.

13.7 Dune Stability

As yet there is no definite indicators that the dunes in Geotechnical Zone S2 are unstable. However, residential development in such conditions will be difficult due to the very loose consistency of the sand. Careful consideration must thus be given to placement of houses in such area and the natural environment disturbed as little as possible. Vegetation must be re-established to ensure that the dunes stay stable as far as possible.

14 SOURCES OF REFERENCE

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FJ Breytenbach, Pr Eng
For Cedar Land Geotechnical Consult (Pty) Ltd

23 September 2020

**GEOTECHNICAL CONDITIONS ON PORTION 16 OF
THE FARM BOEGOEBERG SETTLEMENT 48: A
REPORT FOR THE EXPANSION AND FORMALISATION
OF GROBLERSHOOP COMMUNITY**

2020/J09/MCP_01

ADDENDUM A: TEST PIT PROFILES

TRIAL HOLE: 1

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'09,3" S 21°57'10,1" E

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Consult (Pty) Ltd*
P O Box 607
Ceres
6835
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cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refual of excavation at 1500 mm on medium hard rock, quartz-amphibole schist.
0.20		Dry, light red, very loose, intact, fine SAND and matrix supported, fine, rounded gravels of quartz. Reworked aeolian deposits.				
0.40						
0.60						
0.80		Abundant, clast supported, fine to medium coarse, rounded GRAVELS of quartz in a matrix of dry, light brown, fine sand. Soil matrix is partially calcareous and cemented. Overall consistency is dense. Colluvium.				
1.00						
1.20						
1.40						
1.60		Dull light grey green speckled white, intensely laminated, very closely jointed, very fine grained, slightly weathered, soft rock to medium hard rock at depth, quartz-amphibole SCHIST. Discontinuities are open and filled with white, calcareous fine sand. Discontinuities dip at 30°.				
1.80						

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 1

FIGURE: A1

TRIAL HOLE: 2

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PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'05,8" S 22°00'02,2" E

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refual of excavation at 600 mm on medium hard rock, quartz-amphibole schist.
		Abundant, clast supported, medium coarse, subangular and angular <i>GRAVELS</i> of quartz in a matrix of dry, light brown, sand. Overall consistency is medium dense. Colluvium.				
0.20		Lenses (± 20 mm thick) of dirty white discoloured light brown, very fine grained, very dense hardpan <i>CALCRETE</i> . Discontinuities are open and filled with light brown sand. Pedogenic deposits.				
0.40	Dull light grey green speckled white, intensely laminated, very closely jointed, very fine grained, slightly weathered, soft rock to medium hard rock at depth, <i>quartz-amphibole SCHIST</i> . Discontinuities are open and filled with white, calcareous fine sand. Discontinuities dip at 15°.	U9309	0,2-0,6			
0.60						
0.80						
1.00						

Contractor: ALS Plant Hire
Date Drilled: 10/7/2020
Machine: Bell 315SK

Hole Diameter: 600 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 2

FIGURE: A2

TRIAL HOLE: 3	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i> P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za
PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY	
LOGGED BY: FJB	
SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48	
DATE LOGGED: 10/7/2020	
CLIENT: !KHEIS MUNICIPALITY	
LOCATION: 28°55'05,8" S 21°59'56,8" E	

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refual of excavation at 300 mm on very dense hardpan calcrete.
		Abundant, clast supported, medium coarse, subangular and angular <i>GRAVELS</i> of quartz in a matrix of dry, light brown, sand. Overall consistency is medium dense. Colluvium.				
0.20		Lenses of dirty white discoloured light brown, very fine grained, very dense hardpan <i>CALCRETE</i> . Pedogenic deposits.				
0.40						
0.60						
0.80						
1.00						

- Water encountered
- Water level
- Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 10/7/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1

SOIL PROFILE: TEST PIT 3	FIGURE: A3
---------------------------------	-------------------

TRIAL HOLE: 4

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

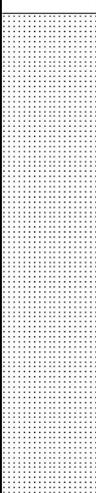
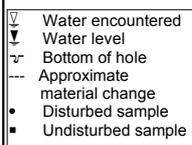
SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'06,2" S 21°59'52,4" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface Dry, light brown, loose, intact, fine SAND. Reworked aeolian deposits.				NOTES: 1 Refual of excavation at 700 mm on hard rock, quartzite.
0.20						
0.40		Light green brown, closely jointed, very fine grained, unweathered, hard rock, micaceous QUARTZITE. Discontinuities are closed, smooth and clean. Discontinuities dip at 75°.				
0.60						
0.80						
1.00						

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 4

FIGURE: A4

TRIAL HOLE: 5**PROJECT:** EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY**LOGGED BY:** FJB**SITE:** PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48**DATE LOGGED:** 10/7/2020**CLIENT:** !KHEIS MUNICIPALITY**LOCATION:** 28°55'01,0" S 22°00'01,4" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refual of excavation at 600 mm on hard rock, quartz-amphibole schist.
		Abundant, clast supported, medium coarse, subangular and angular <i>GRAVELS</i> of quartz in a matrix of dry, light brown, sand. Overall consistency is medium dense. Colluvium.				
0.20		Light green brown, closely jointed, very intensely laminated, very fine grained, unweathered, hard rock, <i>quartz-amphibole SCHIST</i> . Discontinuities are open and filled with white, calcareous sand. Discontinuities dip at 75°.				
0.40						
0.60						
0.80						
1.00						

- ∇ Water encountered
- ↓ Water level
- ~ Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire**Date Drilled:** 10/7/2020**Machine:** Bell 315SK**Hole Diameter:** 600 mm**Water Depth:****Sheet:** 1 of 1**SOIL PROFILE:** TEST PIT 5**FIGURE:** A5

TRIAL HOLE: 6

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'01,1" S 21°59'56,4" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refual of excavation at 600 mm on hard rock, quartz-amphibole schist.
0.20		Abundant, clast supported, medium coarse, subangular and angular GRAVELS of quartz in a matrix of dry, light brown, sand. Overall consistency is medium dense. Colluvium.				
0.40		Light grey green, closely jointed, very intensely laminated, very fine grained, unweathered, hard rock, quartz-amphibole SCHIST. Discontinuities are open and filled with white, calcareous sand. Discontinuities dip at 75°.				
0.60						
0.80						
1.00						

- Water encountered
- Water level
- Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 6

FIGURE: A6

TRIAL HOLE: 7

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'01,7" S 21°59'51,0" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface Dry, light brown, loose, intact, fine SAND. Reworked aeolian sand.				NOTES: 1 Refual of excavation at 900 mm on very dense boulder calcrete.
0.20						
0.40						
0.60		Abundant, clast supported, medium coarse, subangular and angular GRAVELS of quartz in a matrix of dry, light brown, sand. Overall consistency is medium dense. Colluvium.				
0.80		White, very fine grained, very dense, boulder CALCRETE with pockets of dry, light grey brown, fine sand. Pedogenic deposits.				
1.00						

- ∇ Water encountered
- ↓ Water level
- ~ Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 7

FIGURE: A7

TRIAL HOLE: 8	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i> P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za
PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY	
LOGGED BY: FJB	
SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48	
DATE LOGGED: 10/7/2020	
CLIENT: !KHEIS MUNICIPALITY	
LOCATION: 28°54'55,1" S 22°00'00,0" E	

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface Dirty white discoloured light brown, very fine grained, very dense, hardpan CALCRETE . Pedogenic deposits.				NOTES: 1 Refual of excavation at 100 mm on very dense hardpan calcrete.
0.20						
0.40						
0.60						
0.80						
1.00						

-  Water encountered
-  Water level
-  Bottom of hole
-  Approximate material change
-  Disturbed sample
-  Undisturbed sample

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 10/7/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1

SOIL PROFILE: TEST PIT 8	FIGURE: A8
---------------------------------	-------------------

TRIAL HOLE: 9

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°54'55,7" S 21°59'55,2" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refual of excavation at 800 mm on hard rock, quartz-amphibole schist.
0.20		Abundant, clast supported, medium coarse, subangular and angular <i>GRAVELS</i> of quartz in a matrix of dry, light brown, sand. Overall consistency is medium dense. Colluvium.				
0.40		Light green grey, closely jointed, very intensely laminated, very fine grained, unweathered, hard rock, <i>quartz-amphibole SCHIST</i> . Discontinuities are open and filled with white, calcareous sand. Discontinuities dip at 45°.	U9310	0-0,8		
0.60						
0.80						
1.00						

- Water encountered
- Water level
- Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire
Date Drilled: 10/7/2020
Machine: Bell 315SK

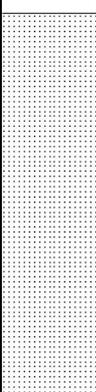
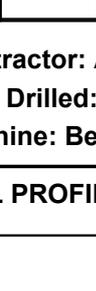
Hole Diameter: 600 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 9

FIGURE: A9

TRIAL HOLE: 10**PROJECT:** EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY**LOGGED BY:** FJB**SITE:** PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48**DATE LOGGED:** 10/7/2020**CLIENT:** !KHEIS MUNICIPALITY**LOCATION:** 28°54'56,2" S 21°59'48,5" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refual of excavation at 700 mm on very dense boulder calcrete.
		Dry, light red, very loose becoming dense with depth, intact, fine SAND. Reworked aeolian sand.				
0.20						
		White, very fine grained, very dense, boulder CALCRETE with pockets of dry, light grey brown, fine sand. Pedogenic deposits.				
0.40						
0.60						
0.80						 Water encountered  Water level  Bottom of hole  Approximate material change  Disturbed sample  Undisturbed sample
1.00						

Contractor: ALS Plant Hire**Date Drilled:** 10/7/2020**Machine:** Bell 315SK**Hole Diameter:** 600 mm**Water Depth:****Sheet:** 1 of 1**SOIL PROFILE:** TEST PIT 10**FIGURE:** A10

TRIAL HOLE: 11	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i> P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za
PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY	
LOGGED BY: FJB	
SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48	
DATE LOGGED: 10/7/2020	
CLIENT: !KHEIS MUNICIPALITY	
LOCATION: 28°54'50,2" S 21°59'58,6" E	

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refual of excavation at 600 mm on very dense boulder calcrete.
0.20		Abundant, clast supported, medium coarse, subangular and angular GRAVELS of quartz in a matrix of dry, light brown, sand. Overall consistency is medium dense. Colluvium.				
0.40		White, very fine grained, very dense, boulder CALCRETE with pockets of dry, light grey brown, fine sand. Pedogenic deposits.				
0.60						
0.80						
1.00						

- Water encountered
- Water level
- Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 10/7/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1

SOIL PROFILE: TEST PIT 11	FIGURE: A11
----------------------------------	--------------------

TRIAL HOLE: 12	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i> P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za
PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY	
LOGGED BY: FJB	
SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48	
DATE LOGGED: 10/7/2020	
CLIENT: !KHEIS MUNICIPALITY	LOCATION: 28°54'50,6" S 21°59'55,0" E

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refual of excavation at 500 mm on very dense boulder calcrete.
0.20		Abundant, clast supported, medium coarse, subangular and angular <i>GRAVELS</i> of quartz in a matrix of dry, light brown, sand. Overall consistency is medium dense. Colluvium.				
0.40	White, very fine grained, very dense, boulder <i>CALCRETE</i> with pockets of dry, light grey brown, fine sand. Pedogenic deposits.					
0.60						
0.80						
1.00						

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 10/7/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1

SOIL PROFILE: TEST PIT 12	FIGURE: A12
----------------------------------	--------------------

TRIAL HOLE: 13	<i>Cedar Land Geotechnical Consult (Pty) Ltd P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za</i>
PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY	
LOGGED BY: FJB	
SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48	
DATE LOGGED: 10/7/2020	
CLIENT: !KHEIS MUNICIPALITY	
LOCATION: 28°54'51,4" S 21°59'50,3" E	

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refual of excavation at 400 mm on very dense boulder calcrete.
0.20		Abundant, clast supported, medium coarse, subangular and angular <i>GRAVELS</i> of quartz in a matrix of dry, light brown, sand. Overall consistency is medium dense. Colluvium.				
0.40		White, very fine grained, very dense, boulder <i>CALCRETE</i> . Pedogenic deposits.				
0.60						
0.80						
1.00						

-  Water encountered
-  Water level
-  Bottom of hole
-  Approximate material change
-  Disturbed sample
-  Undisturbed sample

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 10/7/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1

SOIL PROFILE: TEST PIT 13	FIGURE: A13
----------------------------------	--------------------

TRIAL HOLE: 14	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i> P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za
PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY	
LOGGED BY: FJB	
SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48	
DATE LOGGED: 10/7/2020	
CLIENT: !KHEIS MUNICIPALITY	
LOCATION: 28°54'50,2" S 21°59'58,6" E	

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refual of excavation at 200 mm on very dense boulder calcrete.
		Abundant, clast supported, medium coarse, subangular and angular <i>GRAVELS</i> of quartz in a matrix of dry, light brown, sand. Overall consistency is medium dense. Colluvium.				
0.20		White, very fine grained, very dense, boulder <i>CALCRETE</i> with pockets of dry, light grey brown, fine sand. Pedogenic deposits.				
0.40						
0.60						
0.80						
1.00						

- Water encountered
- Water level
- Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 10/7/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1

SOIL PROFILE: TEST PIT 14	FIGURE: A14
----------------------------------	--------------------

TRIAL HOLE: 15

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°54'45,2" S 21°59'57,5" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refual of excavation at 500 mm on medium hard rock, quartz-amphibole schist.
		Abundant, clast supported, medium coarse, subangular and angular <i>GRAVELS</i> of quartz in a matrix of dry, light brown, sand. Overall consistency is medium dense. Colluvium.				
0.20		White, very fine grained, very dense, boulder <i>CALCRETE</i> . Pedogenic deposits.				
0.40		Dull light grey brown speckled white, intensely laminated, very closely jointed, very fine grained, slightly weathered, soft rock to medium hard rock at depth, <i>quartz-amphibole SCHIST</i> . Discontinuities are open and filled with white, calcareous fine sand. Discontinuities dip at 15°.	U9307	0,1-0,5		
0.60						
0.80						
1.00						

-  Water encountered
-  Water level
-  Bottom of hole
-  Approximate material change
-  Disturbed sample
-  Undisturbed sample

Contractor: ALS Plant Hire
Date Drilled: 10/7/2020
Machine: Bell 315SK

Hole Diameter: 600 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 15

FIGURE: A15

TRIAL HOLE: 16**PROJECT:** EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY**LOGGED BY:** FJB**SITE:** PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48**DATE LOGGED:** 10/7/2020**CLIENT:** !KHEIS MUNICIPALITY**LOCATION:** 28°54'45,5" S 21°59'52,0" E

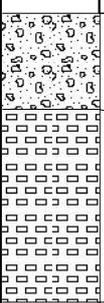
*Cedar Land Geotechnical
Consult (Pty) Ltd*
**P O Box 607
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Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za**

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refual of excavation at 1200 mm on medium hard rock, quartz-amphibole schist.
0.20		Dry, light red, very loose becoming dense with depth, fine SAND. Aeolian sand.				
0.40						
0.60						
0.80		Abundant, clast supported, medium coarse, subangular and angular GRAVELS of quartz in a matrix of dry, light brown, sand. Overall consistency is medium dense. Colluvium.				
1.00		Dull light grey green speckled white, intensely laminated, very closely jointed, very fine grained, slightly weathered, soft rock to medium hard rock at depth, quartz-amphibole SCHIST. Discontinuities are open and filled with white, calcareous fine sand. Discontinuities dip at 15°.				
1.20						
1.40						

- ∇ Water encountered
- ↓ Water level
- ⊥ Bottom of hole
- - - Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire**Date Drilled:** 10/7/2020**Machine:** Bell 315SK**Hole Diameter:** 600 mm**Water Depth:****Sheet:** 1 of 1**SOIL PROFILE:** TEST PIT 16**FIGURE:** A16

TRIAL HOLE: 17	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i> P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za
PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY	
LOGGED BY: FJB	
SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48	
DATE LOGGED: 10/7/2020	
CLIENT: !KHEIS MUNICIPALITY	LOCATION: 28°54'52,3" S 21°59'46,0" E

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refual of excavation at 300 mm on very dense boulder calcrete.
		Abundant, clast supported, medium coarse, subangular and angular <i>GRAVELS</i> of quartz in a matrix of dry, light brown, sand. Overall consistency is medium dense. Colluvium.	U9308	0-0,3		
0.20		White, very fine grained, very dense, boulder <i>CALCRETE</i> with pockets of dry, light grey brown, fine sand. Pedogenic deposits.				
0.40						
0.60						
0.80						
1.00						

-  Water encountered
-  Water level
-  Bottom of hole
-  Approximate material change
-  Disturbed sample
-  Undisturbed sample

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 10/7/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1
SOIL PROFILE: TEST PIT 17	FIGURE: A17

TRIAL HOLE: 18	<i>Cedar Land Geotechnical Consult (Pty) Ltd P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za</i>
PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY	
LOGGED BY: FJB	
SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48	
DATE LOGGED: 10/7/2020	
CLIENT: !KHEIS MUNICIPALITY	
LOCATION: 28°54'48,2" S 21°59'41,2" E	

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refual of excavation at 600 mm on very dense boulder calcrete.
0.20		Abundant, clast supported, medium coarse, subangular and angular <i>GRAVELS</i> of quartz in a matrix of dry, light brown, sand. Overall consistency is medium dense. Colluvium.				
0.40		White, very fine grained, very dense, boulder <i>CALCRETE</i> with pockets of dry, light grey brown, fine sand. Pedogenic deposits.				
0.60						
0.80						
1.00						

- ∇ Water encountered
- ↓ Water level
- ~ Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 10/7/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1

SOIL PROFILE: TEST PIT 18	FIGURE: A18
----------------------------------	--------------------

TRIAL HOLE: 19

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

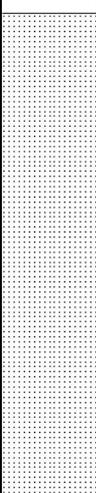
SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°54'40,6" S 21°59'56,7" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface Dry, light red, very loose, intact, fine SAND. Aeolian deposits. Roots are present in the horizon.				NOTES: 1 Refual of excavation at 1000 mm on very hard rock, quartz-amphibole schist.
0.20						
0.40						
0.60		White, very fine grained, very dense, boulder CALCRETE. Pedogenic deposits.				
0.80						
1.00		Dull light yellow grey speckled dark grey, very closely jointed, very intensely laminated, fine grained, slightly weathered, hard rock, quartz-amphibole SCHIST. Joints are open, smooth and filled with light red sand. Laminations are closed, smooth and clean. Well developed, black, needle-like amphibole crystals are contained in the rock matrix. Discontinuities dip at 60°.				
1.20						

-  Water encountered
-  Water level
-  Bottom of hole
-  Approximate material change
-  Disturbed sample
-  Undisturbed sample

Contractor: ALS Plant Hire
Date Drilled: 10/7/2020
Machine: Bell 315SK

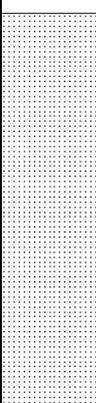
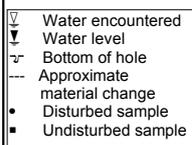
Hole Diameter: 600 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 19

FIGURE: A19

TRIAL HOLE: 20**PROJECT:** EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY**LOGGED BY:** FJB**SITE:** PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48**DATE LOGGED:** 10/7/2020**CLIENT:** !KHEIS MUNICIPALITY**LOCATION:** 28°54'41,2" S 21°59'51,8" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface Dry, light red, very loose, intact, fine SAND. Aeolian deposits.				NOTES: 1 Refual of excavation at 1200 mm on very dense boulder calcrete. 2 Test pit collapses from surface.
0.20						
0.40		White, very fine grained, very dense, boulder CALCRETE with pockets of dry, light grey brown, fine sand. Pedogenic deposits.				
0.60						
0.80						
1.00						
1.20						

Contractor: ALS Plant Hire**Date Drilled:** 10/7/2020**Machine:** Bell 315SK**Hole Diameter:** 600 mm**Water Depth:****Sheet:** 1 of 1**SOIL PROFILE:** TEST PIT 20**FIGURE:** A20

TRIAL HOLE: 21

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°54'42,3" S 21°59'46,3" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refual of excavation at 1100 mm on medium hard rock, quartz-amphibole schist.
0.20		Abundant, clast supported, medium coarse, subangular and angular <i>GRAVELS</i> of quartz in a matrix of dry, light brown sand. Overall consistency is medium dense. Colluvium.				
0.40		White, very fine grained, very dense, boulder <i>CALCRETE</i> with pockets of dry, light grey brown, fine sand. Pedogenic deposits.				
0.60						
0.80						
1.00		Dull light grey green speckled white, intensely laminated, very closely jointed, very fine grained, slightly weathered, soft rock to medium hard rock at depth, <i>quartz-amphibole SCHIST</i> . Discontinuities are open and filled with white calcareous fine sand. Discontinuities dip at 30°.				
1.20						

- ∇ Water encountered
- ↓ Water level
- ⌋ Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 21

FIGURE: A21

TRIAL HOLE: 22

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

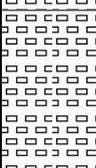
SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°54'43,8" S 21°59'39,3" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface Dry, light red, very loose, intact, fine SAND. Aeolian deposits. Roots are present in the horizon.				NOTES: 1 Refual of excavation at 900 mm on very dense hardpan calcrete.
0.20						
0.40			White, very fine grained, very dense, boulder CALCRETE. Pedogenic deposits.	U9304	0-0,7	
0.60						
0.80		Dirty white, very fine grained, very dense, hardpan CALCRETE. Pedogenic deposits.				
1.00						▽ Water encountered ↓ Water level ~ Bottom of hole --- Approximate material change • Disturbed sample ■ Undisturbed sample
1.20						

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 22

FIGURE: A22

TRIAL HOLE: 23

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°54'35,3" S 21°59'56,3" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refual of excavation at 400 mm on very hard rock, quartz-amphibole schist.
0.20		Abundant, clast supported, medium coarse, subangular and angular <i>GRAVELS</i> of quartz in a matrix of dry, light brown sand. Overall consistency is medium dense. Colluvium.				
0.40		Dull light yellow grey green speckled dark grey, very intensely laminated, very closely jointed, fine grained, slightly weathered, hard rock, <i>quartz-amphibole SCHIST</i> . Joints are open and filled with light red sand. Laminations are closed, smooth and clean. Well developed, black, needle-like amphibole crystals are contained in the rock matrix. Discontinuities dip at 30°.	U9306	0-0,4		
0.60						
0.80						
1.00						
1.20						

-  Water encountered
-  Water level
-  Bottom of hole
-  Approximate material change
-  Disturbed sample
-  Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 23

FIGURE: A23

TRIAL HOLE: 24

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°54'36,1" S 21°59'52,3" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Test pit abandoned. Dangerous and collapses from surface.
0.20		Dry, light red, very loose, intact, fine SAND. Aeolian deposits. Roots are present in the horizon.				
0.40						
0.60						
0.80						
1.00						
1.20						
1.40						
1.60						
1.80						
2.00		Abundant, clast supported, coarse, angular GRAVELS and COBBLES of quartz. Colluvium.				
2.20						
2.40						

- ∇ Water encountered
- ↓ Water level
- └ Bottom of hole
- - - Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 24

FIGURE: A24

TRIAL HOLE: 25

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°54'38,2" S 21°59'48,4" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface Dry, light red, very loose, intact, fine SAND. Aeolian deposits. Roots are present in the horizon.				NOTES: 1 Refual of excavation at 1100 mm on very hard rock, quartz-amphibole schist.
0.20						
0.40				U9305	0-0,6	
0.60		White, very fine grained, very dense, boulder CALCRETE. Pedogenic deposits.				
0.80						
1.00		Dull light yellow grey speckled dark grey, very intensely laminated, very closely jointed, fine grained, slightly weathered, hard rock, quartz-amphibole SCHIST. Joints are open, smooth and filled with light red sand. Laminations are closed, smooth and clean. Well developed, black, needle-like amphibole crystals are contained in the rock matrix. Discontinuities dip at 60°.				 Water encountered  Water level  Bottom of hole  Approximate material change  Disturbed sample  Undisturbed sample
1.20						
1.40						

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 25

FIGURE: A25

TRIAL HOLE: 26

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°54'38,9" S 21°59'42,5" E

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Cell: 082 570 2767
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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refual of excavation at 600 mm on very dense, hardpan calcrete.
0.20		Abundant, clast supported, medium coarse, subangular and angular GRAVELS of quartz in a matrix of dry, light brown sand. Overall consistency is medium dense. Colluvium. Dirty white, very fine grained, very dense, hardpan CALCRETE . Pedogenic deposits.				
0.40						
0.60						
0.80						
1.00						
1.20						

- ∇ Water encountered
- ↓ Water level
- ~ Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 26

FIGURE: A26

TRIAL HOLE: 27	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i> P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za
PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY	
LOGGED BY: FJB	
SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48	
DATE LOGGED: 10/7/2020	
CLIENT: !KHEIS MUNICIPALITY	
LOCATION: 28°54'39,4" S 21°59'38,3" E	

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refual of excavation at 400 mm on very dense, hardpan calcrete.
0.20		Abundant, clast supported, medium coarse, subangular and angular GRAVELS of quartz in a matrix of dry, light brown sand. Overall consistency is medium dense. Colluvium. Dirty white, very fine grained, very dense, hardpan CALCRETE . Pedogenic deposits.				
0.40						
0.60						
0.80						
1.00						
1.20						

-  Water encountered
-  Water level
-  Bottom of hole
-  Approximate material change
-  Disturbed sample
-  Undisturbed sample

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 10/7/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1

SOIL PROFILE: TEST PIT 27	FIGURE: A27
----------------------------------	--------------------

TRIAL HOLE: 28

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°54'31,5" S 21°59'55,1" E

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Email:
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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refual of excavation at 800 mm on hard rock, quartz-amphibole schist.
0.20		Abundant, clast supported, medium coarse, subangular and angular <i>GRAVELS</i> of quartz in a matrix of dry, light brown, sand. Overall consistency is medium dense. Colluvium.				
0.40		Lenses of dirty white discoloured light brown, very fine grained, dense, hardpan <i>CALCRETE</i> . Pedogenic deposits.				
0.60		Light grey brown, very closely jointed, very intensely laminated, very fine grained, unweathered, hard rock, <i>quartz-amphibole SCHIST</i> . Joints are closed, smooth and clean. Discontinuities dip at 30°.				
0.80						
1.00						
1.20						
1.40						
1.60						
1.80						

- Water encountered
- Water level
- Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 28

FIGURE: A28

TRIAL HOLE: 29

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°54'31,3" S 21°59'49,8" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refual of excavation at 600 mm on hard rock, quartz-amphibole schist.
0.20		Abundant, clast supported, medium coarse, subangular and angular <i>GRAVELS</i> of quartz in a matrix of dry, light brown, sand. Overall consistency is medium dense. Colluvium.				
0.40		Lenses of dirty white discoloured light brown, very fine grained, dense, hardpan <i>CALCRETE</i> . Pedogenic deposits.				
0.60		Light grey brown, very closely jointed, very intensely laminated, very fine grained, unweathered, hard rock, <i>quartz-amphibole SCHIST</i> . Joints are closed, smooth and clean. Discontinuities dip at 30°.				
0.80						
1.00						
1.20						
1.40						
1.60						
1.80						

- Water encountered
- Water level
- Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 29

FIGURE: A29

TRIAL HOLE: 30	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i> P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za
PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY	
LOGGED BY: FJB	
SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48	
DATE LOGGED: 10/7/2020	
CLIENT: !KHEIS MUNICIPALITY	LOCATION: 28°54'31,5" S 21°59'41,5" E

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 800 mm on very dense boulder calcrete.
		Dry, light red, very loose, intact, fine SAND. Aeolian deposits. Roots are present in the horizon.				
0.20				U9303	0-0,5	
0.40						
0.60		Abundant, clast supported, rounded and subrounded, medium coarse, GRAVELS of quartz in a matrix of light red, fine sand. Overall consistency is medium dense. Colluvium.				
0.80		White, very fine grained, very dense, boulder CALCRETE. Pedogenic deposits.				
1.00						Water encountered Water level Bottom of hole Approximate material change Disturbed sample Undisturbed sample

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 10/7/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1

SOIL PROFILE: TEST PIT 30	FIGURE: A30
----------------------------------	--------------------

TRIAL HOLE: 31**PROJECT:** EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY**LOGGED BY:** FJB**SITE:** PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48**DATE LOGGED:** 10/7/2020**CLIENT:** !KHEIS MUNICIPALITY**LOCATION:** 28°54'33,9" S 21°59'36,7" E

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Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za**

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface Dry, light red, very loose, intact, fine SAND. Aeolian deposits.				NOTES: 1 Refusal of excavation at 400 mm on hard rock, quartz-amphibole schist.
0.20		Dull light yellow grey speckled dark grey, very closely jointed, very intensely laminated, fine grained, slightly weathered, hard rock, quartz-amphibole SCHIST. Joints are open, smooth and filled with light red sand. Laminations are closed, smooth and clean. Well developed, black, needle-like amphibole crystals are contained in the rock matrix. Discontinuities dip at 45°.				
0.40						
0.60						
0.80						
1.00						

-  Water encountered
-  Water level
-  Bottom of hole
-  Approximate material change
-  Disturbed sample
-  Undisturbed sample

Contractor: ALS Plant Hire**Date Drilled:** 10/7/2020**Machine:** Bell 315SK**Hole Diameter:** 600 mm**Water Depth:****Sheet:** 1 of 1**SOIL PROFILE:** TEST PIT 31**FIGURE:** A31

TRIAL HOLE: 32	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i> P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za
PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY	
LOGGED BY: FJB	
SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48	
DATE LOGGED: 9/7/2020	
CLIENT: !KHEIS MUNICIPALITY	
LOCATION: 28°54'26,1" S 21°59'54,3" E	

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 300 mm on very dense hardpan calcrete.
0.20		Abundant, clast supported, medium coarse, subangular and angular, <i>GRAVELS</i> of quartz in a matrix of dry, light brown sand. Overall consistency is medium dense. Colluvium.				
0.20		Dirty white mottled light brown, very fine grained, very dense, hardpan <i>CALCRETE</i> . Pedogenic deposits.				
0.40						
0.60						
0.80						
1.00						

- Water encountered
- Water level
- Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 9/7/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1
SOIL PROFILE: TEST PIT 32	FIGURE: A32

TRIAL HOLE: 33

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 9/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°54'26,9" S 21°59'49,0" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				<p>NOTES:</p> <p>1 Refusal of excavation at 500 mm on hard rock, quartz-amphibole schist.</p>
		Abundant, clast supported, medium coarse, subangular and angular, <i>GRAVELS</i> of quartz in a matrix of dry, light brown sand. Overall consistency is medium dense. Colluvium.				
0.20		Lenses of dirty white discoloured light brown, very fine grained, dense, hardpan <i>CALCRETE</i> . Pedogenic deposits.				
0.40	Light grey brown, very closely jointed, very intensely laminated, very fine grained, unweathered, hard rock, <i>quartz-amphibole SCHIST</i> . Joints are closed, smooth and clean. Discontinuities dip at 60°.	U9299	0,3-0,5			
0.60						
0.80						
1.00						

- Water encountered
- Water level
- Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire
Date Drilled: 9/7/2020
Machine: Bell 315SK

Hole Diameter: 600 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 33

FIGURE: A33

TRIAL HOLE: 34

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 9/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°54'27,3" S 21°59'46,1" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				<p>NOTES:</p> <p>1 Refusal of excavation at 600 mm on hard rock, quartz-amphibole schist.</p>
0.20		Abundant, clast supported, medium coarse, subangular and angular, <i>GRAVELS</i> of quartz in a matrix of dry, light brown sand. Overall consistency is medium dense. Colluvium.				
0.40		Lenses of dirty white discoloured light brown, very fine grained, dense, hardpan <i>CALCRETE</i> . Pedogenic deposits.				
0.60		Light grey brown, very closely jointed, very intensely laminated, very fine grained, unweathered, hard rock, <i>quartz-amphibole SCHIST</i> . Joints are closed, smooth and clean. Discontinuities dip at 30°.				
0.80						<p>▽ Water encountered</p> <p>↓ Water level</p> <p>~ Bottom of hole</p> <p>--- Approximate material change</p> <p>• Disturbed sample</p> <p>▪ Undisturbed sample</p>
1.00						

Contractor: ALS Plant Hire

Date Drilled: 9/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 34

FIGURE: A34

TRIAL HOLE: 35**PROJECT:** EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY**LOGGED BY:** FJB**SITE:** PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48**DATE LOGGED:** 9/7/2020**CLIENT:** !KHEIS MUNICIPALITY**LOCATION:** 28°54'27,9" S 21°59'42,3" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 600 mm on hard rock, quartz-amphibole schist.
0.20		Abundant, clast supported, medium coarse, subangular and angular, <i>GRAVELS</i> of quartz in a matrix of dry, light brown sand. Overall consistency is medium dense. Colluvium.				
0.40		Light grey brown, very closely jointed, very intensely laminated, very fine grained, unweathered, hard rock, <i>quartz-amphibole SCHIST</i> . Joints are closed, smooth and clean. Discontinuities dip at 45°.				
0.60						
0.80						
1.00						

- Water encountered
- Water level
- Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire**Date Drilled:** 9/7/2020**Machine:** Bell 315SK**Hole Diameter:** 600 mm**Water Depth:****Sheet:** 1 of 1**SOIL PROFILE:** TEST PIT 35**FIGURE:** A35

TRIAL HOLE: 36

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 9/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°54'29,1" S 21°59'38,2" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 1000 mm on very hard rock, quartz-amphibole schist.
0.20		Dry, light red, very loose, intact, fine SAND. Aeolian deposits. Roots are present in the horizon.				
0.40						
0.60		Abundant, clast supported, medium coarse, subangular and angular, GRAVELS of quartz in a matrix of dry, light brown sand. Overall consistency is medium dense. Colluvium.				
0.80						
1.00		Light grey, very closely jointed, very intensely laminated, fine grained, unweathered, very hard rock, quartz-amphibole SCHIST. Joints are closed, smooth and clean. Discontinuities dip at 15°.				
1.20						

- ∇ Water encountered
- ↓ Water level
- └ Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire
Date Drilled: 9/7/2020
Machine: Bell 315SK

Hole Diameter: 600 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 36

FIGURE: A36

TRIAL HOLE: 37

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 9/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°54'30,2" S 21°59'35,0" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface Dry, light red, very loose, intact, fine SAND. Aeolian deposits.				NOTES: 1 Test pit abandoned - dangerous collapse from the surface.
0.20						
0.40				U9298	0-0,6	
0.60		Lenses (± 20 mm thick) of dirty white, very fine grained, dense, hardpan CALCRETE. Pedogenic deposits.				 Water encountered  Water level  Bottom of hole  Approximate material change  Disturbed sample  Undisturbed sample
0.80						
1.00		Dirty white, very closely jointed, very intensely laminated, very fine grained, slightly weathered, medium hard rock, quartz-amphibole SCHIST. Joints are closed, smooth and clean. Discontinuities dip at 30°.				
1.20						

Contractor: ALS Plant Hire

Date Drilled: 9/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 37

FIGURE: A37

TRIAL HOLE: 38

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 9/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°54'19,5" S 21°59'51,4" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 500 mm on medium hard rock, quartz-amphibole schist.
		Abundant, clast supported, medium coarse, subangular and angular, <i>GRAVELS</i> of quartz in a matrix of dry, light brown sand. Overall consistency is medium dense. Colluvium.				
0.20						
0.40		Dull light grey green speckled white, very closely jointed, very intensely laminated, very fine grained, slightly weathered, soft rock to medium hard rock at depth, <i>quartz-amphibole SCHIST</i> . Joints are open and filled with white, calcareous fine sand. Discontinuities dip at 15°.	U9293	0,3-0,5		
0.60						
0.80						
1.00						

-  Water encountered
-  Water level
-  Bottom of hole
-  Approximate material change
-  Disturbed sample
-  Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 9/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 38

FIGURE: A38

TRIAL HOLE: 39

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 9/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°54'20,7" S 21°59'47,7" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				<p>NOTES:</p> <p>1 Refusal of excavation at 800 mm on medium hard rock, quartz-amphibole schist.</p>
0.20		Dry, light red brown, medium dense, intact, fine SAND and matrix supported, subrounded, medium coarse gravels of quartz and banded ironstone. Colluvium.				
0.40		Lenses of dirty white discoloured light brown, very fine grained, dense, hardpan CALCRETE. Pedogenic deposits.				
0.60		Dull light grey green speckled white, very closely jointed, intensely laminated, very fine grained, slightly weathered, soft rock to medium hard rock at depth, quartz-amphibole SCHIST. Joints are open and filled with white, calcareous fine sand. Discontinuities orientated horizontally.				
0.80						
1.00						
1.20						

- ∇ Water encountered
- ↓ Water level
- ~ Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 9/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 39

FIGURE: A39

TRIAL HOLE: 40**PROJECT:** EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY**LOGGED BY:** FJB**SITE:** PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48**DATE LOGGED:** 9/7/2020**CLIENT:** !KHEIS MUNICIPALITY**LOCATION:** 28°54'23,0" S 21°59'41,2" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 400 mm on very hard rock, quartzite.
		Dry, light red brown, medium dense, intact, fine SAND and matrix supported, subrounded, medium coarse gravels of quartz and banded ironstone. Colluvium				
0.20		Lenses of dirty white discoloured light brown, very fine grained, very dense, hardpan CALCRETE. Pedogenic deposits.	U9297	0-0,3	●	
0.40		Dark grey speckled white, widely jointed, fine grained, slightly weathered, very hard rock, QUARTZITE. Joints are closed, smooth and clean.				
0.60						
0.80						
1.00						
1.20						

- ∇ Water encountered
- ↓ Water level
- ~ Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire**Date Drilled:** 9/7/2020**Machine:** Bell 315SK**Hole Diameter:** 600 mm**Water Depth:****Sheet:** 1 of 1**SOIL PROFILE:** TEST PIT 40**FIGURE:** A40

TRIAL HOLE: 41

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 9/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°54'24,0" S 21°59'36,5" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				<p>NOTES:</p> <p>1 Refusal of excavation at 800 mm on medium hard rock, quartz-amphibole schist.</p>
0.20		Abundant, clast supported, medium coarse, subangular and angular, <i>GRAVELS</i> of quartz in a matrix of dry, light brown sand. Overall consistency is medium dense. Colluvium.				
0.40						<p>▽ Water encountered ↓ Water level ~ Bottom of hole --- Approximate material change • Disturbed sample ▪ Undisturbed sample</p>
0.60		Dull light grey green speckled white, very closely jointed, intensely laminated, very fine grained, slightly weathered, soft rock to medium hard rock at depth, <i>quartz-amphibole SCHIST</i> . Joints are open and filled with white, calcareous fine sand. Discontinuities dip at 15°.				
0.80						
1.00						

Contractor: ALS Plant Hire

Date Drilled: 9/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 41

FIGURE: A41

TRIAL HOLE: 42

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PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY**LOGGED BY:** FJB**SITE:** PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48**DATE LOGGED:** 9/7/2020**CLIENT:** !KHEIS MUNICIPALITY**LOCATION:** 28°54'25,3" S 21°59'29,9" E

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 1200 mm on very hard rock, quartzite. 2 Test pit collapses from the surface.
0.20		Dry, light red, very loose, intact, fine SAND. Aeolian deposits.				
0.40						
0.60						
0.80						
1.00						
1.20		Light grey discoloured light yellow brown, widely jointed, fine grained, slightly weathered, very hard rock, QUARTZITE. Discontinuities are closed, smooth and clean.				▽ Water encountered ↓ Water level ~ Bottom of hole --- Approximate material change • Disturbed sample ■ Undisturbed sample
1.40						

Contractor: ALS Plant Hire**Date Drilled:** 9/7/2020**Machine:** Bell 315SK**Hole Diameter:** 600 mm**Water Depth:****Sheet:** 1 of 1**SOIL PROFILE:** TEST PIT 42**FIGURE:** A42

TRIAL HOLE: 43

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 9/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°54'16,8" S 21°59'50,6" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 800 mm on medium hard rock, quartz-amphibole schist.
		Abundant, clast supported, medium coarse, subangular and angular, <i>GRAVELS</i> of quartz in a matrix of dry, light brown sand. Overall consistency is medium dense. Colluvium.				
0.20						
		Dull light grey green speckled white, very closely jointed, intensely laminated, very fine grained, slightly weathered, soft rock to medium hard rock at depth, <i>quartz-amphibole SCHIST</i> . Joints are open and filled with white, calcareous fine sand. Discontinuities dip at 15°.				
0.40						
0.60						
0.80						
1.00						

-  Water encountered
-  Water level
-  Bottom of hole
-  Approximate material change
-  Disturbed sample
-  Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 9/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 43

FIGURE: A43

TRIAL HOLE: 44

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 9/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°54'17,7" S 21°59'45,9" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 800 mm on medium hard rock, quartz-amphibole schist.
0.20		Abundant, clast supported, medium coarse, subangular and angular, <i>GRAVELS</i> of quartz in a matrix of dry, light brown sand. Overall consistency is medium dense. Colluvium.	U9296	0-0,5		
0.40		Dull light grey green speckled white, very closely jointed, intensely laminated, very fine grained, slightly weathered, soft rock to medium hard rock at depth, <i>quartz-amphibole SCHIST</i> . Joints are open and filled with white, calcareous fine sand. Discontinuities dip at 15°.				
0.60						
0.80						<ul style="list-style-type: none">  Water encountered  Water level  Bottom of hole  Approximate material change  Disturbed sample  Undisturbed sample
1.00						

Contractor: ALS Plant Hire

Date Drilled: 9/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 44

FIGURE: A44

TRIAL HOLE: 45	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i> P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za
PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY	
LOGGED BY: FJB	
SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48	
DATE LOGGED: 9/7/2020	
CLIENT: !KHEIS MUNICIPALITY	
LOCATION: 28°54'18,9" S 21°59'39,6" E	

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 800 mm on very dense hardpan calcrete.
0.20		Abundant, clast supported, medium coarse, subangular and angular, <i>GRAVELS</i> of quartz in a matrix of dry, light brown sand. Overall consistency is medium dense. Colluvium.				
0.40						
0.60		Dirty white, very fine grained, very dense, hardpan <i>CALCRETE</i> . Pedogenic deposits.				
0.80						<ul style="list-style-type: none"> ∇ Water encountered ↓ Water level ~ Bottom of hole --- Approximate material change • Disturbed sample ▪ Undisturbed sample
1.00						

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 9/7/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1

SOIL PROFILE: TEST PIT 45	FIGURE: A45
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TRIAL HOLE: 46

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 9/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°54'19,3" S 21°59'34,2" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 1000 mm on hard rock, quartzite. 2 Test pit collapses from the surface.
0.20		Dry, light red, very loose, intact, fine SAND. Aeolian deposits.				
0.40			U9295	0-0,7		
0.60						
0.80		Dry, light brown, loose, intact, fine SAND and matrix supported, fine, rounded gravels of quartz. Colluvium.				
1.00		Pale light yellow grey speckled light grey, medium jointed, very fine grained, slightly weathered, hard rock, QUARTZITE. Joints are closed, smooth and clean.				
1.20						
1.40						

- Water encountered
- Water level
- Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 9/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 46

FIGURE: A46

TRIAL HOLE: 47

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 9/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°54'12,0" S 21°59'46,6" E

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				<p>NOTES:</p> <p>1 Refusal of excavation at 500 mm on medium hard rock, quartz-amphibole schist.</p> <p> Water encountered Water level Bottom of hole Approximate material change Disturbed sample Undisturbed sample </p>
		Abundant, clast supported, medium coarse, subangular and angular, <i>GRAVELS</i> of quartz in a matrix of dry, light brown sand. Overall consistency is medium dense. Colluvium.				
0.20		Lenses of dirty white discoloured light brown, very fine grained, dense, hardpan <i>CALCRETE</i> . Pedogenic deposits.				
0.40	Dull light grey green speckled white, very closely jointed, intensely laminated, very fine grained, slightly weathered, soft rock to medium hard rock at depth, <i>quartz-amphibole SCHIST</i> . Joints are open and filled with white calcareous fine sand. Discontinuities dip at 15°.					
0.60						
0.80						
1.00						

Contractor: ALS Plant Hire

Date Drilled: 9/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 47

FIGURE: A47

TRIAL HOLE: 48	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i> P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za
PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY	
LOGGED BY: FJB	
SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48	
DATE LOGGED: 9/7/2020	
CLIENT: !KHEIS MUNICIPALITY	
LOCATION: 28°54'13,4" S 21°59'40,4" E	

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 300 mm on very dense hardpan calccrete.
		Abundant, clast supported, medium coarse, subangular and angular, <i>GRAVELS</i> of quartz in a matrix of dry, light brown sand. Overall consistency is medium dense. Colluvium.				
0.20		Pale light brown and pink mottled dark grey, very fine grained, very dense, hardpan <i>CALCRETE</i> . Pedogenic deposits.				
0.40						
0.60						
0.80						
1.00						

- Water encountered
- Water level
- Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 9/7/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1
SOIL PROFILE: TEST PIT 48	FIGURE: A48

TRIAL HOLE: 49

PROJECT: EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY

LOGGED BY: FJB

SITE: PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48

DATE LOGGED: 9/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°54'14,2" S 21°59'35,7" E

*Cedar Land Geotechnical
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Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				<p>NOTES:</p> <p>1 Refusal of excavation at 800 mm on hard rock, quartzite.</p>
0.20		Dry, light brown, very loose, intact, fine SAND and matrix supported, fine, rounded gravels of quartz. Colluvium. Tree roots are present in the horizon.				
0.40		Abundant, clast supported, COBBLES and BOULDERS (< 500 mm in diameter) of quartzite and subrounded GRAVELS of calcrete in a matrix of dry, light brown, fine sand. Overall consistency is medium dense. Weakly calcareous and cemented residual quartzite.				
0.60		Pale light yellow grey speckled light grey, medium jointed, very fine grained, slightly weathered, hard rock, QUARTZITE. Joints are closed, smooth and clean.				
0.80						
1.00						
1.20						
1.40						

- ∇ Water encountered
- ↓ Water level
- ⌒ Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire
Date Drilled: 9/7/2020
Machine: Bell 315SK

Hole Diameter: 600 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 49

FIGURE: A49

TRIAL HOLE: 50**PROJECT:** EXPANSION AND FORMALISATION OF THE GROBLERSHOOP COMMUNITY**LOGGED BY:** FJB**SITE:** PORTION 16 OF THE FARM BOEGOEBERG SETTLEMENT NO 48**DATE LOGGED:** 9/7/2020**CLIENT:** !KHEIS MUNICIPALITY**LOCATION:** 28°54'08,3" S 21°59'40,3" E

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Cell: 082 570 2767
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cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 1000 mm on medium hard rock, quartz-amphibole schist.
		Dry, light brown, loose, intact, fine SAND. Colluvium.				
0.20		Dull light grey green speckled white, very closely jointed, intensely laminated, very fine grained, slightly weathered, soft rock to medium hard rock at depth, <i>quartz-amphibole SCHIST</i> . Joints are open and filled with white calcareous fine sand. Discontinuities dip at 75°.				
0.40						
0.60			U9294	0,2-1,0		
0.80						
1.00						

-  Water encountered
-  Water level
-  Bottom of hole
-  Approximate material change
-  Disturbed sample
-  Undisturbed sample

Contractor: ALS Plant Hire**Date Drilled:** 9/7/2020**Machine:** Bell 315SK**Hole Diameter:** 600 mm**Water Depth:****Sheet:** 1 of 1**SOIL PROFILE:** TEST PIT 50**FIGURE:** A50

**GEOTECHNICAL CONDITIONS ON PORTION 16 OF
THE FARM BOEGOEBERG SETTLEMENT 48: A
REPORT FOR THE EXPANSION AND FORMALISATION
OF GROBLERSHOOP COMMUNITYUNITY**

2020/J09/MCP_01

ADDENDUM B: RESULTS OF MATERIALS TESTING

Job Request No.: RU3525
 Cedar Land Geotechnical Consult (Pty) Ltd
 PO Box 607
 Ceres
 6835
 Attention : Frans Breytenbach

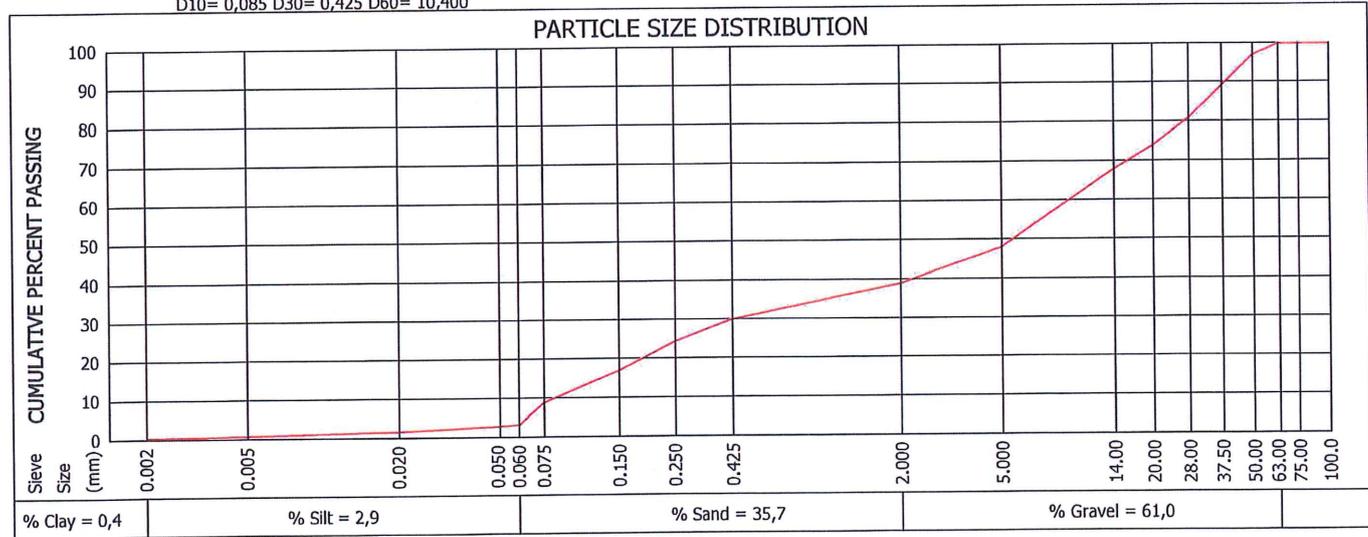
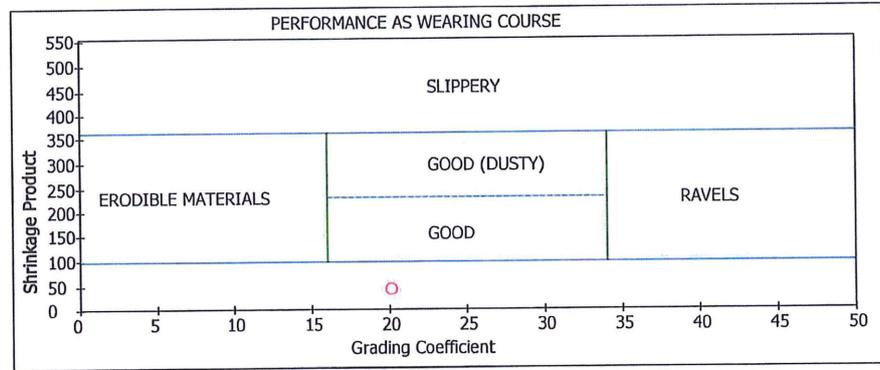
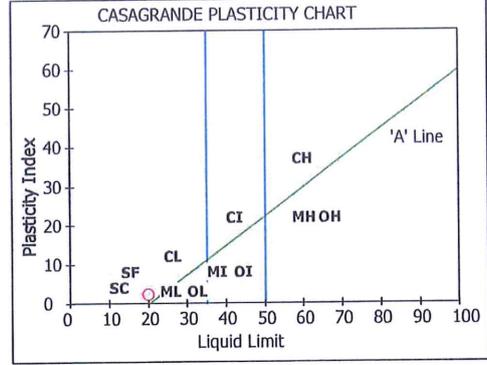
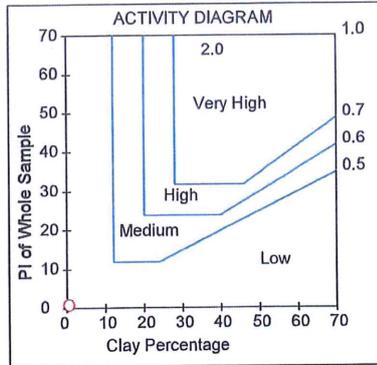
Date Reported : 2020-08-24

Project : Groblershoop Infrastructure Upgrade

Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

Sample No. : U9309
 Position : TP 2
 Layer Type : 200-600mm
 Sample Colour : Light Brown Gravel
 Sample Type : Mix Calcrete

Sieve Size(mm)	% Passing	Soil Mortar		
100.0	100	2.000 - 0.425	22	
75.00	100	0.425 - 0.250	15	
63.00	100	0.250 - 0.150	19	
50.00	97	0.150 - 0.075	21	
37.50	89	< 0.075	23	
28.00	81	Effective Size	0,085	
20.00	74	Uniformity Coefficient	122,4	
14.00	68	Curvature Coefficient	0,2	
5.000	48	Oversize Index	8,0	
2.000	39	Shrinkage Product	45,0	
0.425	30	Grading Coefficient	20,2	
0.250	24	Grading Modulus	2,20	
0.150	17	Atterberg Limits	Liquid Limit	20
0.075	8,9		Plasticity Index	2.0
0.060	3,3		Linear Shrinkage	1.5
0.050	2,9		PI < 0.075	
0.020	1,7	Unified Soil Classification	GW-GC	
0.005	0,9	US Highway Classification	A-1-a(0)	
0.002	0,4	D10= 0,085 D30= 0,425 D60= 10,400		



Deviation from Test Method :
 Remarks and Notes : Chemistry: pH = 7.76 [SANS 5854] & Conductivity = 0.16 S/m [SANS 6240]

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
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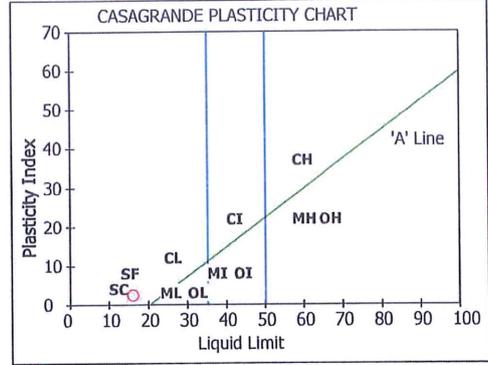
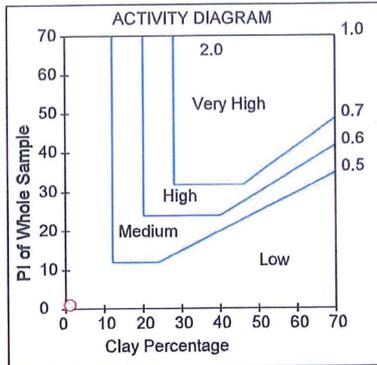
Job Request No.: RU3525
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 Attention : Frans Breytenbach

Date Reported : 2020-08-24

Project : Groblershoop Infrastructure Upgrade

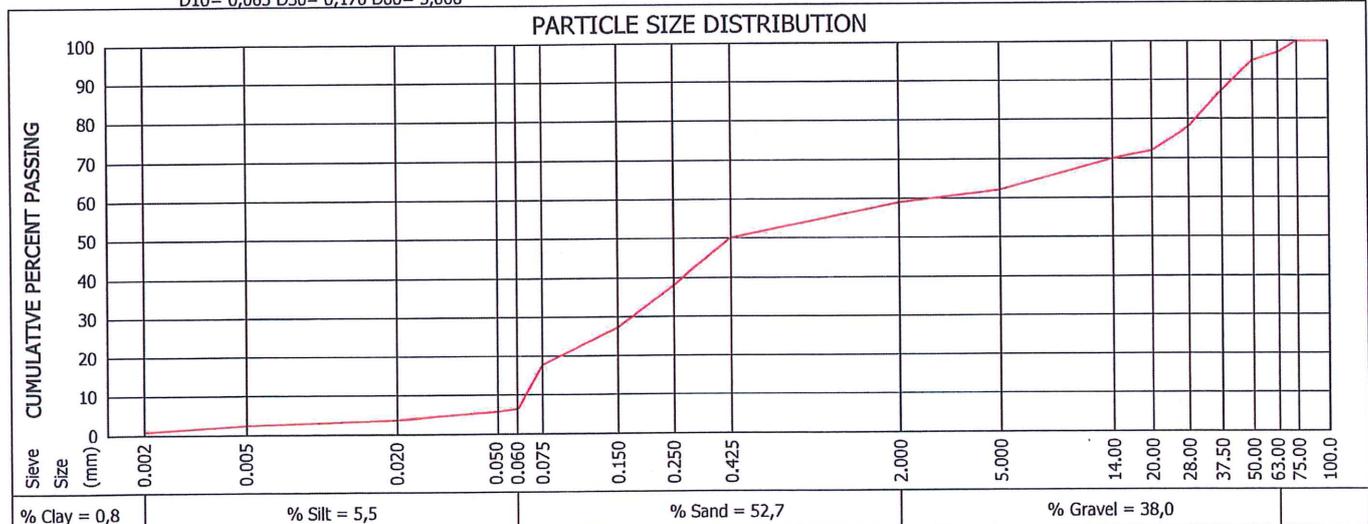
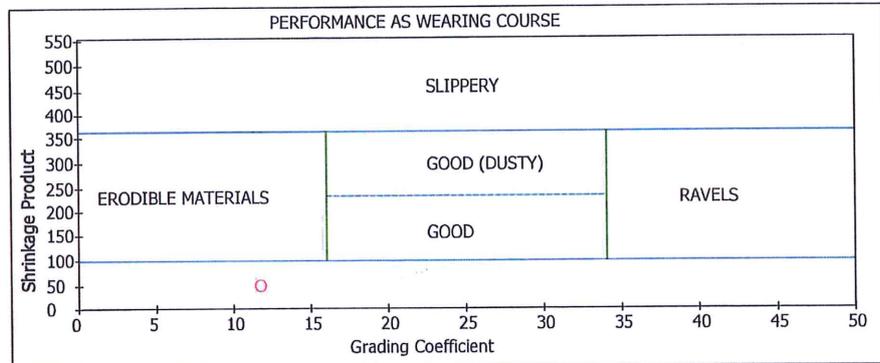
Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

Sample No.	: U9310
Position	: TP 9
Layer Type	: 0-800mm
Sample Colour	: Orange Brown Gravel
Sample Type	: Mix Quartz



Sieve Size(mm)	% Passing	Soil Mortar		
100.0	100	2.000 - 0.425	16	
75.00	100	0.425 - 0.250	20	
63.00	97	0.250 - 0.150	18	
50.00	95	0.150 - 0.075	16	
37.50	87	< 0.075	31	
28.00	78	Effective Size	0,065	
20.00	72	Uniformity Coefficient	46,2	
14.00	70	Curvature Coefficient	0,2	
5.000	62	Oversize Index	8,0	
2.000	59	Shrinkage Product	50,0	
0.425	50	Grading Coefficient	11,8	
0.250	38	Grading Modulus	1,70	
0.150	27	Atterberg Limits	Liquid Limit	16
0.075	18		Plasticity Index	2.0
0.060	6,3		Linear Shrinkage	1.0
0.050	5,6		PI < 0.075	
0.020	3,6	Unified Soil Classification	SC	
0.005	2,3	US Highway Classification	A-1-b(0)	
0.002	0,8			

D10= 0,065 D30= 0,176 D60= 3,000



Deviation from Test Method :
 Remarks and Notes : Chemistry: pH = 7.90 [SANS 5854] & Conductivity = 0.03 S/m [SANS 6240]

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
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Web: www.roadlab.co.za

Date Reported : 2020-08-06

Job Request No.: RU3525

Ceder Land Geotechnical Consult (Pty) Ltd

PO Box 607

Ceres

6835

Project : Groblershoop

Attention : Frans Breytenbach

Determination of the California Bearing Ratio Test Report SANS 3001 - GR1 / GR2 / GR10 / GR20 / GR30 / GR40 / PR5

SAMPLE INFORMATION AND PROPERTIES

SAMPLE NO.	U9310
HOLE NO./ Km / CHAINAGE	TP9
ROAD NO./ NAME Line 1	S28° 54' 55,7"
ROAD NO./ NAME Line 2	E21° 59' 55,2"
LAYER TESTED/SAMPLED	0-800mm
SAMPLE DEPTH	0-800mm
DATE SAMPLED	2020-07-13
COLOUR OF SAMPLE	Orange Brown
TYPE OF SAMPLE	Mix Quartz

SIEVE ANALYSIS - % PASSING SIEVES *(SANS 3001-GR1:2010, SANS 3001-GR2:2010)

SIEVE ANALYSIS (GR 1) % PASSING	100.0 mm	
	75.0 mm	100
	63.0 mm	97
	50.0 mm	95
	37.5 mm	87
	28.0 mm	78
	20.0 mm	72
	14.0 mm	70
	5.0 mm	62
	2.0 mm	59
0.425 mm	50	
0.075 mm	18	
GM %		1,7

SOIL MORTAR ANALYSIS (SANS 3001-PR5:2011)

COARSE SAND	2.000 - 0.425	16
COARSE FINE SAND	0.425 - 0.250	20
MEDIUM FINE SAND	0.250 - 0.150	18
FINE FINE SAND	0.150 - 0.075	16
SILT CLAY	0.075	31

ATTERBERG LIMITS ANALYSIS - *(SANS 3001-GR10:2010)

ATTERBERG LIMITS (%) SANS GR10,GR11	LIQUID LIMIT	16
	PLASTICITY INDEX	2.4
	LINEAR SHRINKAGE	1.0
CLASSIFICATION	H.R.B.	A-1-b(0)
	COLTO	G6
	TRH 14	G6

CALIFORNIA BEARING RATIO - *(SANS 3001-GR30:2010, SANS 3001-GR40:2010)

SANS GR30 MAX. DRY DENSITY	OMC %	6,5
	MDD (kg/m³)	2179
	COMP MC %	6,6
SWELL % @	MOD NRB PRO	0,00 0,01 0,02
	100 %	35
C.B.R. SANS GR40	98 %	32
	97 %	31
	95 %	28
	93 %	26
	90 %	23

STABILISER IN LAB	Not Applicable
TEST TYPE	CBR
SAMPLING METHOD	TMH 5
WEATHER WHEN SAMPLED	Cold

Deviation from Test Method :

Remarks and Notes :

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
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 Ceder Land Geotechnical Consult (Pty) Ltd
 PO Box 607
 Ceres
 6835
 Attention : Frans Breytonbach

Date Reported : 2020-07-29

Project : Groblershoop

Determination Maximum Dry Density & Optimum Moisture Content Test Report

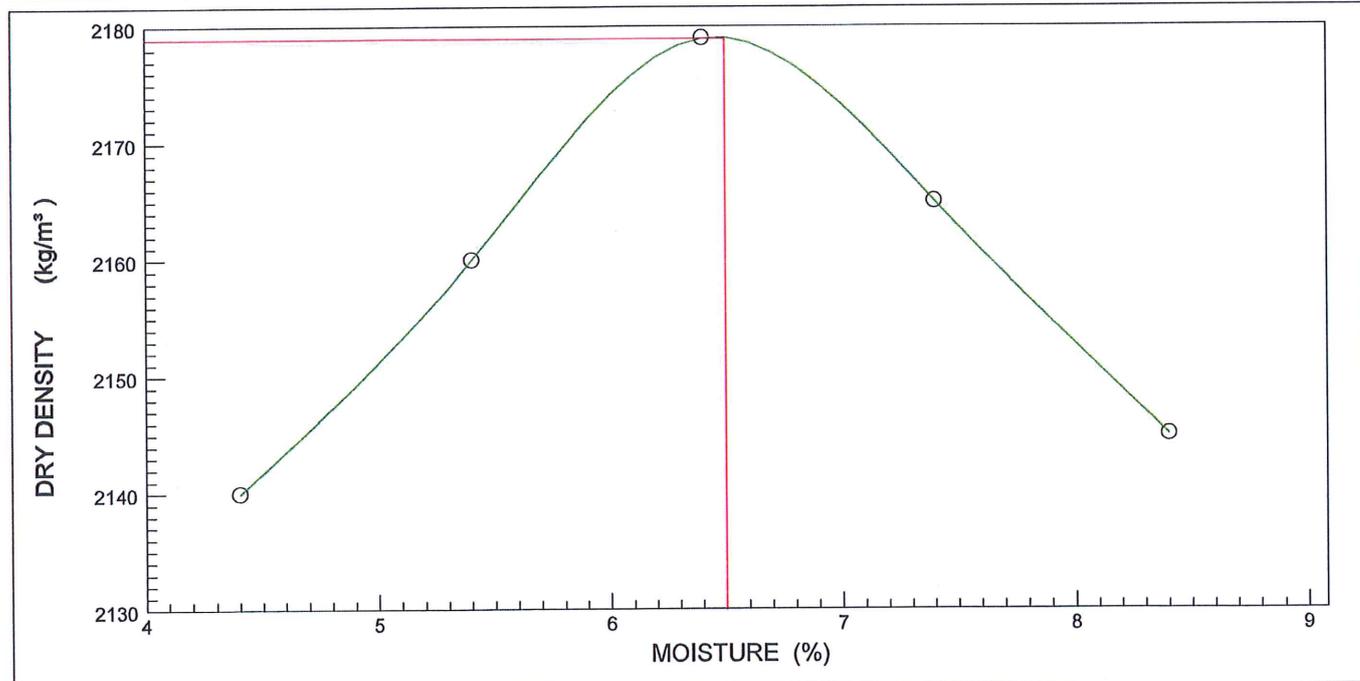
SANS 3001 - GR20/GR30

SAMPLE NO.	U9310
CONTAINER FOR SAMPLING	Black Bags
SIZE / APPROX. MASS OF SAMPLE	100kg
MOISTURE CONDITION OF SAMPLE	Moist
LAYER TESTED / SAMPLED FROM	0-800mm
MATERIAL DESCRIPTION	Mix Quartz
HOLE NO./ km / CHAINAGE	TP9
ROAD NO.	Not Specified
DATE RECEIVED	2020-07-14
DATE SAMPLED	2020-07-13
CLIENT MARKING	U9310
COLOUR AND TYPE	Orange Brown Gravel

POINT NO.	1	2	3	4	5			
DRY DENSITY (kg/m ³)	2140	2160	2179	2165	2145			
MOISTURE (%)	4,4	5,4	6,4	7,4	8,4			

MAXIMUM DRY DENSITY (kg/m³) : 2179

OPTIMUM MOISTURE CONTENT (%) : 6,5



Deviation from Test Method :
 Remarks and Notes :

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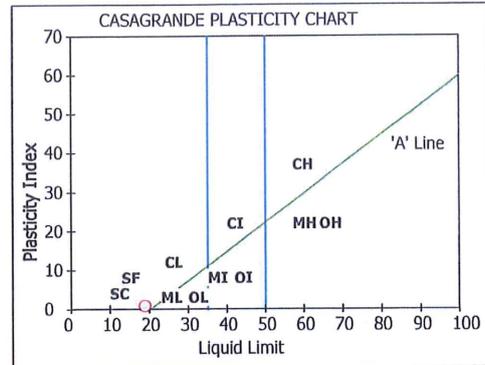
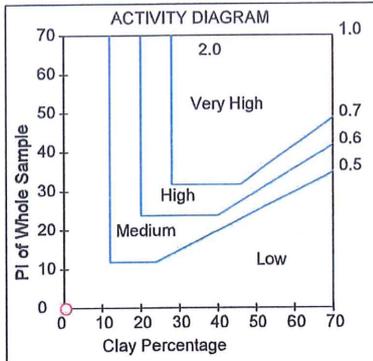
Job Request No.: RU3525
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Date Reported : 2020-08-24

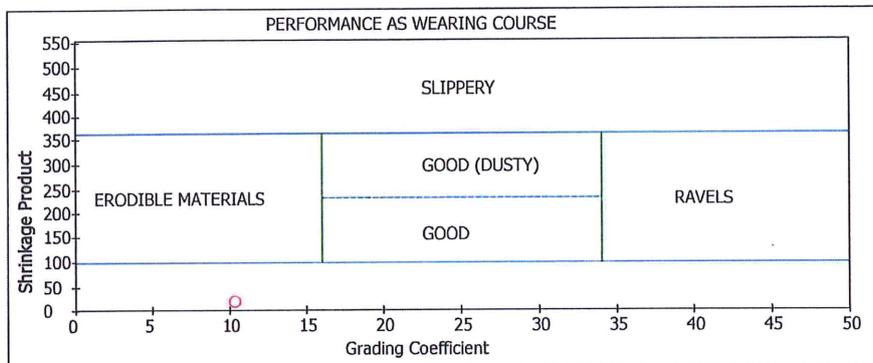
Project : Groblershoop Infrastructure Upgrade

Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

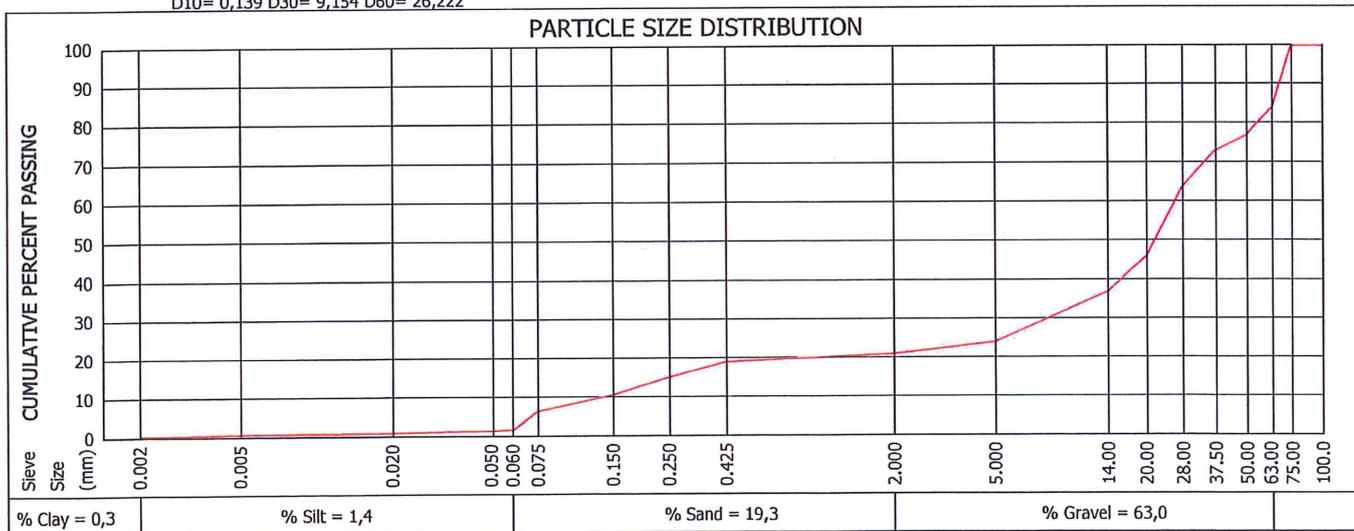
Sample No.	: U9307
Position	: TP 15
Layer Type	: 100-500mm
Sample Colour	: Brown Gravel
Sample Type	: Mix Calcrete Quartz



Sieve Size (mm)	% Passing	Soil Mortar		
100.0	100	Soil Mortar	2.000 - 0.425	10
75.00	100		0.425 - 0.250	19
63.00	84		0.250 - 0.150	21
50.00	77		0.150 - 0.075	22
37.50	73		< 0.075	28
28.00	64	Effective Size		0,139
20.00	46	Uniformity Coefficient		188,6
14.00	37	Curvature Coefficient		23,0
5.000	24	Oversize Index		4,0
2.000	21	Shrinkage Product		19,0
0.425	19	Grading Coefficient		10,3
0.250	15	Grading Modulus		2,50
0.150	11	Atterberg Limits	Liquid Limit	19
0.075	6,4		Plasticity Index	1.0
0.060	1,7		Linear Shrinkage	1.0
0.050	1,5		PI < 0.075	
0.020	1,0		Unified Soil Classification	GW-GC
0.005	0,8	US Highway Classification	A-1-a(0)	
0.002	0,3			



D10= 0,139 D30= 9,154 D60= 26,222



Deviation from Test Method :
 Remarks and Notes : Chemistry: pH = 7.77 [SANS 5854] & Conductivity = 0.12 S/m [SANS 6240]

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
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Date Reported : 2020-08-24

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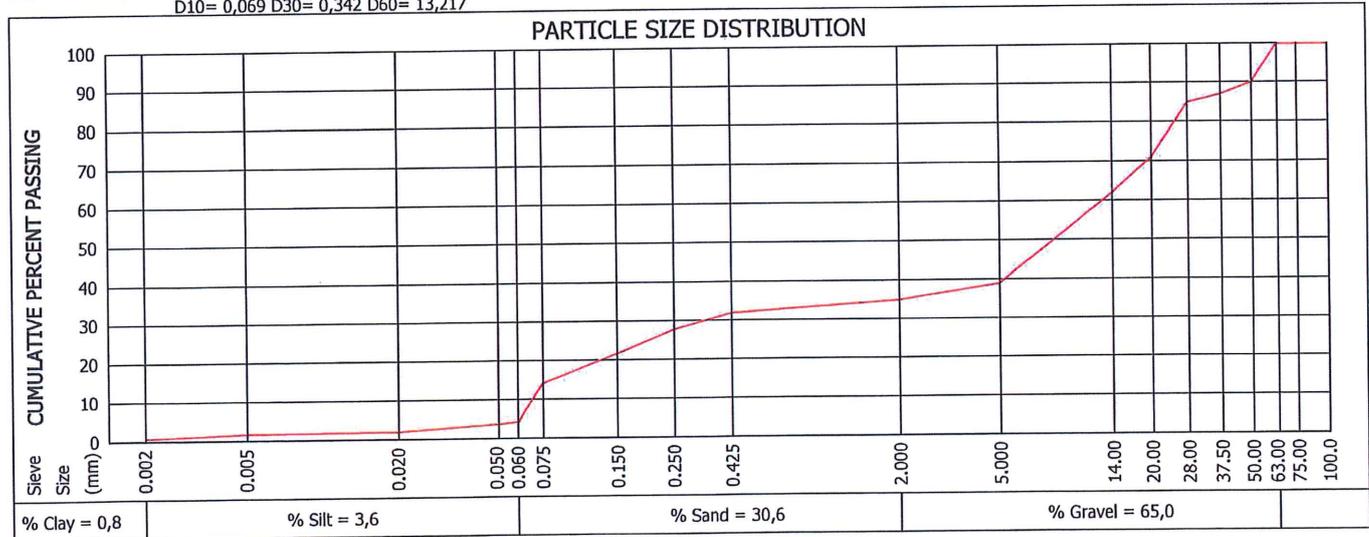
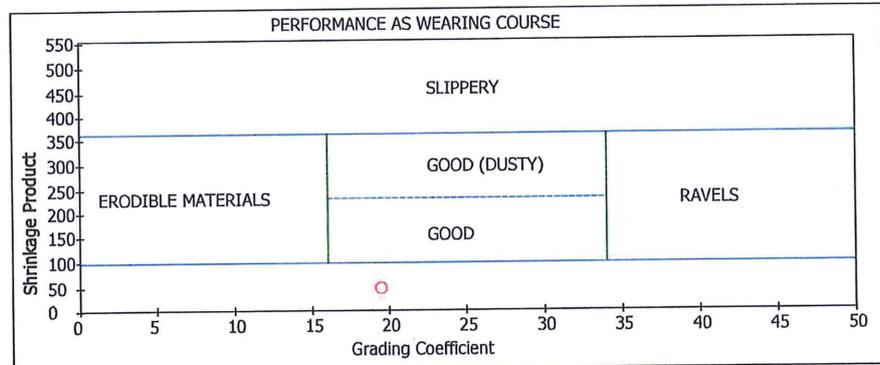
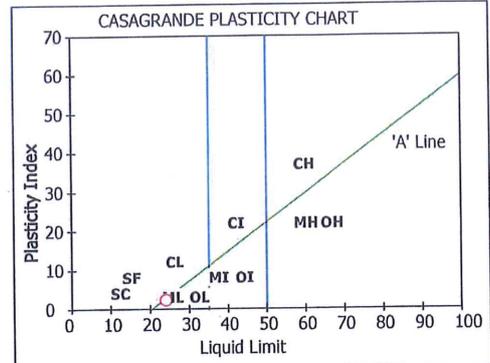
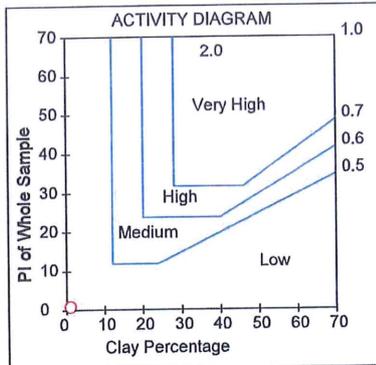
Project : Groblershoop Infrastructure Upgrade

Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

Sample No. : U9308
 Position : TP 17
 Layer Type : 0-300mm
 Sample Colour : Dark Brown Gravel
 Sample Type : Mix Quartz+Cal+OCC I

Sieve Size(mm)	% Passing	Soil	Montar		
			2.000 - 0.425		10
100,0	100		0.425 - 0.250		12
75,00	100		0.250 - 0.150		17
63,00	100		0.150 - 0.075		22
50,00	90		< 0.075		40
37,50	87		Effective Size		0,069
28,00	85		Uniformity Coefficient		191,6
20,00	71		Curvature Coefficient		0,1
14,00	62		Oversize Index		3,0
5,000	39		Shrinkage Product		48,0
2,000	35		Grading Coefficient		19,5
0,425	32		Grading Modulus		2,20
0,250	28	Atterberg Limits	Liquid Limit		24
0,150	22		Plasticity Index		2,0
0,075	14		Linear Shrinkage		1,5
0,060	4,4		PI < 0,075		
0,050	3,8		Unified Soil Classification		GM
0,020	2,1		US Highway Classification		A-1-b(0)
0,005	1,8				
0,002	0,8				

D10= 0,069 D30= 0,342 D60= 13,217



Deviation from Test Method :
 Remarks and Notes :

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
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ROADLAB

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Web: www.roadlab.co.za

Date Reported : 2020-08-05

Job Request No.: RU3525
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 6835

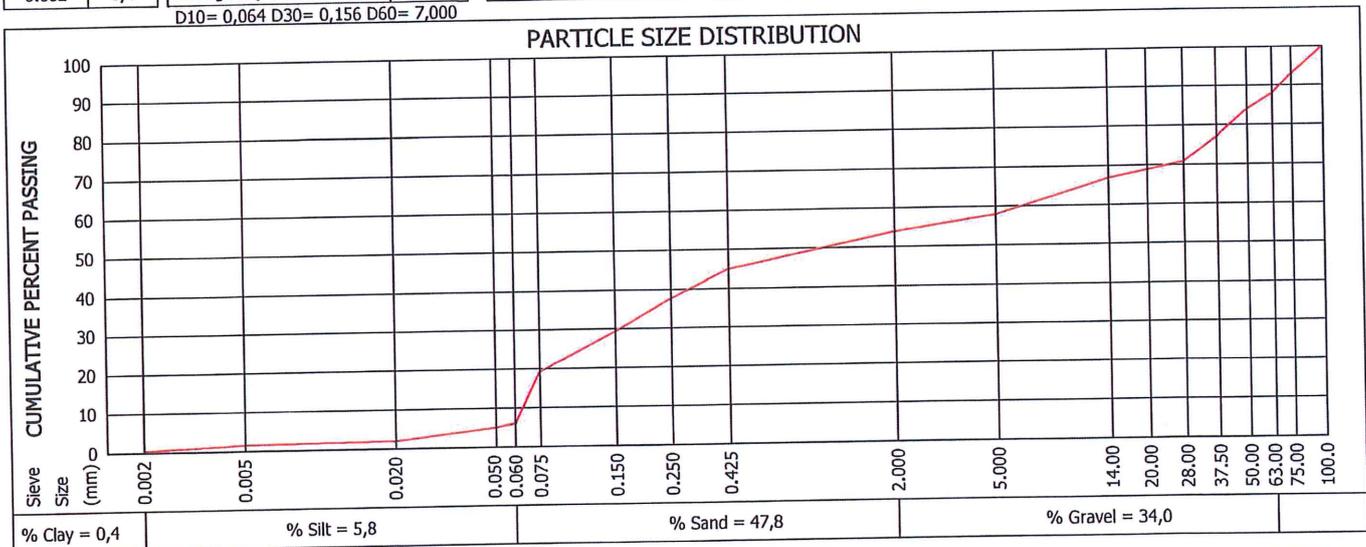
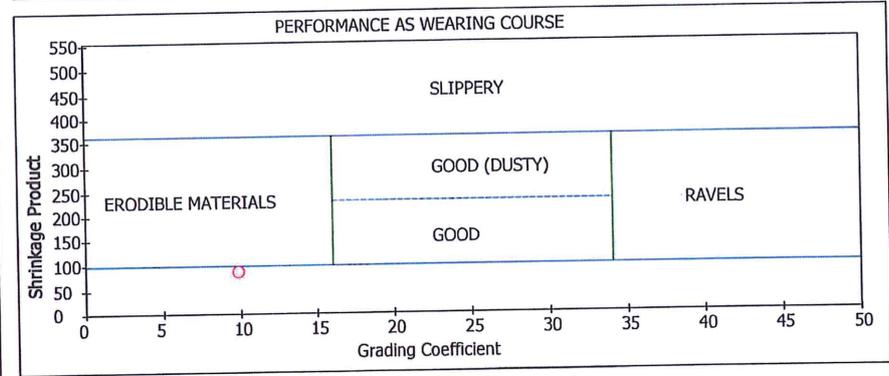
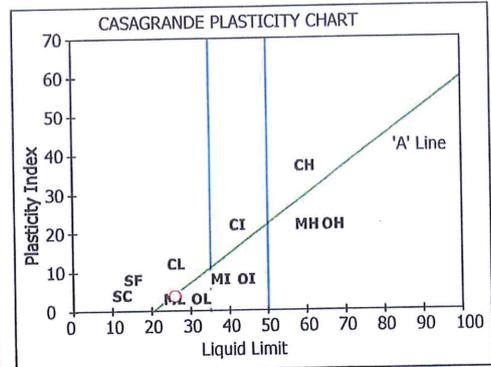
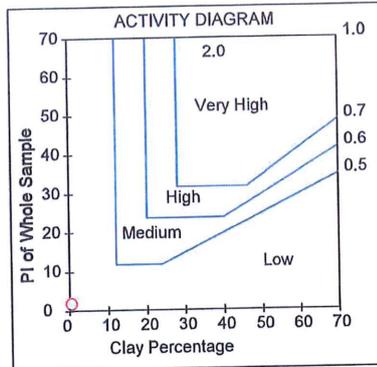
Project : Groblershoop Infrastructure Upgrade

Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

Sample No. : U9304
 Position : TP 22
 Layer Type : 0-700mm
 Sample Colour : Orange Brown Gravel
 Sample Type : Mix Calcrete+Quartz

Sieve Size(mm)	% Passing	Soil Mortar	2.000 - 0.425	17
100.0	100		0.425 - 0.250	13
75.00	93		0.250 - 0.150	15
63.00	88		0.150 - 0.075	19
50.00	84		< 0.075	35
37.50	77	Effective Size		0,064
28.00	71	Uniformity Coefficient		109,4
20.00	69	Curvature Coefficient		0,1
14.00	67	Oversize Index		7,0
5.000	58	Shrinkage Product		90,0
2.000	54	Grading Coefficient		9,9
0.425	45	Grading Modulus		1,80
0.250	38	Atterberg Limits	Liquid Limit	26
0.150	30		Plasticity Index	4
0.075	19		Linear Shrinkage	2,0
0.060	6,2		PI < 0.075	
0.050	5,2	Unified Soil Classification		SM
0.020	2,2	US Highway Classification		A-1-b(0)
0.005	1,7			
0.002	0,4			

D10= 0,064 D30= 0,156 D60= 7,000



Deviation from Test Method :
 Remarks and Notes : Chemistry: pH = 7.52 [SANS 5854] & Conductivity = 0.11 S/m [SANS 6240]

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
 The test results reported relate to the samples tested.
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ROADLAB

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Job Request No.: RU3525
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 PO Box 607
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Date Reported : 2020-08-05

Project : Groblershoop Infrastructure Upgrade

Attention : Frans Breytenbach

Determination of the California Bearing Ratio Test Report SANS 3001 - GR1 / GR2 / GR10 / GR20 / GR30 / GR40 / PR5

SAMPLE INFORMATION AND PROPERTIES

SAMPLE NO.	U9304
HOLE NO./ Km / CHAINAGE	TP22
ROAD NO./ NAME Line 1	S28° 54' 43,8"
ROAD NO./ NAME Line 2	E21° 59' 39,3"
LAYER TESTED/SAMPLED	0-700mm
SAMPLE DEPTH	0-700mm
DATE SAMPLED	2020-07-13
COLOUR OF SAMPLE	Orange Brown
TYPE OF SAMPLE	Mix Calcrete+Quartz

SIEVE ANALYSIS - % PASSING SIEVES *(SANS 3001-GR1:2010, SANS 3001-GR2:2010)

SIEVE ANALYSIS (GR 1) % PASSING	100.0 mm	100
	75.0 mm	93
	63.0 mm	88
	50.0 mm	84
	37.5 mm	77
	28.0 mm	71
	20.0 mm	69
	14.0 mm	67
	5.0 mm	58
	2.0 mm	54
0.425 mm	45	
0.075 mm	19	
GM %		1,8

SOIL MORTAR ANALYSIS (SANS 3001-PR5:2011)

COARSE SAND	2.000 - 0.425	17
COARSE FINE SAND	0.425 - 0.250	13
MEDIUM FINE SAND	0.250 - 0.150	15
FINE FINE SAND	0.150 - 0.075	19
SILT CLAY	0.075	35

ATTERBERG LIMITS ANALYSIS - *(SANS 3001-GR10:2010)

ATTERBERG LIMITS (%) SANS GR10,GR11	LIQUID LIMIT	26
	PLASTICITY INDEX	4
	LINEAR SHRINKAGE	2.0
CLASSIFICATION	H.R.B.	A-1-b(0)
	COLTO	G6
	TRH 14	G7

CALIFORNIA BEARING RATIO - *(SANS 3001-GR30:2010, SANS 3001-GR40:2010)

SANS GR30 MAX. DRY DENSITY	OMC %	7,7
	MDD (kg/m³)	2146
	COMP MC %	7,5
SWELL % @	MOD NRB PRO	0,01 0,04 0,06
	100 %	82
	98 %	54
C.B.R. SANS GR40	97 %	43
	95 %	28
	93 %	18
	90 %	10

STABILISER IN LAB	Not Applicable
TEST TYPE	CBR
SAMPLING METHOD	TMH 5
WEATHER WHEN SAMPLED	Cold

Deviation from Test Method :
 Remarks and Notes :

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
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 Ceder Land Geotechnical Consult (Pty) Ltd
 PO Box 607
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 Attention : Frans Breytenbach

Date Reported : 2020-07-29

Project : Groblershoop Infrastructure Upgrade

Determination Maximum Dry Density & Optimum Moisture Content Test Report

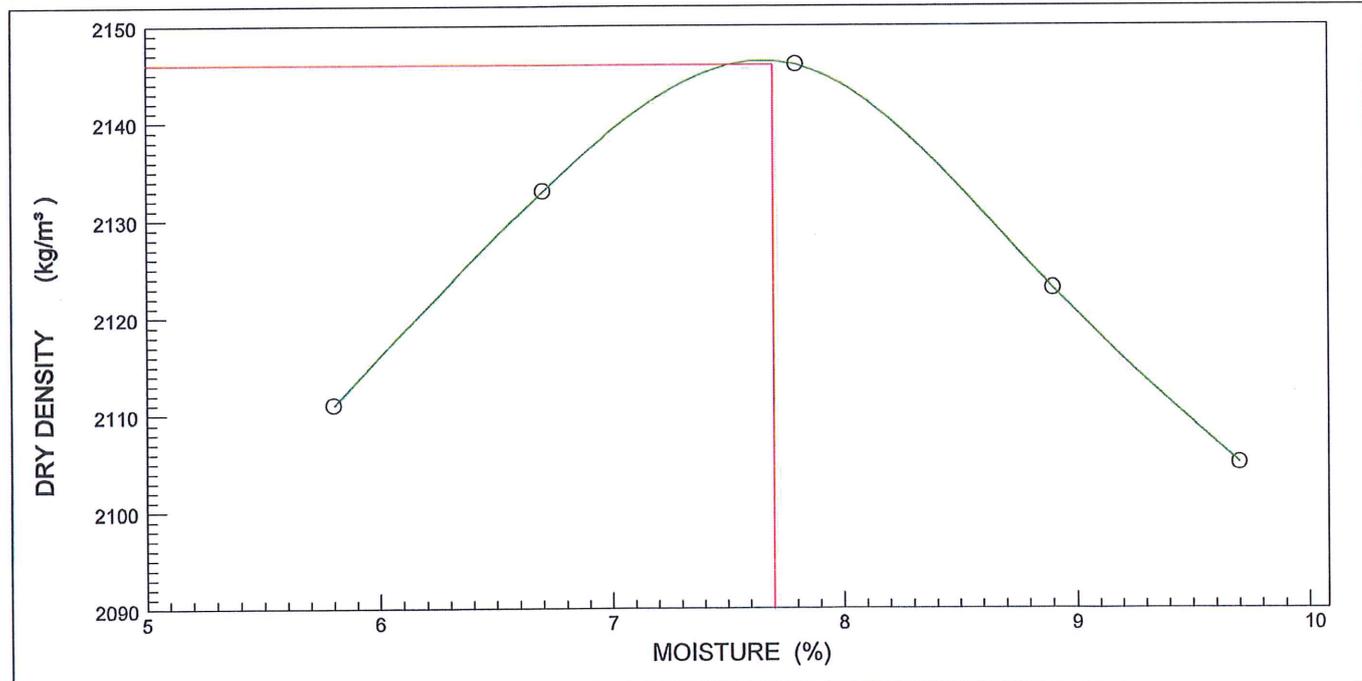
SANS 3001 - GR20/GR30

SAMPLE NO.	U9304
CONTAINER FOR SAMPLING	Black Bags
SIZE / APPROX. MASS OF SAMPLE	99kg
MOISTURE CONDITION OF SAMPLE	Moist
LAYER TESTED / SAMPLED FROM	0-700mm
MATERIAL DESCRIPTION	Mix Calcrete+Quartz
HOLE NO./ km / CHAINAGE	TP22
ROAD NO.	Not Specified
DATE RECEIVED	2020-07-14
DATE SAMPLED	2020-07-13
CLIENT MARKING	S28° 54' 43,8"; E21° 59' 39,3"
COLOUR AND TYPE	Orange Brown Gravel

POINT NO.	1	2	3	4	5			
DRY DENSITY (kg/m³)	2111	2133	2146	2123	2105			
MOISTURE (%)	5,8	6,7	7,8	8,9	9,7			

MAXIMUM DRY DENSITY (kg/m³) : 2146

OPTIMUM MOISTURE CONTENT (%) : 7,7



Deviation from Test Method :
 Remarks and Notes :

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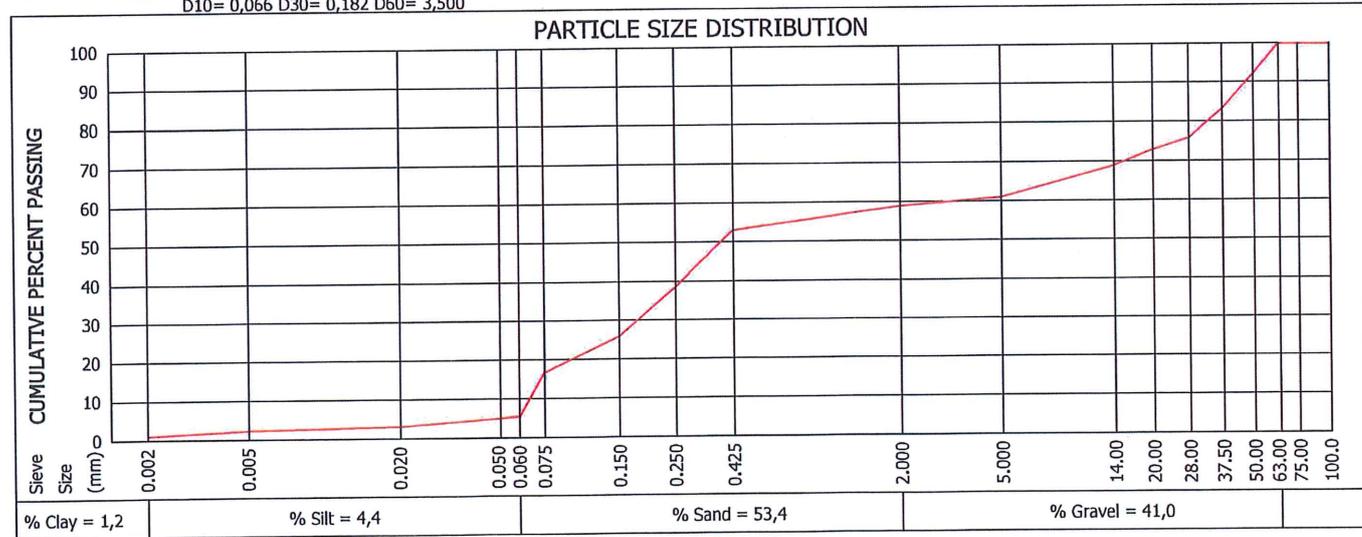
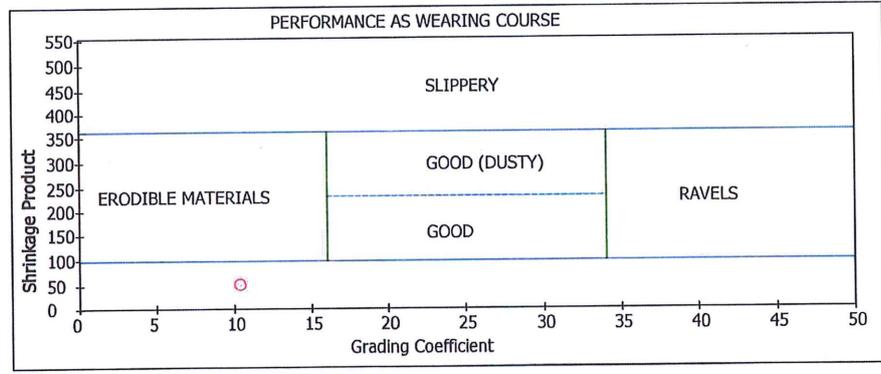
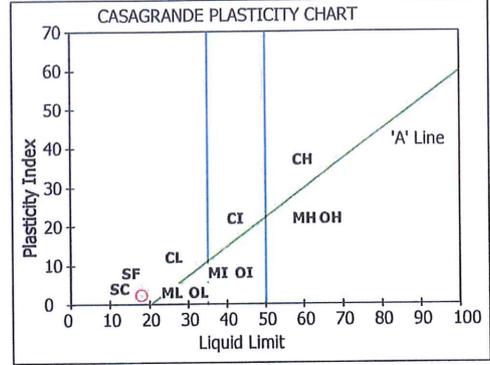
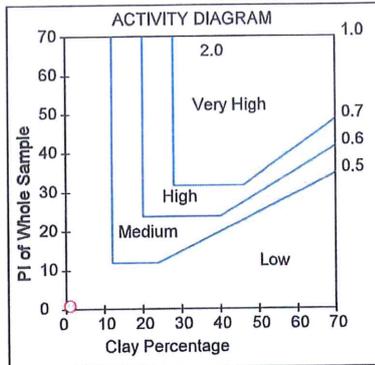
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 Attention : Frans Breytenbach

Project : Groblershoop Infrastructure Upgrade

Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

Sample No.	: U9306
Position	: TP 23
Layer Type	: 0-400mm
Sample Colour	: Orange Brown Gravel
Sample Type	: Mix Quartz

Sieve Size(mm)	% Passing	Soil Mortar		
2.000	11	2.000 - 0.425	11	
100.0	100	0.425 - 0.250	24	
75.00	100	0.250 - 0.150	21	
63.00	100	0.150 - 0.075	15	
50.00	92	< 0.075	29	
37.50	83	Effective Size	0,066	
28.00	76	Uniformity Coefficient	53,0	
20.00	73	Curvature Coefficient	0,1	
14.00	69	Oversize Index	9,0	
5.000	61	Shrinkage Product	53,0	
2.000	59	Grading Coefficient	10,4	
0.425	53	Grading Modulus	1,70	
0.250	39	Atterberg Limits	Liquid Limit	18
0.150	26		Plasticity Index	2.0
0.075	17		Linear Shrinkage	1.0
0.060	5,6		PI < 0.075	
0.050	5,1	Unified Soil Classification	SC	
0.020	3,2	US Highway Classification	A-2-4(0)	
0.005	2,4	D10= 0,066 D30= 0,182 D60= 3,500		
0.002	1,2			



Deviation from Test Method :
 Remarks and Notes :

Opinions and interpretations are not included in our scope of works. (T0296)
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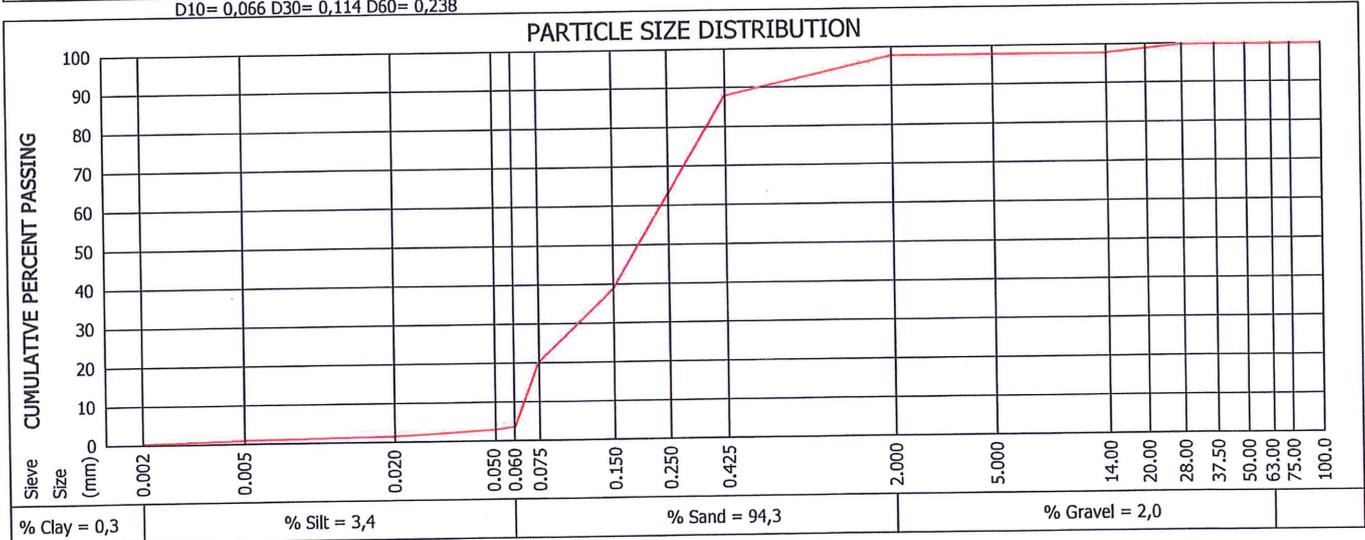
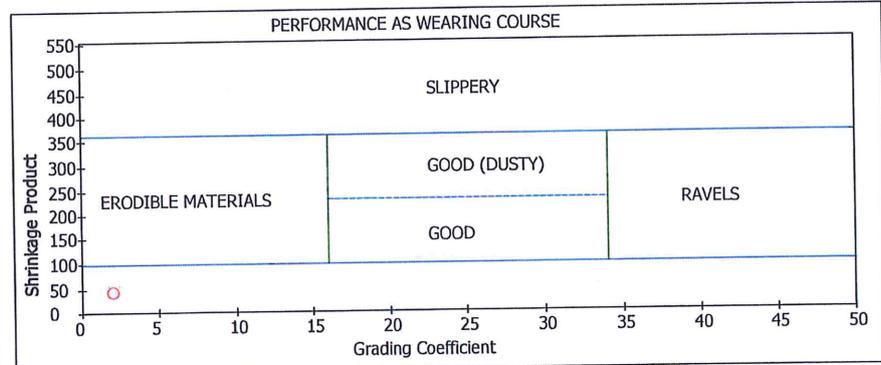
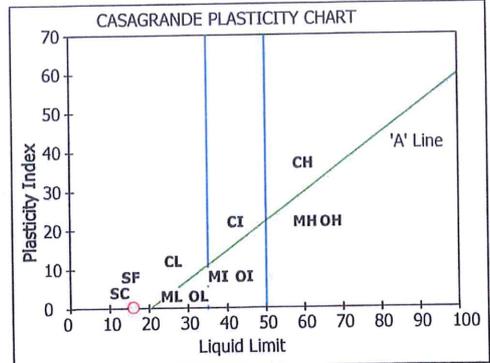
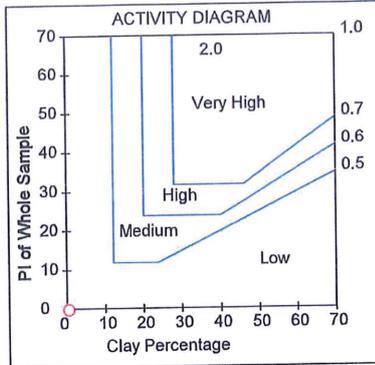
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Project : Groblershoop Infrastructure Upgrade

Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

Sample No. : U9305
 Position : TP 25
 Layer Type : 0-600mm
 Sample Colour : Orange Brown Gravel
 Sample Type : Mix Quartzstone

Sieve Size(mm)	% Passing	Soil Mortar		
100.0	100	2.000 - 0.425	9	
75.00	100	0.425 - 0.250	26	
63.00	100	0.250 - 0.150	25	
50.00	100	0.150 - 0.075	19	
37.50	100	< 0.075	21	
		Effective Size	0,066	
		Uniformity Coefficient	3,6	
		Curvature Coefficient	0,8	
		Oversize Index	0,0	
		Shrinkage Product	44,0	
		Grading Coefficient	2,0	
		Grading Modulus	0,90	
		Atterberg Limits	Liquid Limit	16
			Plasticity Index	0,0
			Linear Shrinkage	0,5
			PI < 0.075	
		Unified Soil Classification	SC	
		US Highway Classification	A-2-4(0)	
		D10= 0,066 D30= 0,114 D60= 0,238		



Deviation from Test Method :
 Remarks and Notes : Chemistry: pH = 7.63 [SANS 5854] & Conductivity = 0.13 S/m [SANS 6240]

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
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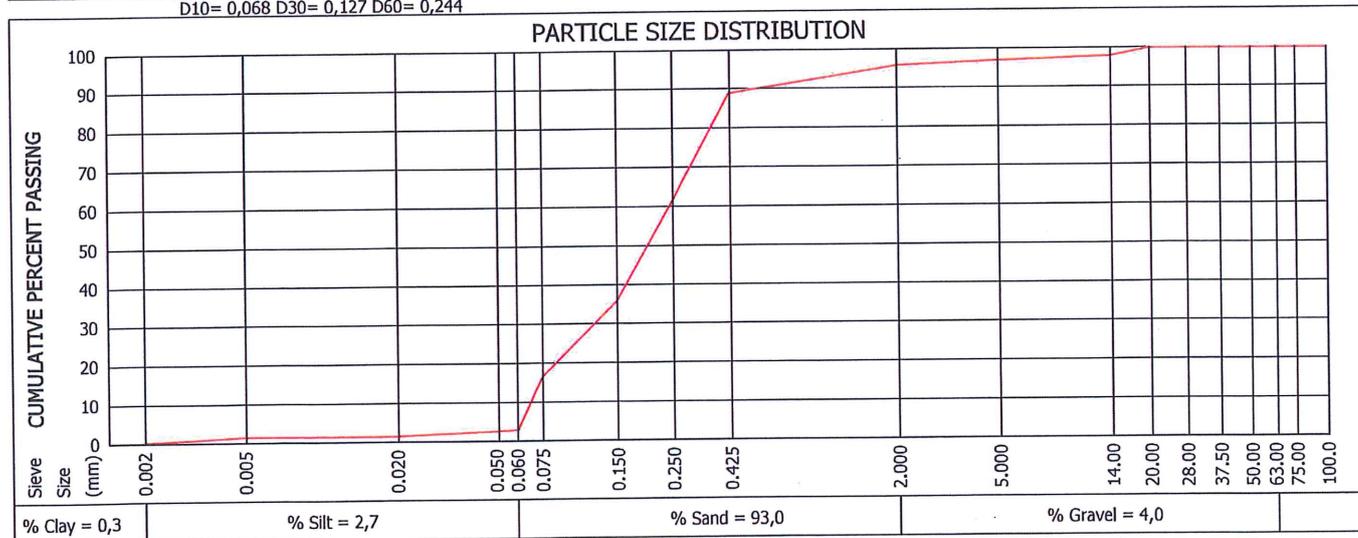
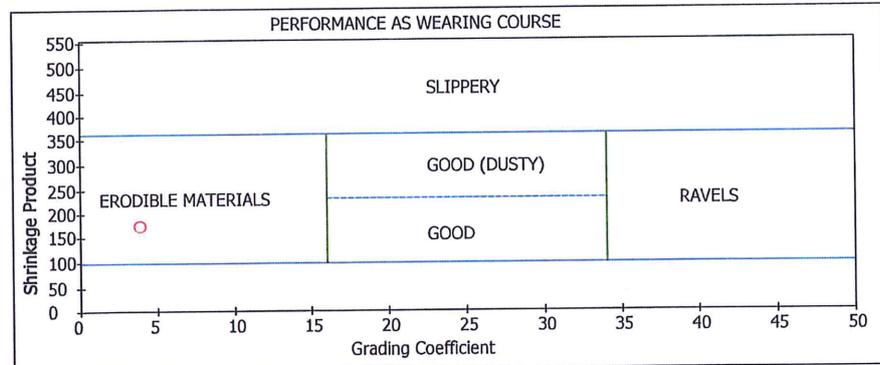
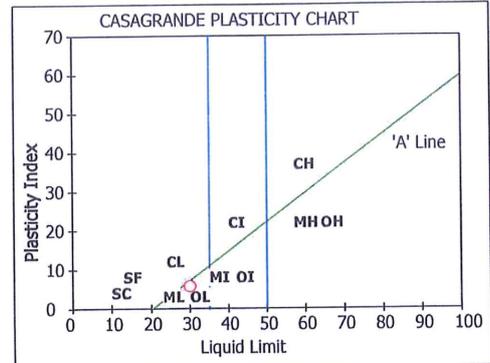
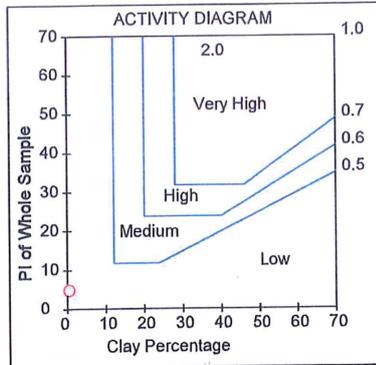
Date Reported : 2020-08-21

Project : Groblershoop Infrastructure Upgrade

Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

Sample No.	: U9303
Position	: TP 30
Layer Type	: 0-500mm
Sample Colour	: Orange Brown Gravel
Sample Type	: Mix Quartzstone

Sieve Size(mm)	% Passing	Soil Mortar		
100.0	100	2.000 - 0.425	8	
75.00	100	0.425 - 0.250	29	
63.00	100	0.250 - 0.150	27	
50.00	100	0.150 - 0.075	20	
37.50	100	< 0.075	18	
28.00	100	Effective Size	0,068	
20.00	100	Uniformity Coefficient	3,6	
14.00	98	Curvature Coefficient	1,0	
5.000	97	Oversize Index	0,0	
2.000	96	Shrinkage Product	178,0	
0.425	89	Grading Coefficient	3,9	
0.250	62	Grading Modulus	1,00	
0.150	36	Atterberg Limits	Liquid Limit	30
0.075	17		Plasticity Index	6
0.060	3,0		Linear Shrinkage	2.0
0.050	2,7		PI < 0,075	
0.020	1,6	Unified Soil Classification	SM	
0.005	1,6	US Highway Classification	A-2-4(0)	
0.002	0,3	D10= 0,068 D30= 0,127 D60= 0,244		



Deviation from Test Method :
 Remarks and Notes : Chemistry: pH = 7.56 [SANS 5854] & Conductivity = 0.15 S/m [SANS 6240]

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
 The test results reported relate to the samples tested.
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Job Request No.: RU3525

Date Reported : 2020-08-12

Ceder Land Geotechnical Consult (Pty) Ltd

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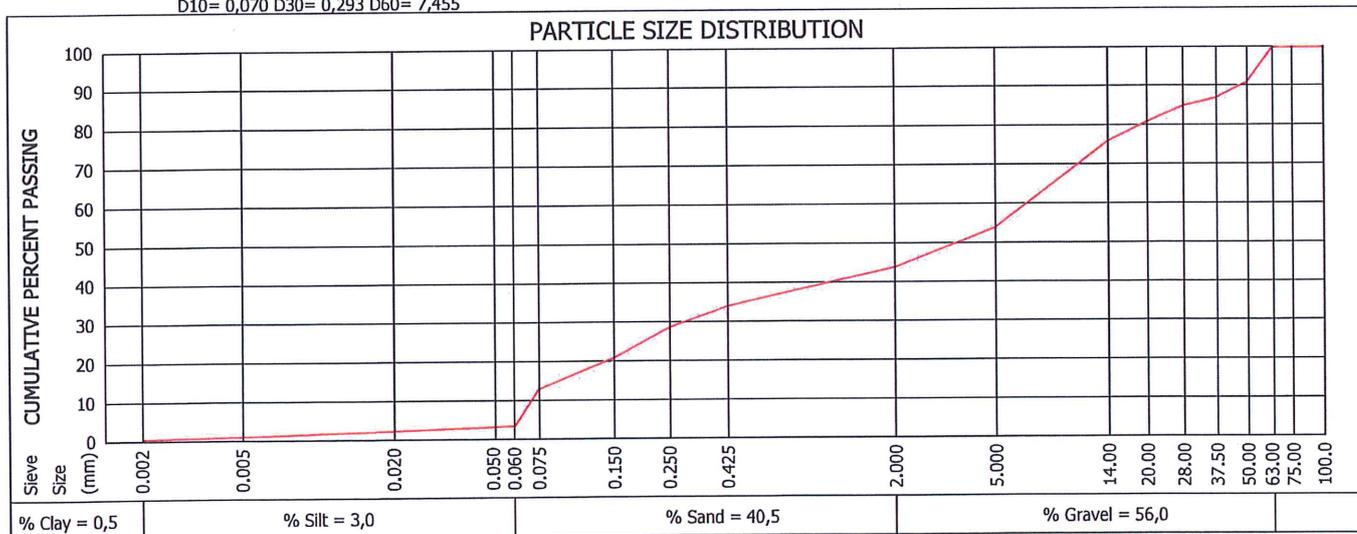
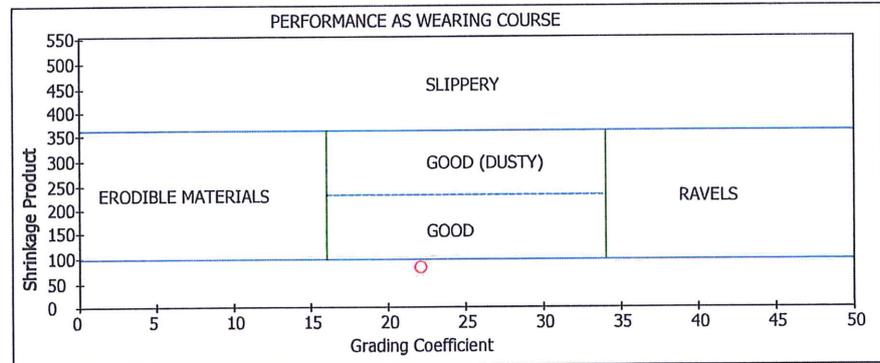
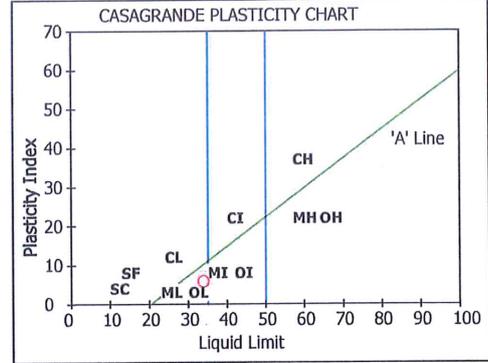
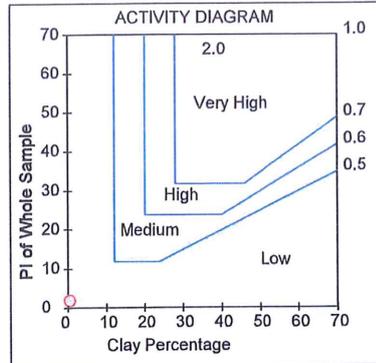
Project : Groblershoop Infrastructure Upgrade

Attention : Frans Breytenbach

Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

Sample No.	: U9299
Position	: TP 33
Layer Type	: 300-500mm
Sample Colour	: Brown Gravel
Sample Type	: Weathered Calcrete+Q

Sieve Size(mm)	% Passing	Soil Mortar		
100.0	100	2.000 - 0.425	23	
75.00	100	0.425 - 0.250	12	
63.00	100	0.250 - 0.150	18	
50.00	91	0.150 - 0.075	18	
37.50	87	< 0.075	30	
28.00	85	Effective Size	0,070	
20.00	81	Uniformity Coefficient	106,5	
14.00	76	Curvature Coefficient	0,2	
5.000	54	Oversize Index	4,0	
2.000	44	Shrinkage Product	85,0	
0.425	34	Grading Coefficient	22,1	
0.250	29	Grading Modulus	2,10	
0.150	21	Atterberg Limits	Liquid Limit	34
0.075	13		Plasticity Index	6
0.060	3,5		Linear Shrinkage	2.5
0.050	3,3		PI < 0.075	
0.020	2,3	Unified Soil Classification	SM	
0.005	1,1	US Highway Classification	A-1-b(0)	
0.002	0,5	D10= 0,070 D30= 0,293 D60= 7,455		



Deviation from Test Method :

Remarks and Notes :

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
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 Attention : Frans Breytenbach

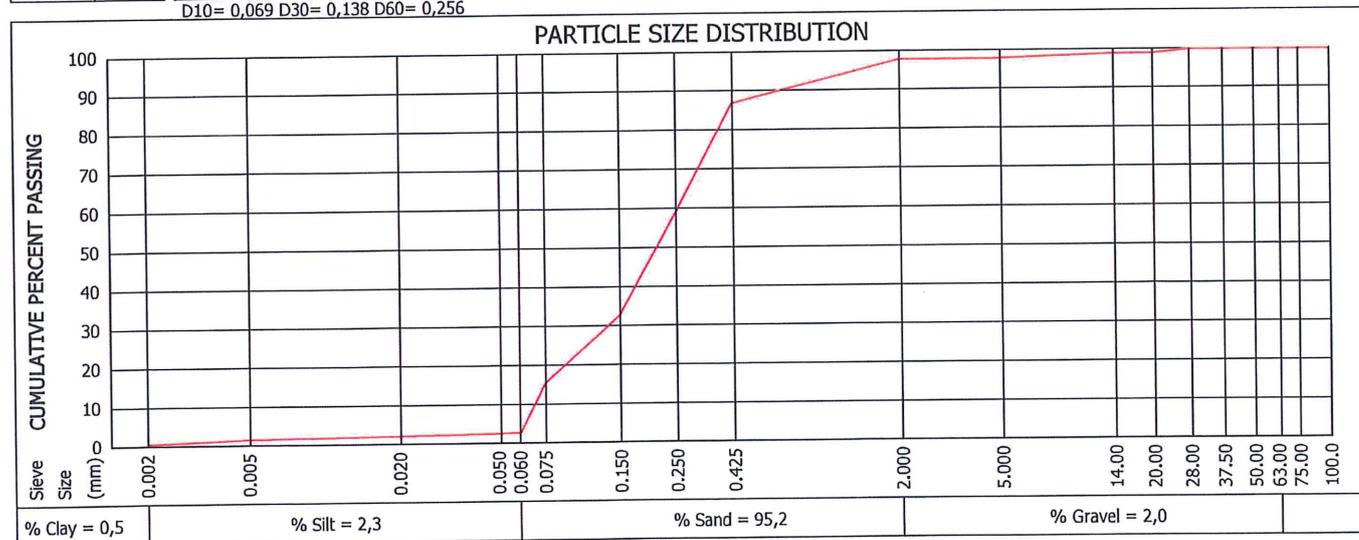
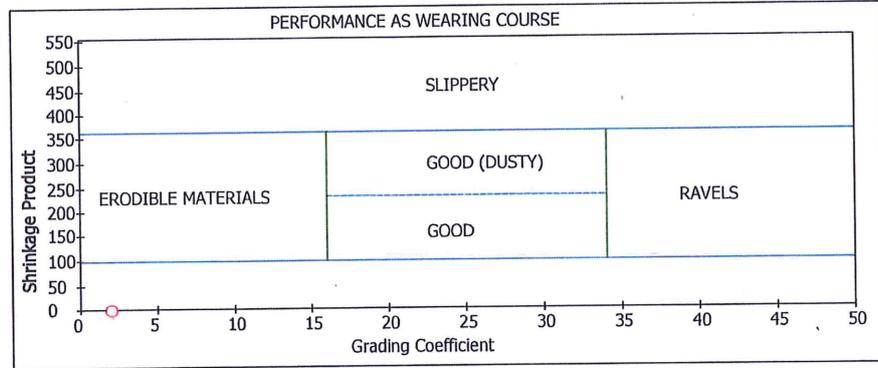
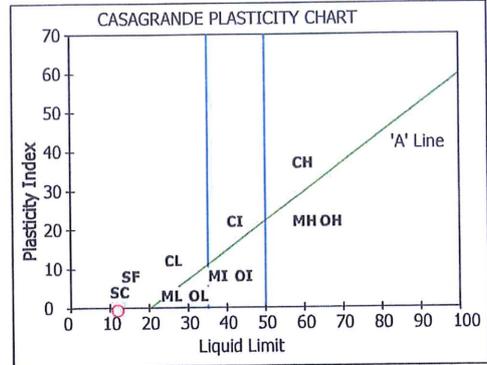
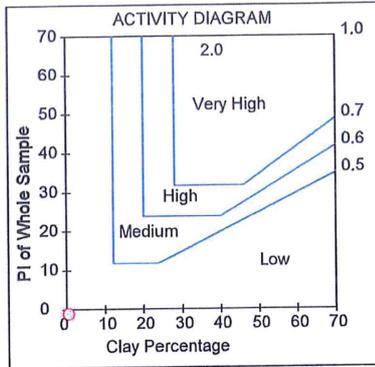
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Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

Sample No. : U9298
 Position : TP 37
 Layer Type : 0-600mm
 Sample Colour : Kalahari Sand
 Sample Type : Kalahari Sand

Sieve Size(mm)	% Passing	Soil Mortar	2.000 - 0.425	11
100.0	100		0.425 - 0.250	29
75.00	100		0.250 - 0.150	27
63.00	100		0.150 - 0.075	17
50.00	100		< 0.075	16
37.50	100	Effective Size		0,069
28.00	100	Uniformity Coefficient		3,7
20.00	99	Curvature Coefficient		1,1
14.00	99	Oversize Index		0,0
5.000	98	Shrinkage Product		0,0
2.000	98	Grading Coefficient		2,0
0.425	87	Grading Modulus		1,00
0.250	59	Atterberg Limits	Liquid Limit	12
0.150	33		Plasticity Index	-1.0
0.075	16		Linear Shrinkage	0.0
0.060	2,8		PI < 0.075	
0.050	2,6		Unified Soil Classification	SC
0.020	2,1	US Highway Classification	A-2-4(0)	
0.005	1,6			
0.002	0,5			

D10= 0,069 D30= 0,138 D60= 0,256



Deviation from Test Method :
 Remarks and Notes : Chemistry: pH = 7.50 [SANS 5854] & Conductivity = 0.18 S/m [SANS 6240]

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
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Date Reported : 2020-08-12

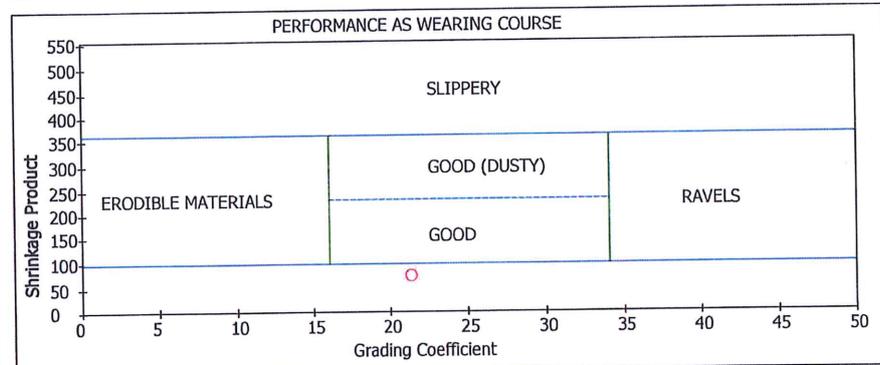
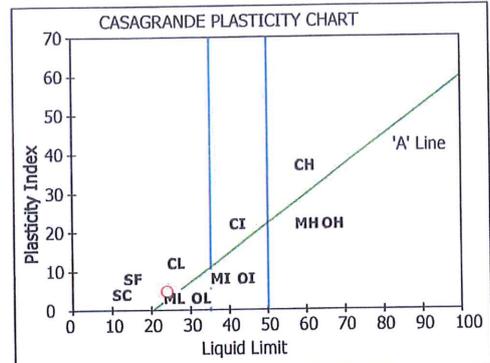
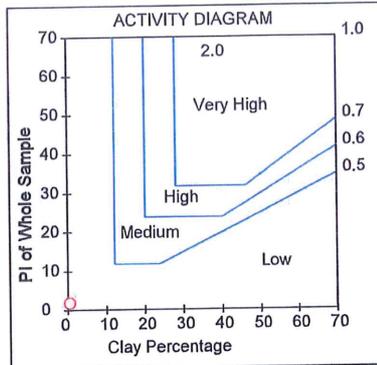
Project : Groblershoop Infrastructure Upgrade

Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

Sample No.	: U9293
Position	: TP 38
Layer Type	: 300-500mm
Sample Colour	: Dark Brown Gravel
Sample Type	: Mix Calcrete + Quart

Sieve Size(mm)	% Passing	Soil Mortar		
100.0	100	2.000 - 0.425	15	
75.00	100	0.425 - 0.250	13	
63.00	100	0.250 - 0.150	18	
50.00	95	0.150 - 0.075	19	
37.50	95	< 0.075	34	
28.00	86	Effective Size	0,071	
20.00	74	Uniformity Coefficient	169,6	
14.00	65	Curvature Coefficient	0,2	
5.000	42	Over-size Index	0,0	
2.000	35	Shrinkage Product	75,0	
0.425	30	Grading Coefficient	21,4	
0.250	25	Grading Modulus	2,20	
0.150	19	Atterberg Limits	Liquid Limit	24
0.075	12		Plasticity Index	5
0.060	3,8		Linear Shrinkage	2.5
0.050	3,6		PI < 0.075	
0.020	2,7	Unified Soil Classification	GM-GC	
0.005	1,6	US Highway Classification	A-1-a(0)	
0.002	0,3			

D10= 0,071 D30= 0,425 D60= 12,043



PARTICLE SIZE DISTRIBUTION



Deviation from Test Method :
 Remarks and Notes :

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
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Date Reported : 2020-08-06

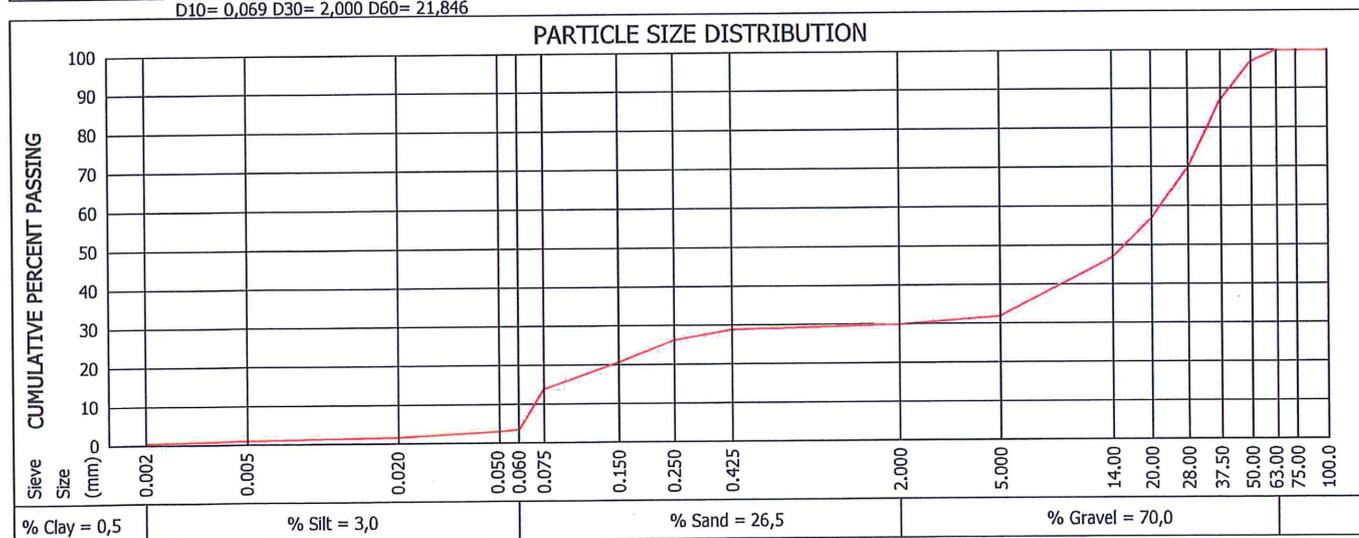
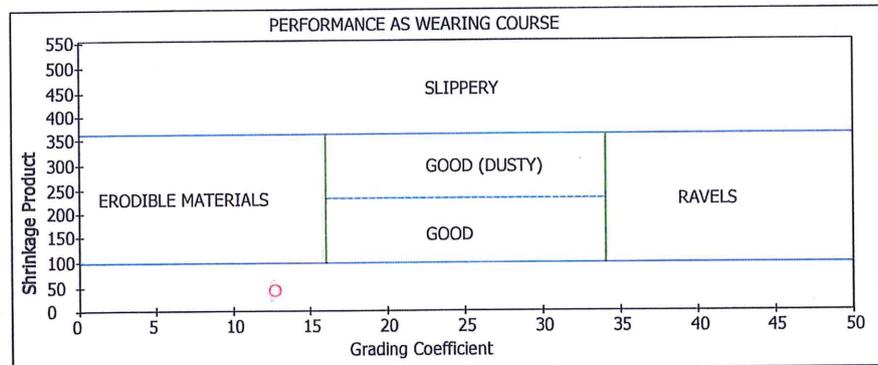
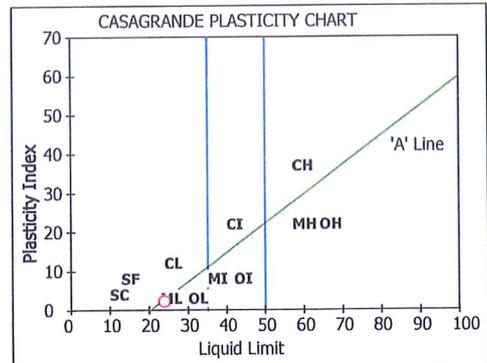
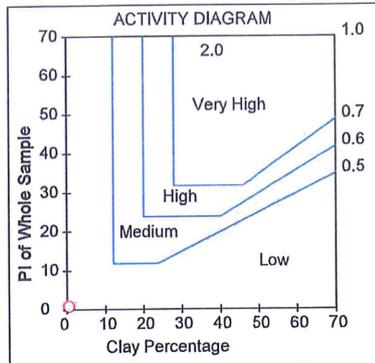
Project : Groblershoop Infrastructure Upgrade

Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

Sample No. : U9297
 Position : TP 40
 Layer Type : 0-300mm
 Sample Colour : Dark Brown Gravel
 Sample Type : Mix Calcrete+Quartz

Sieve Size(mm)	% Passing	Soil Mortar	2.000 - 0.425	4
100.0	100		0.425 - 0.250	10
75.00	100		0.250 - 0.150	19
63.00	100		0.150 - 0.075	22
50.00	97		< 0.075	46
37.50	87	Effective Size		0,069
28.00	70	Uniformity Coefficient		316,6
20.00	57	Curvature Coefficient		2,7
14.00	47	Oversize Index		10,0
5.000	32	Shrinkage Product		43,5
2.000	30	Grading Coefficient		12,8
0.425	29	Grading Modulus		2,30
0.250	26	Atterberg Limits	Liquid Limit	24
0.150	21		Plasticity Index	2,0
0.075	14		Linear Shrinkage	1,5
0.060	3,5		PI < 0,075	
0.050	3,1	Unified Soil Classification		GM
0.020	1,7	US Highway Classification		A-1-a(0)
0.005	1,1			
0.002	0,5			

D10= 0,069 D30= 2,000 D60= 21,846



Deviation from Test Method :
 Remarks and Notes : Chemistry: pH = 7.73 [SANS 5854] & Conductivity = 0.05 S/m [SANS 6240]

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
 The test results reported relate to the samples tested.
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 Report compiled by : Juraine Okkies

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Date Reported : 2020-08-06

Job Request No.: RU3525
 Ceder Land Geotechnical Consult (Pty) Ltd
 PO Box 607
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 6835

Project : Groblershoop Infrastructure Upgrade

Attention : Frans Breytenbach
 Determination of the California Bearing Ratio Test Report SANS 3001 - GR1 / GR2 / GR10 / GR20 / GR30 / GR40 / PR5

SAMPLE INFORMATION AND PROPERTIES

SAMPLE NO.	U9297		
HOLE NO./ Km / CHAINAGE	TP40		
ROAD NO./ NAME Line 1	S28° 54' 23,0"		
ROAD NO./ NAME Line 2	E21° 59' 41,2"		
LAYER TESTED/SAMPLED	0-300mm		
SAMPLE DEPTH	0-300mm		
DATE SAMPLED	2020-07-09		
COLOUR OF SAMPLE	Dark Brown		
TYPE OF SAMPLE	Mix Quartz+Calcrete		

SIEVE ANALYSIS - % PASSING SIEVES *(SANS 3001-GR1:2010, SANS 3001-GR2:2010)

SIEVE ANALYSIS (GR 1) % PASSING	100.0 mm		
	75.0 mm		
	63.0 mm	100	
	50.0 mm	97	
	37.5 mm	87	
	28.0 mm	70	
	20.0 mm	57	
	14.0 mm	47	
	5.0 mm	32	
	2.0 mm	30	
0.425 mm	29		
0.075 mm	14		
GM %		2,3	

SOIL MORTAR ANALYSIS (SANS 3001-PR5:2011)

COARSE SAND	2.000 - 0.425	4	
COARSE FINE SAND	0.425 - 0.250	10	
MEDIUM FINE SAND	0.250 - 0.150	19	
FINE FINE SAND	0.150 - 0.075	22	
SILT CLAY	0.075	46	

ATTERBERG LIMITS ANALYSIS - *(SANS 3001-GR10:2010)

ATTERBERG LIMITS (%) SANS GR10,GR11	LIQUID LIMIT	24	
	PLASTICITY INDEX	2,4	
	LINEAR SHRINKAGE	1,5	
CLASSIFICATION	H.R.B.	A-1-a(0)	
	COLTO	G6	
	TRH 14	G6	

CALIFORNIA BEARING RATIO - *(SANS 3001-GR30:2010, SANS 3001-GR40:2010)

SANS GR30 MAX. DRY DENSITY	OMC %	5,7	
	MDD (kg/m³)	2096	
	COMP MC %	5,5	
SWELL % @	MOD NRB PRO	0,01 0,02 0,05	
	100 %	55	
	98 %	49	
C.B.R. SANS GR40	97 %	47	
	95 %	42	
	93 %	37	
	90 %	31	

STABILISER IN LAB	Not Applicable		
TEST TYPE	CBR		
SAMPLING METHOD	TMH 5		
WEATHER WHEN SAMPLED	Cold		

Deviation from Test Method :
 Remarks and Notes :

Opinions and interpretations are not included in our scope of works. (T0296)
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ROADLAB

Job Request No.: RU3525
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Date Reported : 2020-08-04

Project : Groblershoop Infrastructure Upgrade

Determination Maximum Dry Density & Optimum Moisture Content Test Report

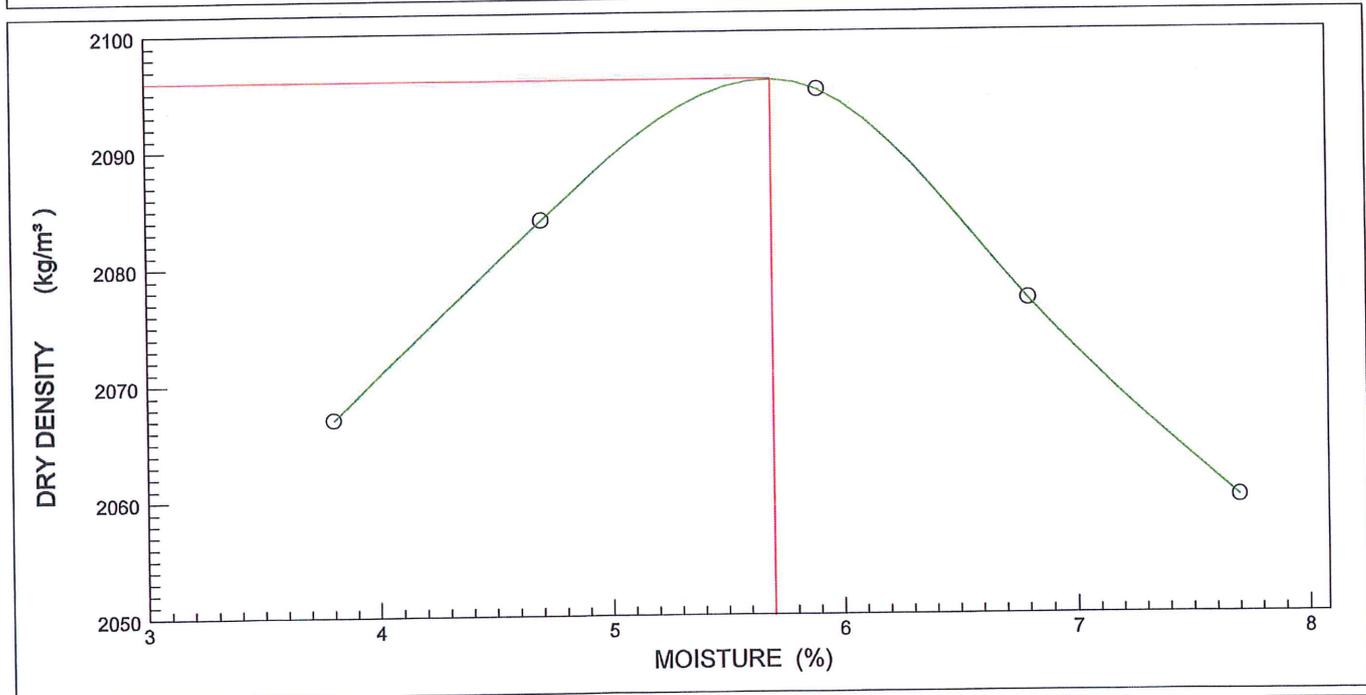
SANS 3001 - GR20/GR30

SAMPLE NO.	U9297
CONTAINER FOR SAMPLING	Black Bags
SIZE / APPROX. MASS OF SAMPLE	95kg
MOISTURE CONDITION OF SAMPLE	Moist
LAYER TESTED / SAMPLED FROM	0-300mm
MATERIAL DESCRIPTION	Mix Calcrete + Quartzstone
HOLE NO./ km / CHAINAGE	TP40
ROAD NO.	Not Specified
DATE RECEIVED	2020-07-10
DATE SAMPLED	2020-07-09
CLIENT MARKING	S28° 54' 23,0"; E21° 59' 41,2"
COLOUR AND TYPE	Dark Brown Gravel

POINT NO.	1	2	3	4	5			
DRY DENSITY (kg/m ³)	2067	2084	2095	2077	2060			
MOISTURE (%)	3,8	4,7	5,9	6,8	7,7			

MAXIMUM DRY DENSITY (kg/m³) : 2096

OPTIMUM MOISTURE CONTENT (%) : 5,7



Deviation from Test Method :
 Remarks and Notes :

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Date Reported : 2020-08-12

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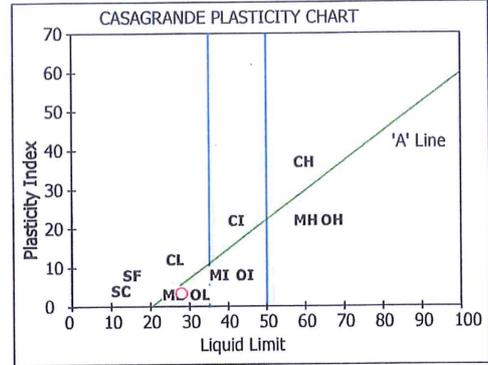
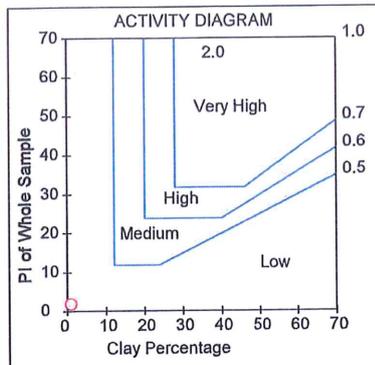
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Project : Groblershoop Infrastructure Upgrade

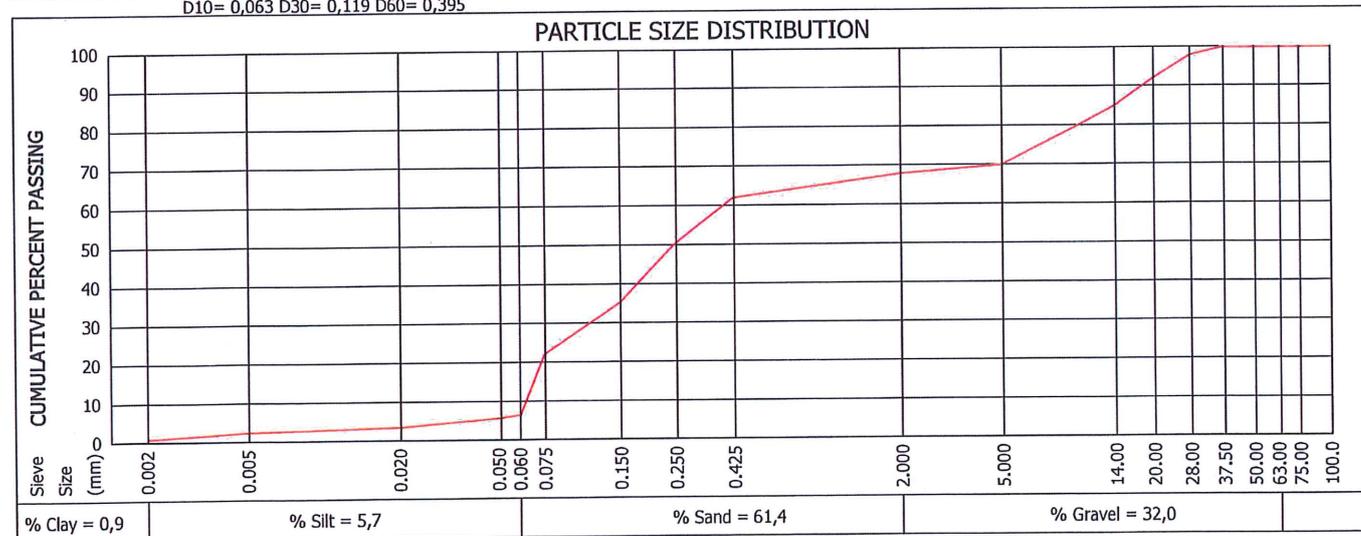
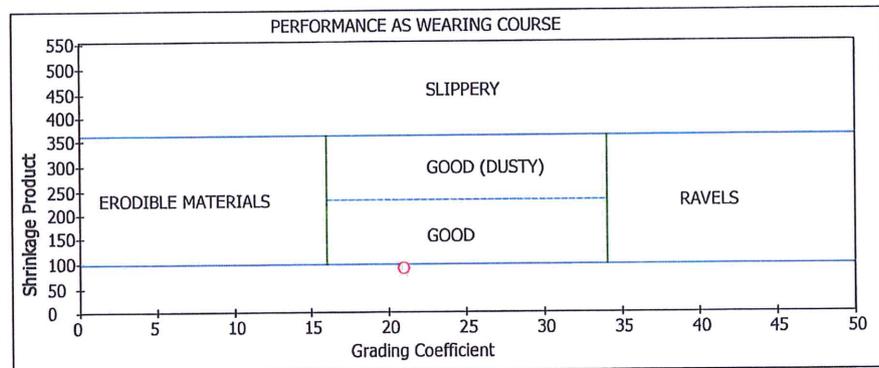
Attention : Frans Breytenbach

Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

Sample No.	: U9296
Position	: TP 44
Layer Type	: 0-500mm
Sample Colour	: Orange Brown Gravel
Sample Type	: Mix Quartzstone



Sieve Size(mm)	% Passing	Soil Mortar		
100.0	100	2.000 - 0.425	8	
75.00	100	0.425 - 0.250	18	
63.00	100	0.250 - 0.150	22	
50.00	100	0.150 - 0.075	20	
37.50	100	< 0.075	33	
28.00	98	Effective Size	0,063	
20.00	92	Uniformity Coefficient	6,3	
14.00	85	Curvature Coefficient	0,6	
5.000	70	Oversize Index	0,0	
2.000	68	Shrinkage Product	93,0	
0.425	62	Grading Coefficient	21,0	
0.250	51	Grading Modulus	1,50	
0.150	35	Atterberg Limits	Liquid Limit	28
0.075	22		Plasticity Index	3,0
0.060	6,6		Linear Shrinkage	1,5
0.050	5,8		PI < 0.075	
0.020	3,5	Unified Soil Classification	SM	
0.005	2,4	US Highway Classification	A-2-4(0)	
0.002	0,9	D10= 0,063 D30= 0,119 D60= 0,395		



Deviation from Test Method :
Remarks and Notes :

Opinions and interpretations are not included in our scope of works. (T0296)
The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
The test results reported relate to the samples tested.
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 Attention : Frans Breytenbach

Date Reported : 2020-08-21

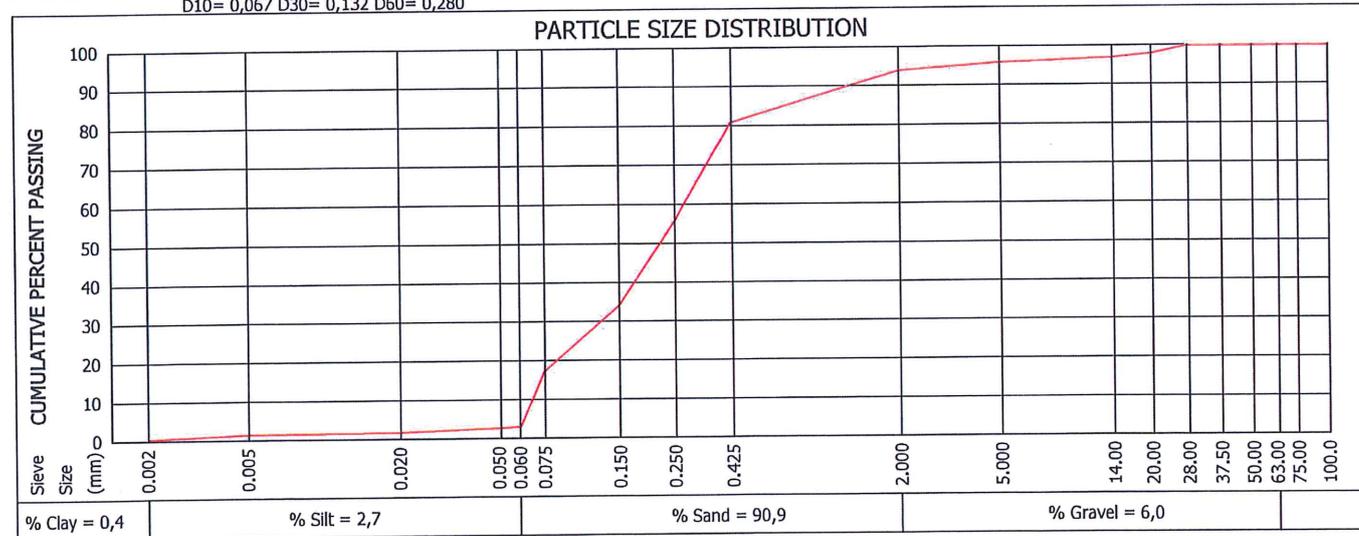
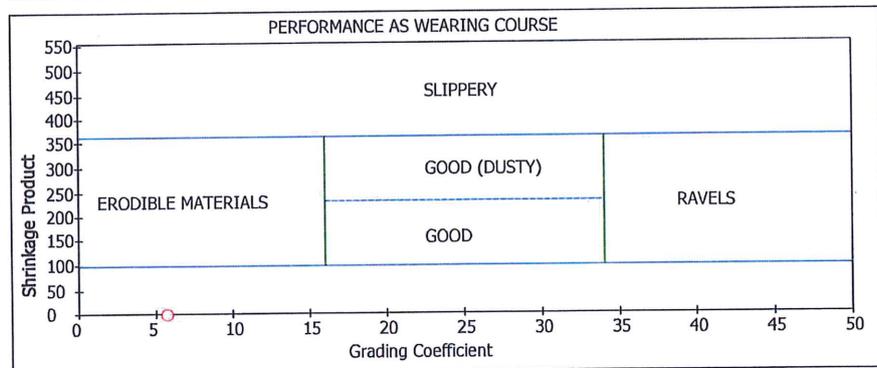
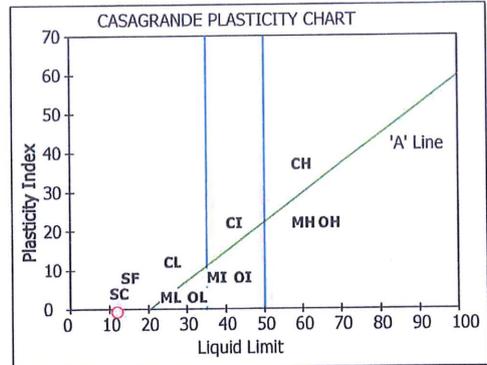
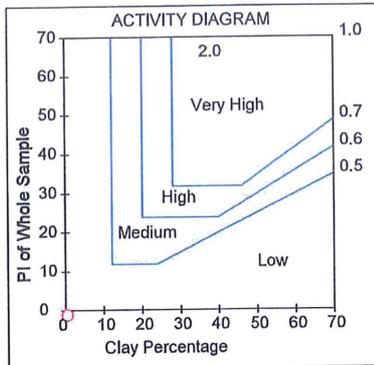
Project : Groblershoop Infrastructure Upgrade

Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

Sample No.	: U9295
Position	: TP 46
Layer Type	: 0-700mm
Sample Colour	: Kalahari Sand
Sample Type	: Kalahari Sand

Sieve Size(mm)	% Passing	Soil Mortar		
100.0	100	2.000 - 0.425		15
75.00	100	0.425 - 0.250		27
63.00	100	0.250 - 0.150		23
50.00	100	0.150 - 0.075		18
37.50	100	< 0.075		18
28.00	100	Effective Size		0,067
20.00	98	Uniformity Coefficient		4,2
14.00	97	Curvature Coefficient		0,9
5.000	96	Oversize Index		0,0
2.000	94	Shrinkage Product		0,0
0.425	81	Grading Coefficient		5,8
0.250	56	Grading Modulus		1,10
0.150	34	Atterberg Limits	Liquid Limit	12
0.075	17		Plasticity Index	-1.0
0.060	3,1		Linear Shrinkage	0.0
0.050	2,8		PI < 0.075	
0.020	1,8	Unified Soil Classification		SC
0.005	1,5	US Highway Classification		A-2-4(0)
0.002	0,4			

D10= 0,067 D30= 0,132 D60= 0,280



Deviation from Test Method :
 Remarks and Notes : Chemistry: pH = 7.70 [SANS 5854] & Conductivity = 0.09 S/m [SANS 6240]

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
 The test results reported relate to the samples tested.
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Job Request No.: RU3525
 Ceder Land Geotechnical Consult (Pty) Ltd
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 Attention : Frans Breytenbach

Date Reported : 2020-08-06

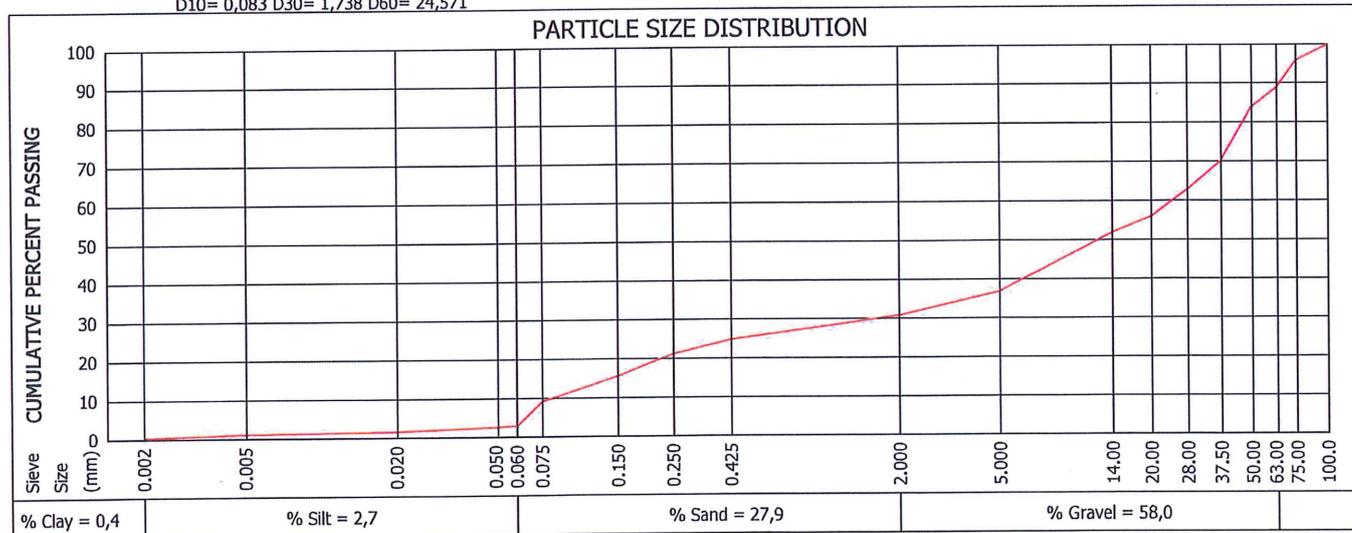
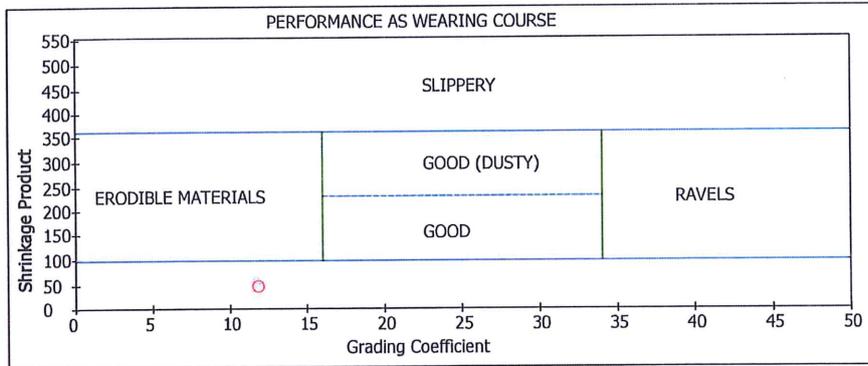
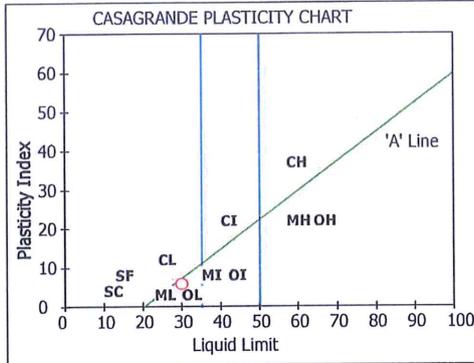
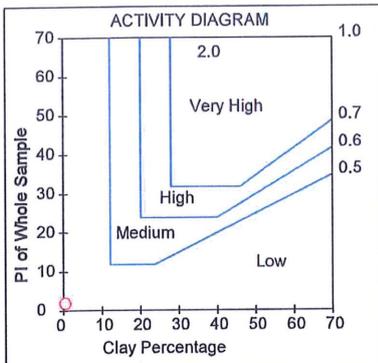
Project : Goblershoop Infrastructure Upgrade

Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

Sample No.	: U9294
Position	: TP 50
Layer Type	: 200-1000mm
Sample Colour	: Light Brown Gravel
Sample Type	: Mix Calcrete+Quartz

Sieve Size(mm)	% Passing	Soil Mortar		
100.0	100	2.000 - 0.425	19	
75.00	96	0.425 - 0.250	13	
63.00	89	0.250 - 0.150	18	
50.00	84	0.150 - 0.075	22	
37.50	70	< 0.075	29	
28.00	63	Effective Size	0,083	
20.00	56	Uniformity Coefficient	296,0	
14.00	52	Curvature Coefficient	1,5	
5.000	37	Oversize Index	14,0	
2.000	31	Shrinkage Product	50,0	
0.425	25	Grading Coefficient	11,8	
0.250	21	Grading Modulus	2,30	
0.150	16	Atterberg Limits	Liquid Limit	30
0.075	9,3		Plasticity Index	6
0.060	3,1		Linear Shrinkage	2.0
0.050	2,8		PI < 0.075	
0.020	1,7	Unified Soil Classification	GW-GM	
0.005	1,3	US Highway Classification	A-1-a(0)	
0.002	0,4			

D10= 0,083 D30= 1,738 D60= 24,571



Deviation from Test Method :
 Remarks and Notes : Chemistry: pH = 7.78 [SANS 5854] & Conductivity = 0.06 S/m [SANS 6240]

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
 The test results reported relate to the samples tested.
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Job Request No.: RU3525
 Ceder Land Geotechnical Consult (Pty) Ltd
 PO Box 607
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 Attention : Frans Breytenbach

Date Reported : 2020-08-06

Project : Groblershoop Infrastructure Upgrade

Determination of the California Bearing Ratio Test Report SANS 3001 - GR1 / GR2 / GR10 / GR20 / GR30 / GR40 / PR5

SAMPLE INFORMATION AND PROPERTIES

SAMPLE NO.	U9294
HOLE NO./ Km / CHAINAGE	TP50
ROAD NO./ NAME Line 1	S28° 54' 08,3"
ROAD NO./ NAME Line 2	E21° 59' 40,3"
LAYER TESTED/SAMPLED	200-1000mm
SAMPLE DEPTH	200-1000mm
DATE SAMPLED	2020-07-09
COLOUR OF SAMPLE	Light Brown
TYPE OF SAMPLE	Mix Calcrete+Quartz

SIEVE ANALYSIS - % PASSING SIEVES *(SANS 3001-GR1:2010, SANS 3001-GR2:2010)

SIEVE ANALYSIS (GR 1) % PASSING	100.0 mm	100
	75.0 mm	96
	63.0 mm	89
	50.0 mm	84
	37.5 mm	70
	28.0 mm	63
	20.0 mm	56
	14.0 mm	52
	5.0 mm	37
	2.0 mm	31
0.425 mm	25	
0.075 mm	9	
GM %		2,3

SOIL MORTAR ANALYSIS (SANS 3001-PR5:2011)

COARSE SAND	2.000 - 0.425	19
COARSE FINE SAND	0.425 - 0.250	13
MEDIUM FINE SAND	0.250 - 0.150	18
FINE FINE SAND	0.150 - 0.075	22
SILT CLAY	0.075	29

ATTERBERG LIMITS ANALYSIS - *(SANS 3001-GR10:2010)

ATTERBERG LIMITS (%) SANS GR10,GR11	LIQUID LIMIT	30
	PLASTICITY INDEX	6
	LINEAR SHRINKAGE	2.0
CLASSIFICATION	H.R.B.	A-1-a(0)
	COLTO	G6
	TRH 14	G7

CALIFORNIA BEARING RATIO - *(SANS 3001-GR30:2010, SANS 3001-GR40:2010)

SANS GR30 MAX. DRY DENSITY	OMC %	11,3
	MDD (kg/m³)	1957
	COMP MC %	11,1
SWELL % @	MOD NRB PRO	0,01 0,03 0,05
	100 %	81
C.B.R. SANS GR40	98 %	56
	97 %	46
	95 %	31
	93 %	21
	90 %	12

STABILISER IN LAB	Not Applicable
TEST TYPE	CBR
SAMPLING METHOD	TMH 5
WEATHER WHEN SAMPLED	Cold

Deviation from Test Method :
 Remarks and Notes :

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
 The test results reported relate to the samples tested.
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Job Request No.: RU3525

Ceder Land Geotechnical Consult (Pty) Ltd

PO Box 607

Ceres

6835

Project : Groblershoop Infrastructure Upgrade

Attention : Frans Breytenbach

Determination Maximum Dry Density & Optimum Moisture Content Test Report

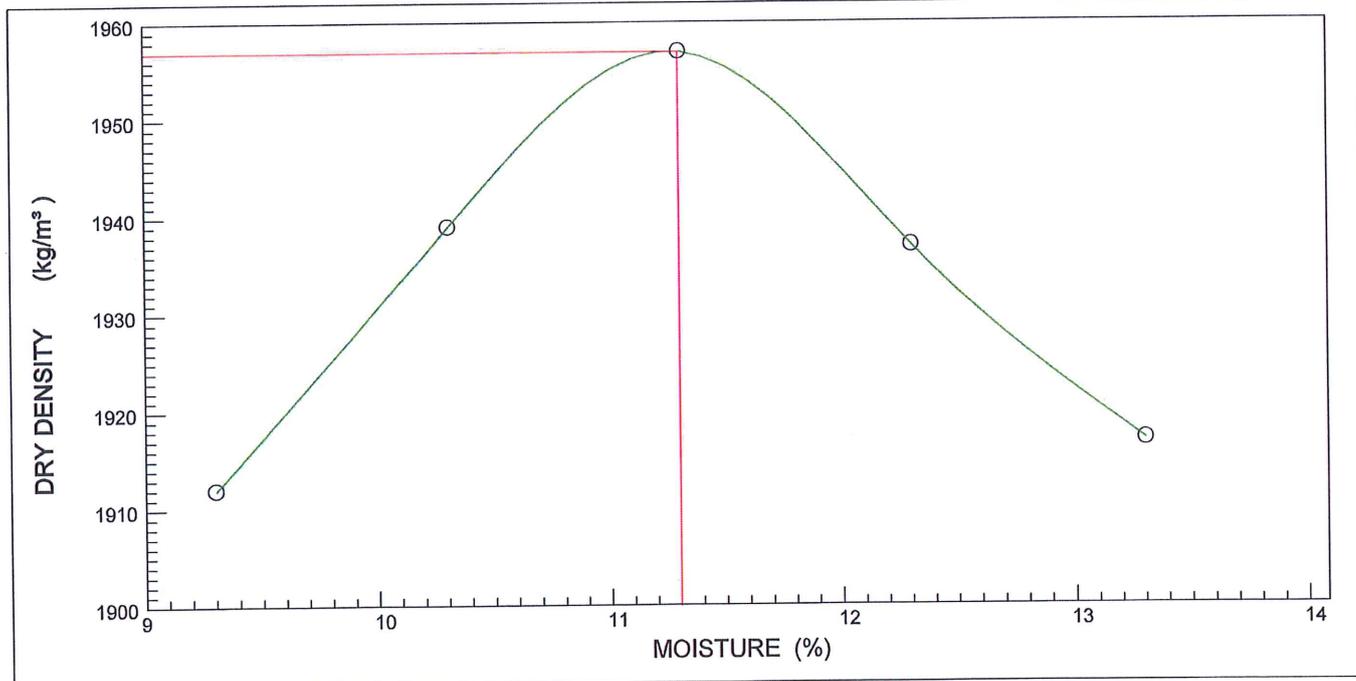
SANS 3001 - GR20/GR30

SAMPLE NO.	U9294
CONTAINER FOR SAMPLING	Black Bags
SIZE / APPROX. MASS OF SAMPLE	100kg
MOISTURE CONDITION OF SAMPLE	Moist
LAYER TESTED / SAMPLED FROM	200-1000mm
MATERIAL DESCRIPTION	Mix Quartz
HOLE NO./ km / CHAINAGE	TP50
ROAD NO.	Not Specified
DATE RECEIVED	2020-07-10
DATE SAMPLED	2020-07-09
CLIENT MARKING	S28° 54' 08,3"; E21° 59' 40,3"
COLOUR AND TYPE	Light Brown Gravel

POINT NO.	1	2	3	4	5		
DRY DENSITY (kg/m ³)	1912	1939	1957	1937	1917		
MOISTURE (%)	9,3	10,3	11,3	12,3	13,3		

MAXIMUM DRY DENSITY (kg/m³) : 1957

OPTIMUM MOISTURE CONTENT (%) : 11,3



Deviation from Test Method :

Remarks and Notes :

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