

**REPORT ON THE GEOTECHNICAL CONDITIONS ON
PORTION 30 OF PORTION 29 OF THE FARM
BLAAUWS KOP 36, DISTRICT KENHARDT**

2020/J011/MCP



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EXECUTIVE SUMMARY

1 INTRODUCTION

It is envisaged to develop some 50 hectare of land on Portion 30 of Portion 29 of the farm Blaauws Kop 36 as a residential area known as Plangeni. For this purpose Cedar Land Geotechnical Consult (Pty) Ltd was appointed as subconsultant to Macroplan to conduct a geotechnical investigation on the property.

2 SITE DESCRIPTION

2.1 Site Location

Portion 30 of Portion 29 of the farm Blaauws Kop 36 is situated on the eastern bank of the Orange River, some 31 kilometers southwest of the town of Upington in the Northern Cape. The eastern and southern boundaries of the property are formed by vacant land ; the western boundary by an irrigation canal and the northern boundary by cultivated agricultural lands. The size of the property is 50 hectare.

2.2 Topography and Drainage

The land investigated is located between 783,0mamsl and 771,0mamsl, sloping east to west at approximately 2,0%. However, the slope is not even and fairly level land and rocky outcrops are present randomly distributed over the area of investigation.

Drainage takes place by means of sheetwash. The sheetwash is disposed of towards the northwest according to the slope of the land. However, several minor non-perennial water courses bisect the land from southeast to northwest. The water courses are contained in narrow and shallow gullies.

2.3 Vegetation and Landscape

The area of investigation is referred to as Bushmanland Arid Grassland. On site it was found that in the areas where natural vegetation is present it consists of a sparse stands of *Acacia melliflora*. Stands of *aloe claviflora* are present, although these plants are removed for herbal medication and extension of urbanization.

2.4 Existing Facilities

The area can be divided into two zones as follows :

2.4.1 Informal Housing

Formal structures of masonry construction and informal housing consisting of galvanized iron structures and some masonry structures are present in the northern part of the site, close to the entrance and from provincial road R359 and local distributor road. Over the larger part of the site reed and galvanized iron structures are being erected on a randomly scattered basis. Sewerage disposal is by means of pit latrines. A few public flush toilets are provided. Some residents have created small vegetable and flower gardens on the stands.

2.4.2 Vacant Land

Vacant, undeveloped land is present in the southern and eastern parts of the site.

3 NATURE OF INVESTIGATION

3.1 Test Pitting

On 6 October 2020 35 test pits were excavated with a Bell 315 SK 4X4 TLB on hire from ALS Plant Rentals. All test pits were excavated to refusal. The test pits were profiled by a professionally registered geotechnical engineer.

3.2 Materials Testing

Soil testing was undertaken by Roadlab in Upington.

Soil testing consisted of the following :

- Conductivity and pH determinations on five samples of the in-situ materials to determine the corrosivity thereof.
- Foundation indicator testing on 11 samples of the in-situ materials to determine possible conditions of heave or settlement.
- CBR and road indicator testing on three samples to determine the suitability of the in-situ materials to be utilized as road layerworks.

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. In the

few cases where it was possible to excavate to an appreciable depth undisturbed sampling failed due to the loose consistency and arenaceous nature of the soil.

4 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 Kakamas Terrane and the site is located on Kanoneiland granite of the Keimoes Suite that is intrusive into the terrane, as described by Moen. The granite is described as dark grey, speckled white rock with a high biotite content. The texture is coarse grained.

5 SOIL PROFILE

5.1 Colluvium

Colluvial deposits are present as surface deposits in a surface horizon between 100mm to 600mm thick. It consists of pale light brown fine sands to coarse sand with contents of gravels and cobbles of granite or calcrete in variable proportions, but mostly matrix supported. The soil matrix is normally intact.

5.2 Alluvium

Alluvium is present as a surface horizon between 300mm and 1300mm thick. The distribution thereof is limited to the debris deposited by the non-perennial water courses bordering the canal. It consists of light brown, medium dense to very loose fine sands to coarse sand with matrix supported fine gravels of quartz and very weak calcareous cementing in variable proportions.

5.3 Residual Granite

Residual granite underlies the colluvium and alluvium, occurring from depths between 100mm and 1300mm minimum, extending to 300mm to 1900mm maximum. The residual granite can be described as dirty white speckled dark grey varying to dark grey speckled white, micaceous or calcareous cemented, coarse sand containing fine gravels of quartz and cobbles of granite. The consistency of the residual granite varied between dense and very dense in the test pits.

5.4 Pedogenic Deposits

5.4.1 Nodular Calcrete

Nodular calcrete generally underlies the transported surface deposits. It was present between zero and

500mm deep minimum, extending to 300mm to 1300mm maximum. The nodular calcrete can be described as dirty white to grey white, rounded, fine to medium coarse, concretions contained in a matrix of fine sand, or as a cemented pedocrete. The consistency varies from medium dense to very dense.

5.4.2 Unconsolidated Calcrete

Unconsolidated calcrete underlies the transported surface deposits. It was present between 300mm and 900mm deep minimum, extending to 1100mm to 1300mm maximum. The unconsolidated powder calcrete can be described as dirty white, fine, calcareous sand. The consistency is medium dense.

6 GROUNDWATER

6.1 Perched Water

Perched groundwater was not encountered on site. Conditions are such that perched will generally not occur in the area.

6.2 Permanent Groundwater

Groundwater is expected to occur at depths between 20 meters and 30 meters in fractures restricted to a zone directly below the water table. The presence of permanent water has no influence on the geotechnical conditions on site.

7 SITE CLASS DESIGNATION

7.1 Geotechnical Zone I

This zone comprises 82,5% of the area investigated. The soil profile consists of a horizon of colluvium less than 600mm thick overlying medium dense to very dense residual sand or nodular calcrete and at depth bedrock granite. As per the materials profile encountered in the test pits the combined thickness of the strata of nodular calcrete and residual soil 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.

7.2 Geotechnical Zone II

This zone comprises 5,4% of the area investigated and is present in three separate areas on site. The soil profile consists of a superficial horizon of colluvium and residual soil less than 400mm thick overlying bedrock of granite. 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. The area is thus zoned as “R” and regarded as stable.

7.3 Geotechnical Zone III

This zone comprises 2,4% of the area investigated. The zone is present in four separate areas along the western boundary of the property. The profile consists of a horizon of transported sand less than 600mm thick overlying medium dense to very dense residual sand or nodular calcrete and at depth bedrock granite. As per the materials profile encountered in the test pits the combined thickness of the strata of nodular calcrete and residual soil is sufficient to dissipate the stresses induced by the foundations effectively. However, the area is influenced by the periodic presence of water originating from blocking the natural water courses and seepage from the canal. Damage to structures by occur due to soil moisture triggering the corrosivity of the soil. Potentially the area can be zoned as “S” and the materials strata can be regarded as compressible to a maximum of 10mm if the inundation of the area can be resolved. In the unresolved condition the area is zoned as “P(Water)” and conditions are regarded as unfavourable for residential development.

7.4 Geotechnical Zone IV

This zone comprises 9,7% of the area investigated. This zone is characterized by the numerous localized granite outcrops. Such outcrops consist of areas of exposed corestones and areas of hard rock present as fairly level batholithic surfaces. Potentially the areas can be zoned as R which can in principle be regarded as stable, but the highly undulating land surface due to the presence of boulders and outcrops detracts from the suitability thereof for residential development. The area is thus zoned as “P(Outcrops)”.

8 CONDITIONS OF EXCAVATION

On average over the entire site it is most likely that a 30 ton track mounted excavator will prove to be more suitable equipment for excavation than the 55kW TLB, achieving deeper levels of penetration prior to refusal.

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

- Unweathered, very hard rock, granite resulting in virtually immediate refusal of excavation.
- Slightly weathered, hard rock, granite resulting in very slow penetration indicating conditions of uneconomical excavation by the mechanical equipment used for the investigation.

- Very dense, residual granite tending to medium hard rock resulting in very slow penetration indicating conditions of uneconomical excavation by mechanical equipment used for the investigation.

Conditions of Boulder Class A excavation could be identified in one test pit only, but should the presence of outcrops be taken into account, the volume of such excavation may be significant.

As for individual areas, the following is applicable :

8.1 Geotechnical Zone I

Refusal of excavation was encountered in all the test pits between depths of 500mm and 1500mm, averaging 1050mm. The implication of this is that should trenches require excavated depths to 1000mm, zero of the excavation may be classified as hard, requiring drilling and blasting. Should the required depth of excavation increase to 1500mm, 30% of the excavation may be classified as hard.

8.2 Geotechnical Zone II

Refusal of excavation was encountered in all the test pits between depths of 50mm and 400mm, averaging 225mm. The implication of this is that should trenches require excavated depths to 1000mm, 77,5% of the excavation may be classified as hard, requiring drilling and blasting. Should the required depth of excavation increase to 1500mm, 85% of the excavation may be classified as hard.

8.3 Geotechnical Zone III

Refusal of excavation was encountered in all the test pits between depths of 1300mm and 2200mm, averaging 1750mm. The implication of this is that conditions of hard rock excavation will not be encountered to trench depths of 1500mm. However, cognizance must be taken of the fact that in the present state conditions of wet excavation may be present.

8.4 Geotechnical Zone IV

Minimal test pitting could be conducted in these areas. The test pitting conducted may not represent actual conditions due to the highly undulating rock profile. It is thus proposed on a preliminary basis to allow for 50% hard rock excavation and 50% boulder class A excavation in this zone.

9 LAND SLOPE

The average slope across the larger part of the land between 1,5% and 2,5%, but highly variable in Geotechnical Zone IV. The land slope does not detract from the development potential of the area.

No steep slopes are present on the property.

10 AREAS SUBJECT TO FLOODING

Blockages of the natural water courses occur on the western perimeter of the property close to the canal. The combination of such blocking and seepage from leakages of the canal results in periodical inundation of four areas close to the canal.

11 MATERIALS UTILISATION

- *Trench Backfilling* : None of the materials are suitable for selected fill or pipe bedding. All materials can be used for normal backfill.
- *Layerworks for Paved or Segmental Block Paving* : The residual soils are suitable for the construction of in-situ selected and subbase for lightly trafficked streets.
- *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 AREAS SUBJECT TO FLOODING

12.1 Presence of Non-perennial Gullies

Five shallow non-perennial gully areas have been identified. Although these areas are not subject to continuous flooding, such events may result in damage to infrastructure if not designed for. It is recommended that the flood characteristics of these water courses be determined and a safe area between the future houses and the gullies maintained.

12.2 Areas of Ponding

These areas are zoned separately as Geotechnical Zone III. Should it be necessary to locate even in this zone, the land shall be rehabilitated to allow safe development thereof. Such rehabilitation shall consist of repairs of the leaks in the canal and providing sufficient channeling for the non-perennial streams to eliminate ponding in the canal area.

13 FOUNDATION AND STRUCTURAL DESIGN

13.1 Geotechnical Zone I

13.1.1 Strip Foundations

Foundations of 400mm wide placed directly on the medium dense to very dense residual granite or nodular 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.

13.1.2 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 to dense nodular calcrete or residual soil. 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.

13.2 Geotechnical Zone II

13.2.1 Strip Foundations

Foundations of 400mm wide placed directly on bedrock of granite 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.

13.2.2 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 bedrock of granite. 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.

13.3 Geotechnical Zone III

Should remedial measures be implemented successfully to the four areas may be made available for residential development. Such remedial measures shall include features to prevent inundation of the areas and disposal of flood water from the water courses, as well as repairs to the canal.

The two options can be discussed as follows :

13.3.1 Strip Foundations

Foundations of 400mm wide placed directly on the medium dense to very dense residual granite or nodular 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.

13.3.2 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 to dense nodular calcrete or residual soil. 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.

13.4 Geotechnical Zone IV

In principle it is possible to build successfully in these rocky conditions, but it will come at a cost. It is recommended that these areas only be developed if the demand for houses exceed the availability of stands in Zones I and II. The conditions in each stand will have to be designed for on an individual basis.

14 CORROSIVE SOIL

The results of materials testing undertaken for this investigation indicate that all soil materials are highly to very highly corrosive. Potentially, this has an influence on pavement design, installation of wet services and house construction. However, the corrosive character of soil is only triggered by the presence of soil moisture, but the condition that soil moisture will never be present cannot be guaranteed.

The presence of different types of soluble salts result in different types of damage to infrastructure. It is therefore recommended that additional testing be conducted to identify the types of corrosive material present, be it sulfides, sulfates or chloride, and provide the correct protection against corrosion that may result due to the presence of these materials.

15 OTHER CONSIDERATIONS

- *Undermining* : The area is not subject to undermining.

- *Seismic Activity* : The Peak Ground Acceleration expected in 50 years is 0,07g. A low risk for the development of earth tremors therefore exist.
- *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.

16 CONCLUSIONS

The property is regarded as being of favourable to poor suitability for residential development. The factors that reduce the suitability of the land for development are :

- The presence of batholithic rock outcrops and large corestones close to the surface. The presence thereof will result in conditions of hard excavation and boulder excavation. While it is physically possible to establish housing units under these conditions, the decision to develop these areas shall be based on economical constraints.
- The presence of ponding in the area close to the canal. The ponding occurs due to the canal blocking the natural flow of the non-perennial water courses and is aggravated by seepage from leakages from the canal. The areas of ponding can only be utilized for erven and provision of housing if the drainage problems are solved.
- The residual soils and calcrete are highly corrosive. This is problematic in especially Geotechnical Zone III as the corrosive properties of soil are usually activated by the presence of interstitial water.

REPORT ON THE GEOTECHNICAL CONDITIONS ON PORTION 30 OF PORTION 29 OF THE FARM BLAAUWS KOP 36, DISTRICT KENHARDT

2020/J032/MCP_01

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REPORT ON THE GEOTECHNICAL CONDITIONS ON PORTION 30 OF PORTION 29 OF THE FARM BLAAUWS KOP 36, DISTRICT KENHARDT

1 INTRODUCTION

It is envisaged to develop some 50 hectare of land on Portion 30 of Portion 29 of the farm Blaauws Kop 36 as a residential area known as Plangeni. For this purpose Cedar Land Geotechnical Consult (Pty) Ltd was appointed as subconsultant to Macroplan to conduct a geotechnical investigation on the property based on a quotation dated 27 September 2019.

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 sources of available information recording available data obtained in the larger Keimoes area have been consulted for background information :

- *Breytenbach FJ* : Geotechnical Conditions in a Part of Keimoes Extension 7 : A Report for the Establishment of 121 Housing Units, issued by Soilkraft cc on behalf of Roadlab/Prehab JV on 12 April 2009.

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

- *Breytenbach FJ* : Geotechnical Conditions on Erf 1070 Upington : A Phase 3 Report for the Development of Upington Truck Stop, issued by Soilkraft cc on behalf of Mr Kobus Duvenhage on 16 November 2011.
- *Breytenbach FJ* : Geotechnical Report for the Town of Keimoes : Rezoning and Subdivision of Erf 666, Keimoes, issued by Soilkraft cc on behalf of the Kai !Garib Municipality on 31 July 2012.
- *Breytenbach FJ* : Geotechnical Conditions on the Remainder of Erf 2867 Keimoes : A Phase 3 Report for the Proposed Construction of a New Magistrate's Office, issued by Soilkraft cc on behalf of WorleyParsons (Pty) Ltd on 14 May 2013.
- *Breytenbach FJ* : Report on the Geotechnical Conditions on Portion 128 and a Portion of the Restant of the Farm Kousas 459, Keimoes, issued by Cedar Land Geotechnical Consult (Pty) Ltd on behalf of Macroplan on 28 May 2020.

4 SITE DESCRIPTION

4.1 Site Location

Portion 30 of Portion 29 of the farm Blaauws Kop 36 is situated on the eastern bank of the Orange River, some 31 kilometers southwest of the town of Upington in the Northern Cape. The eastern and southern boundaries of the property are formed by vacant land ; the western boundary by an irrigation canal and the northern boundary by cultivated agricultural lands. Access to the property is via a concrete block paved road originating from provincial road R359. The size of the property is 50 hectare.

Refer to the attached Figure 1 : Locality Plan.

4.2 Topography and Drainage

The land investigated is located between 783,0mamsl and 771,0mamsl, sloping east to west at approximately 2,0%. However, the slope is not even and fairly level land and rocky outcrops are present randomly distributed over the area of investigation.

Drainage takes place by means of sheetwash. The sheetwash is disposed of towards the northwest according to the slope of the land. However, several minor non-perennial water courses bisect the land from southeast to northwest. The water courses are contained in narrow and shallow gullies. These drainage features are filled with thick deposits of loose and very loose sand and it appears as if some conditions of high soil moisture may develop in the area of the canal.

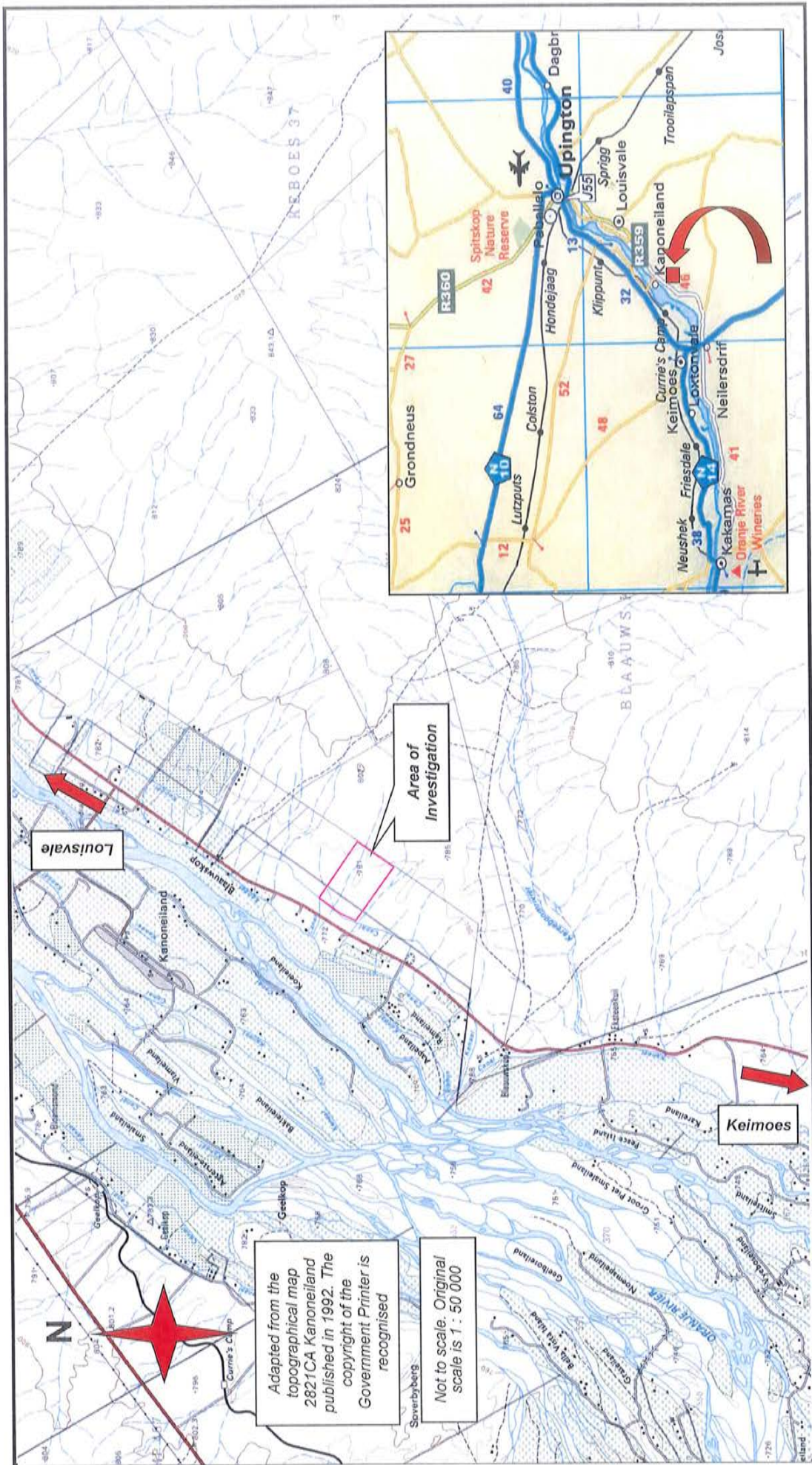


FIGURE 1

LOCALITY PLAN



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 stands of *Acacia melliflora*. Stands of *aloe claviflora* are present, although these plants are removed for herbal medication and extension of urbanization.

4.4 Existing Facilities

Site conditions are illustrated on Photo 1 : Site Conditions. The area can be divided into two zones as follows :

4.4.1 Informal Housing

Formal structures of masonry construction and informal housing consisting of galvanized iron structures and some masonry structures are present in the northern part of the site, close to the entrance and from provincial road R359 and local distributor road. Over the larger part of the site reed and galvanized iron structures are being erected on a randomly scattered basis. Water is provided from emergency tanks via an underground pipe network present in the older part of the village. These tanks were provided as measures during the Covid-19 pandemic and electricity are provided to the structures, though it may not always be legal connections. Sewerage disposal is by means of pit latrines. A few public flush toilets are provided. Some residents have created small vegetable and flower gardens on the stands.

4.4.2 Vacant Land

Vacant, undeveloped land is present in the southern and eastern parts of the site.

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 6 October 2020 35 test pits were excavated with a Bell 315 SK 4X4 TLB on hire from ALS Plant Rentals. The TLB was equipped with a



- 1 Site conditions as seen from southeastern corner. Test pit 1 in excavation. Slight dip and darker rock line may represent a fault zone.
- 2 Informal waste site.
- 3 Granite exposed in non-perennial water course.
- 4 Blocks of excavated (blasted) solid granite.
- 5 Granite corestones.



SITE CONDITIONS IN PLANGENI

PHOTO 1

600mm wide bucket. All test pits were excavated to refusal.

The test pits were profiled by a professionally registered geotechnical engineer. For the benefit of the non-geotechnical reader of this document, these guidelines 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 H are indicated on this figure.

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	<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, sicrete, calcicrete 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



5.2 Materials Testing

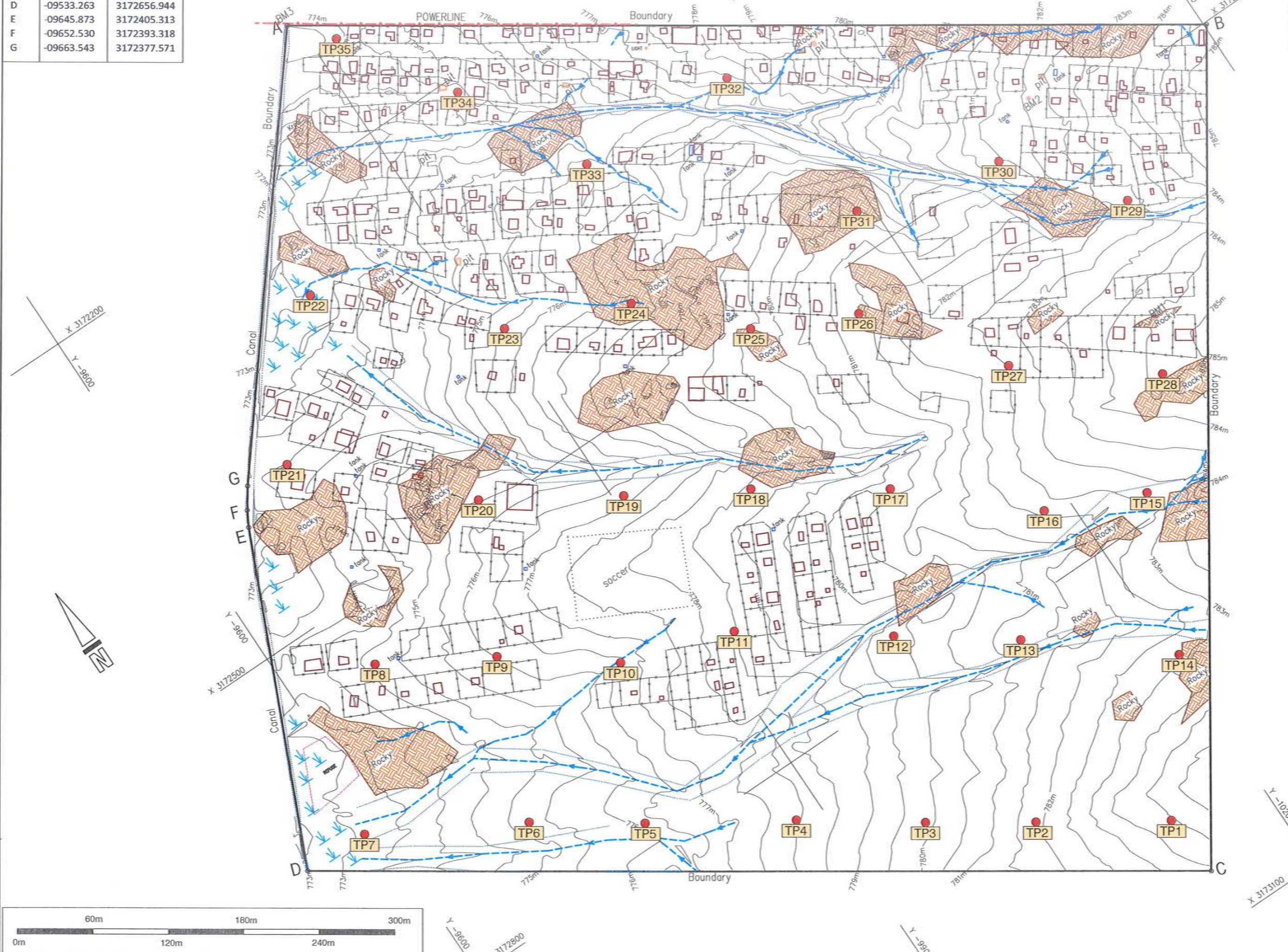
Soil testing was undertaken by Roadlab in Upington. As a matter of quality control duplicate samples were sent to the Roadlab branch in Germiston for independent testing to verify the results.

COORDINATES – PLANGENI		
System: WGS84 WG21		
Point	Y	X
A	-09892.143	3172092.425
B	-10502.108	3172501.970
C	-10128.869	3173057.778
D	-09533.263	3172656.944
E	-09645.873	3172405.313
F	-09652.530	3172393.318
G	-09663.543	3172377.571

FIGURE 2 :
SITE PLAN

LEGEND

-  TEST PIT POSITION
-  ROCKY AREA





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TASK: Plangeni Development
JOB NAME:
LIGGING: Portion 30 of the Farm Blaauwskop 36
SITE:
CLIENT: Kai !Garib Municipality
CLIENT:
TEKENING NO: Figure 2 : Site Plan
DRAWING NO:
DATE: 9 October 2020

Soil testing consisted of the following :

- Conductivity and pH determinations on five samples of the in-situ materials to determine the corrosivity thereof.
- Foundation indicator testing on 11 samples of the in-situ materials to determine possible conditions of heave or settlement.
- CBR and road indicator testing on three samples to determine the suitability of the in-situ materials to be utilized as road layerworks.

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.

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. In the few cases where it was possible to excavate to an appreciable depth undisturbed sampling failed due to the loose consistency and arenaceous nature of the soil.

6 SITE GEOLOGY AND GEOHYDROLOGY

Although the geology of the larger area around Keimoes appears to consist ubiquitously of granitoid rock, 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 explanation of the regional geology of the area. For this purpose publications by Visser^{Reference 14.2}, McCarthy^{Reference 14.3}, Cornell^{Reference 14.4} and Moen^{Reference 14.5} were consulted. Of these four references, the latter two can be regarded as site specific.

Two 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.
- *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.

TABLE 2 : SUMMARY OF SOIL TESTING

TEST PIT	SAMPLE NO.	DEPTH (mm)	SOIL ORIGIN	SOIL TYPE	GM	PI	LL	ACTIVITY	pH	CONDUCTIVITY (Sm^{-1})	% < 0,002mm	OMC (%)	MDD (kgm^{-3})	SOIL CLASS			
														COLTO	PRA	UNIFIED	
3	U9427	300-1100	Residual granite	Well-graded sand	1,60	6	26	Low			0,0				A-1-b(0)		SM-SC
6	U9428	200-800	Residual granite	Sandy gravel	2,30	3	26	Low	8,33	0,09	0,1	6,7	2091	G6	A-1-a(0)		SW-SM-SC
9	U9429	300-900	Residual granite	Gravelly sand	2,10	5	21	Low			0,0				A-1-b(0)		SW-SM-SC
12	U9430	100-1100	Residual granite	Gravelly sand	2,00	3	26	Low	7,73	0,15	0,2				A-1-b(0)		SW-SM
15	U9431	0-600	Alluvium	Fine sand	1,30	5	21	Low			0,0				A-2-4(0)		SM-SC
18	U9432	0-400	Pedogenic deposits	Nodular calcrete	2,00	3	25	Low	8,10	0,15	0,0	9,0	2079	G6	A-1-b(0)		SM
21	U9433	0-600	Colluvium	Well-graded sand	1,70	0	25	Low			0,0				A-1-b(0)		SM
24	U9434	300-1300	Pedogenic deposits	Nodular calcrete	1,80	4	24	Low			0,6				A-1-b(0)		SM-SC
27	U9435	200-700	Residual granite	Coarse sand	2,00	8	31	Low	8,29	0,08	0,1				A-2-4(0)		SM
30	U9436	0-300	Residual granite	Sandy gravel	2,10	2	21	Low			0,3	6,4	2098	G6	A-1-a(0)		SW-SC
33	U9437	200-1300	Residual granite	Coarse sand	1,90	3	27	Low	8,38	0,02	0,2				A-1-b(0)		SW-SM

6.1 Regional Geology

The regional geology of the area is indicated in Figure 3 : 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 4.

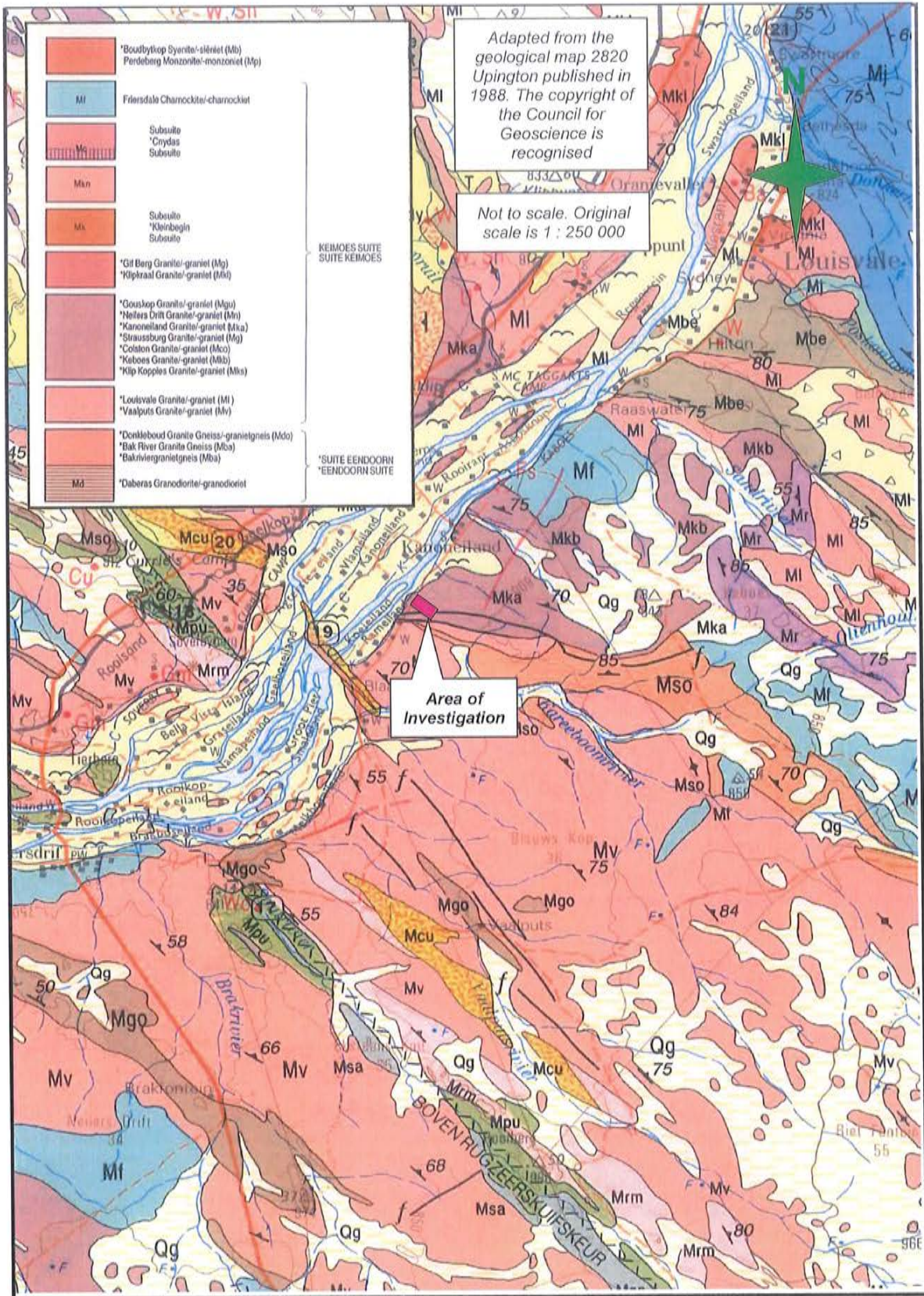
The process of landforming can be described as compatible to the modern concept of plate tectonics. In this case the Namaqua plate became buried beneath the Kaapvaal Craton in a subduction zone. Considering the forces involved it can be regarded as a violent process, resulting in the breaking up of the landmass into the five domains as described above, associated with the intrusion of recycled rock material from the subduction zone. In the case of the Kakamas terrane, numerous intrusions occurred during the process of subduction, of which the Keimoes Suite is one. The Keimoes Suite in turn, consists of several granitic batholiths. Moen as well as the official geology map 2280 describe the presence of Kanoneiland granite batholith of the Keimoes Suite in the area of investigation. On Figure 3 the Kanoneiland granite is indicated in purple and referenced as Mka.

A schematic plate tectonic model showing the process as proposed on Figure 2.40 (Moen) is reproduced in this document as Figure 5. It is on the intrusive rock material of the Keimoes Suite of the Kakamas terrane that the proposed Plangeni development is located.

6.2 Site Geology

The site geology is illustrated on Figure 6 : Site Geology. Although bedrock occurs exclusively as granite of the Kanoneiland batholite, the figure illustrates the possible presence of post intrusive tectonic occurrences.

The Kanoneiland granite is described as a mesocratic biotite granite characterized by a poorly developed tectonic fabric and numerous mafic and leucocratic inclusions. The mafic inclusions consist chiefly of biotite and/or hornblende, lying in the foliation planes. The granite is medium to coarse grained and non-porphyrific. Although the granite generally appeared to



REGIONAL GEOLOGY

FIGURE 3

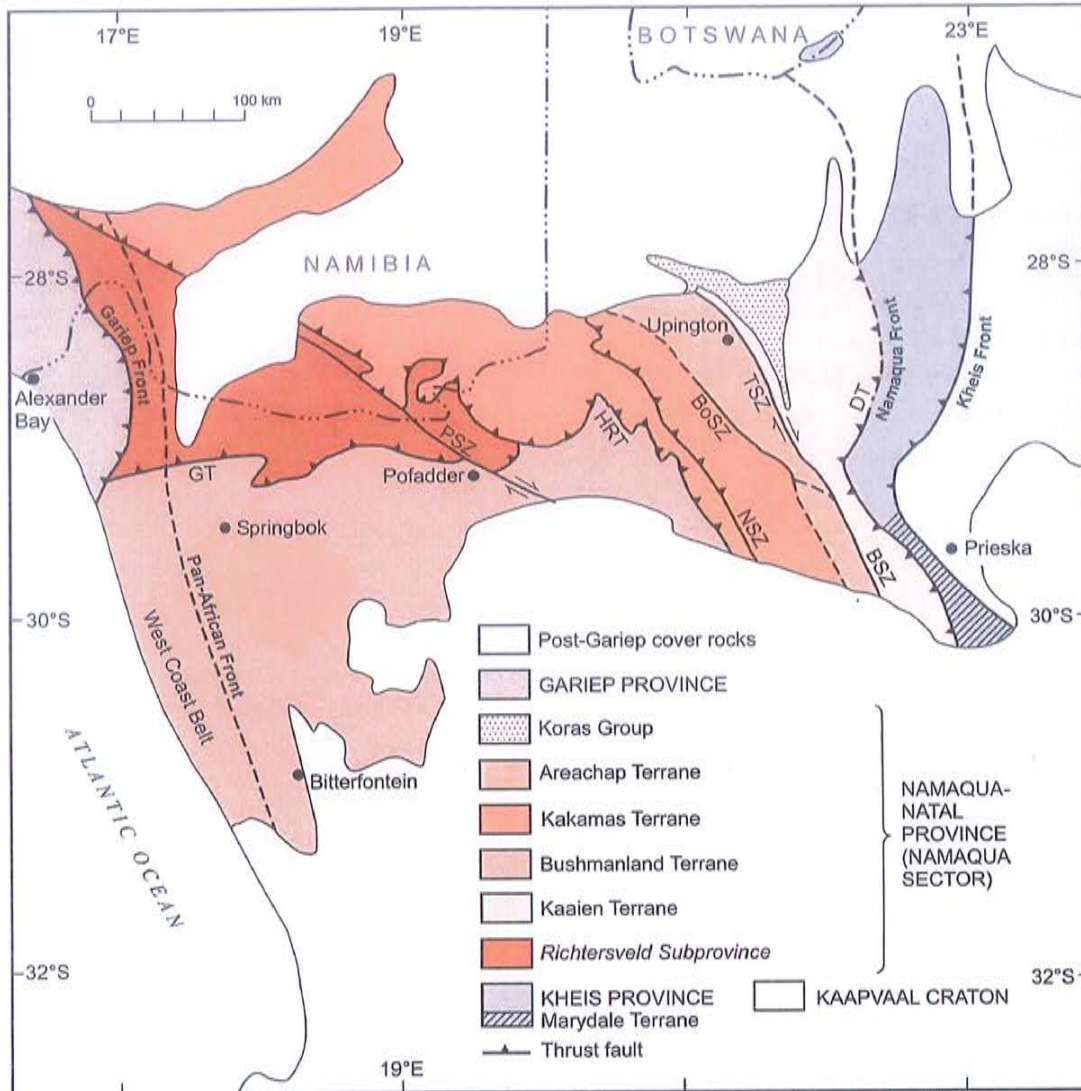


FIGURE 4 : TECTONIC SUBDIVISION OF THE NAMAQUA SECTOR

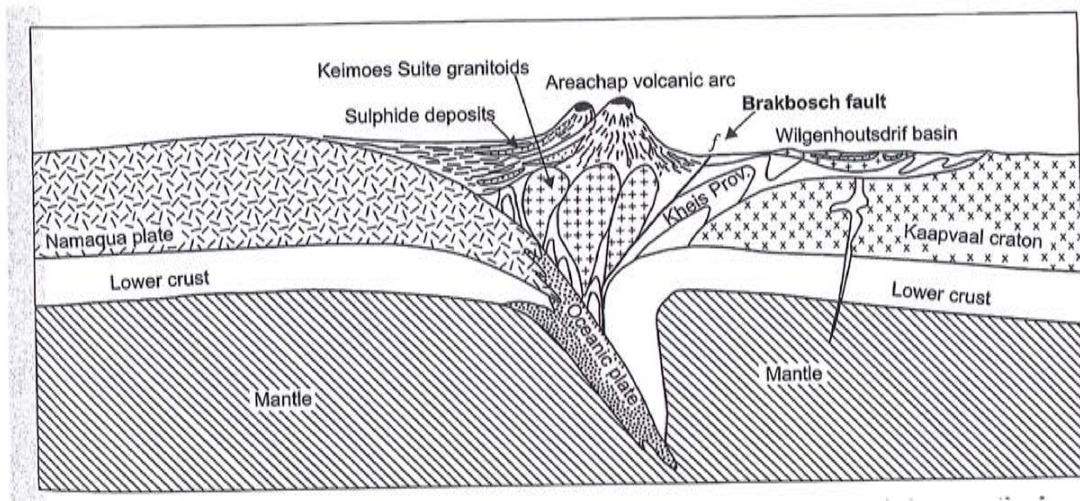


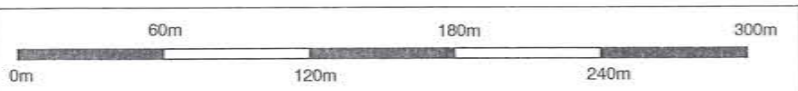
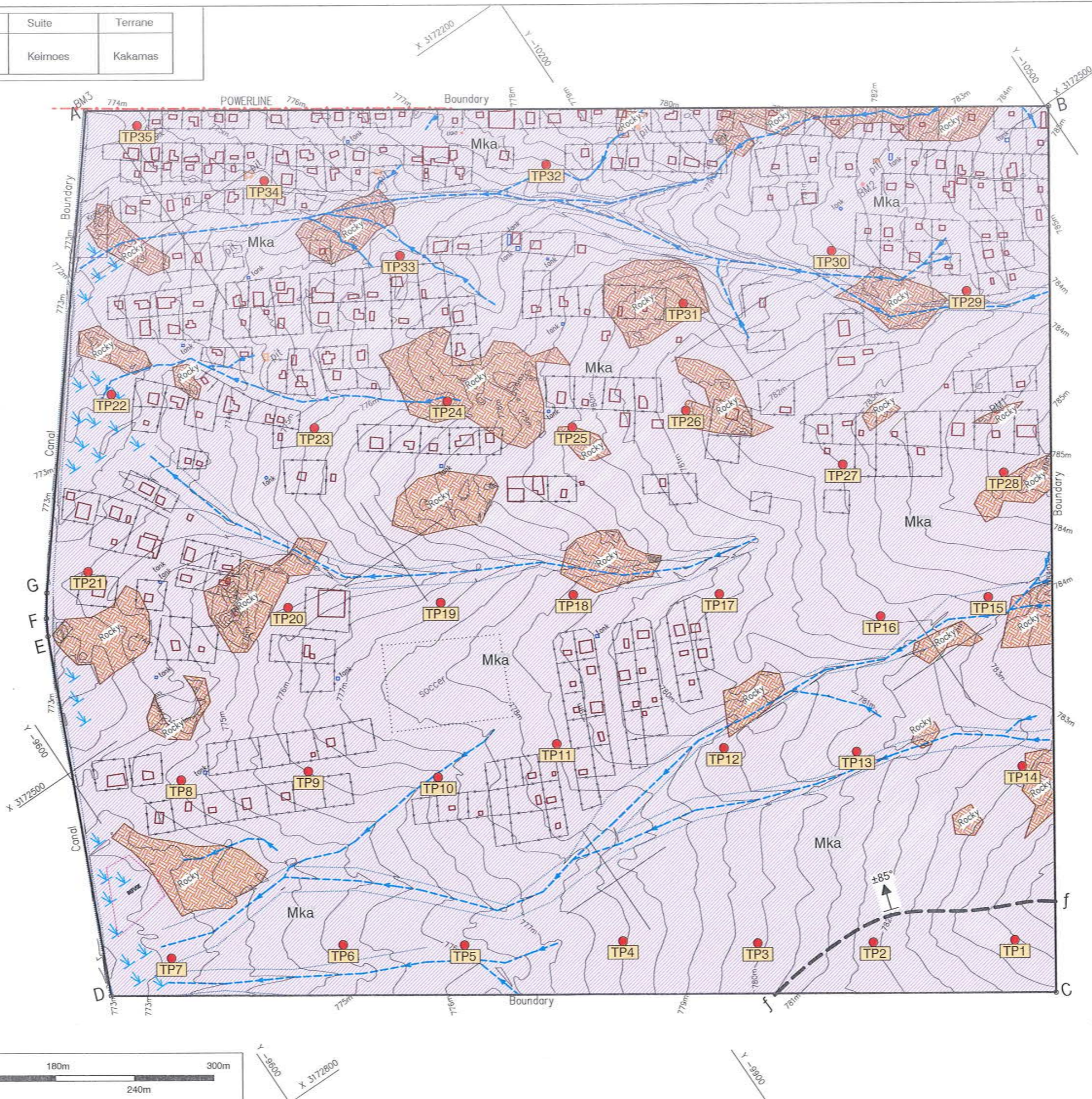
FIGURE 5 : SCHEMATIC PLATE TECTONIC MODEL SHOWING THE GRANITOIDS OF THE KEIMOES SUITE

Lithology	Suite	Terrane
Mka	Kanoneiland Granite	Keimoes
		Kakamas

FIGURE 6 :
SITE GEOLOGY

LEGEND

- TEST PIT POSITION
- ROCKY AREA
- POSSIBLE FAULT ZONE




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TASK:	Plangeni Development
JOB NAME:	Plangeni Development
LIGGING:	Portion 30 of the Farm
SITE:	Blaauwskop 36
KLIJNT:	Kai !Garib Municipality
CLIENT:	Kai !Garib Municipality
TEKENING NO:	Figure 6 : Site Geology
DRAWING NO:	Figure 6 : Site Geology
DATUM:	19 October 2020
DATE:	19 October 2020

be massive in the test pit excavations, a regional dip of 70° to 75° towards the north east is indicated on Figure 3. The area of investigation is characterized by the randomly distributed, numerous outcrops and sub outcrops of granite.

The presence of a fault zone close to or in the area of investigation. The fault line strikes virtually due east-west. Possible evidence of such a line was encountered between TP's 1 and 14, extending to the area between TP's 2 and 3. The line can be clearly identified by a linear, narrow outcrop of granite and is also discernable on Photo 1.

6.3 Soil Profile

6.3.1 Colluvium

Colluvial deposits were encountered in TP's 1 to 6, 8 to 12, 16, 19 to 23, 27 to 31 and 32 to 35 as a surface horizon between 100mm to 600mm thick. It consists of pale light brown, fine sand to coarse sand with contents of gravels and cobbles of granite in variable proportions, but mostly matrix supported. The soil matrix is normally intact, but some examples of very weak calcareous cementing occur as well as the presence of small, rounded calcrete concretions. At the time of investigation the colluvium was dry and the consistency varied between loose and medium dense.

6.3.2 Alluvium

Alluvium was encountered in TP's 7, 13 to 15 and 24 as a surface horizon between 300mm and 1300mm thick. The distribution thereof is limited to the debris deposited by the non-perennial water courses bordering the canal. It consists of light brown fine sand to coarse sand with matrix supported fine gravels of quartz in variable proportions. The soil matrix is normally intact, but some examples of very weak calcareous cementing occur as well as the presence of small, rounded calcrete concretions. At the time of investigation the alluvium was dry and the consistency varied between very loose and medium dense. The alluvium in all the test pits contained a fair number of tree roots.

6.3.3 Residual Granite

Residual granite was encountered in TP's 1 to 12, 15, 19, 20, 22, 23, 26, 27, 30 to 35. It underlies the colluvium and alluvium, occurring from depths between 100mm and 1300mm minimum, extending to 300mm to 1900mm maximum. The thickness of the horizon varied between 150mm and 1100mm in the test pits. The residual granite can be described as dirty white speckled dark grey varying to dark grey speckled white coarse sand containing fine gravels of quartz and cobbles of granite. The soil matrix is normally micaceous, but some

examples of very weak calcareous cementing occur as well as the presence of small, rounded calcrete concretions. The consistency of the residual granite varied between dense and very dense in the test pits.

6.3.4 Pedogenic Deposits

Pedogenic deposits are present on site, both as unconsolidated granular material and nodular calcrete. It appears as if these deposits post-date the Mokalanen Formation. The pedogenic deposits are not as widely distributed on site as in the areas of Upington, Keimoes and Groblershoop.

6.3.4(i) Nodular Calcrete

Nodular calcrete was encountered in TP's 13, 14 and 28 underlying the transported surface deposits, but in TP 18 exposed as surface horizon. It was present between zero and 500mm deep minimum, extending to 300mm to 1300mm maximum. The thickness of the horizon varied between 200mm and 800mm in the test pits. The nodular calcrete can be described as dirty white to grey white, rounded, fine to medium coarse, concretions contained in a matrix of fine sand, or as a cemented pedocrete. The consistency varies from medium dense to very dense.

6.3.4(ii) Unconsolidated Calcrete

Unconsolidated calcrete was encountered in TP's 19 and 24 underlying the transported surface deposits. It was present between 300mm and 900mm deep minimum, extending to 1100mm to 1300mm maximum. Elsewhere on site the presence of powder calcrete as a lesser component of the soil is widely distributed across the site in all soil strata. The unconsolidated powder calcrete can be described as dirty white, fine, calcareous sand. The consistency is medium dense.

6.4 Groundwater

6.4.1 Perched Water

Perched groundwater was not encountered in any of the test pits during the 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. It may be present in the lesser drainage courses 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 14.6} 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 less than 10%. Groundwater is expected to occur at depths between 20 meters and 30 meters in fractures restricted to a zone directly below the water table.

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 0,5% for all the samples tested.

7.1.2 Properties of Settlement

7.1.2(i) Colluvium

Colluvial deposits were encountered in TP's 1 to 6, 8 to 12, 16, 19 to 23, 27 to 31 and 32 to 35 as a surface horizon between 100mm to 600mm thick. It consists of pale light brown fine sands to coarse sand with contents of gravels and cobbles of granite or calcrete in variable proportions, but mostly matrix supported. The soil matrix is normally intact. At the time of investigation the colluvium was dry and the consistency varied between loose and medium dense. The properties of the colluvium are thus such that it does not tend to excessive settlement.

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 ₆)	GRADING COEFFICIENT (G _c)	SHRINKAGE PRODUCT (S _p)	CBR @ 95% MOD	PAVED	UNPAVED
3	U9427	300-1100	Residual granite	Well-graded sand	A-1-b(0)	SM-SC	5 to 22	30° to 35°	Low	5 to 8	2,7X10 ⁻⁶ to 5,0X10 ⁻⁷	28,0	0,0	27,1	144,0		Good	
6	U9428	200-800	Residual granite	Sandy gravel	A-1-a(0)	SW-SM-SC	1 to 22	30° to 38°	Negligible to low	5 to 8	2,7X10 ⁻⁶ to 5,0X10 ⁻⁷	63,0	4,0	30,2	55,0	36	Subbase and selected	Ravels and corrugates
9	U9429	300-900	Residual granite	Gravelly sand	A-1-b(0)	SW-SM-SC	1 to 22	30° to 38°	Negligible to low	5 to 8	2,7X10 ⁻⁶ to 5,0X10 ⁻⁷	20,0	0,0	35,9	60,0		Ravels and corrugates	
12	U9430	100-1100	Residual granite	Gravelly sand	A-1-b(0)	SW-SM	1 to 22	32° to 38°	Negligible to low	6 to 8	(7,5±4,8)X10 ⁻⁶	28,0	0,0	34,8	46,5		Ravels and corrugates	
15	U9431	0-600	Alluvium	Fine sand	A-2-4(0)	SM-SC	5 to 22	30° to 35°	Low	5 to 8	2,7X10 ⁻⁶ to 5,0X10 ⁻⁷	5,0	0,0	11,8	162,5		Erodible	
18	U9432	0-400	Pedogenic deposits	Nodular calcrete	A-1-b(0)	SM	20 to 22	32° to 35°	Low	8	(7,5±4,8)X10 ⁻⁶	63,0	3,0	31,2	108,0	34	Subbase and selected	Good
21	U9433	0-600	Colluvium	Well-graded sand	A-1-b(0)	SM	20 to 22	32° to 35°	Low	8	(7,5±4,8)X10 ⁻⁶	20,0	0,0	32,4	0,0		Ravels and corrugates	
24	U9434	300-1300	Pedogenic deposits	Nodular calcrete	A-1-b(0)	SM-SC	5 to 22	30° to 35°	Low	5 to 8	2,7X10 ⁻⁶ to 5,0X10 ⁻⁷	20,0	0,0	32,8	95,0		Ravels and corrugates	
27	U9435	200-700	Residual granite	Coarse sand	A-2-4(0)	SM	20 to 22	32° to 35°	Low	8	(7,5±4,8)X10 ⁻⁶	20,0	0,0	36,5	128,0		Ravels	
30	U9436	0-300	Residual granite	Sandy gravel	A-1-a(0)	SW-SC	1 to 10	30° to 38°	Negligible to low	5 to 6	(3,0±2,0)X10 ⁻⁷	37,5	3,0	31,5	42,0	44	Subbase and selected	Ravels and corrugates
33	U9437	200-1300	Residual granite	Coarse sand	A-1-b(0)	SW-SM	1 to 22	32° to 38°	Negligible to low	6 to 8	(7,5±4,8)X10 ⁻⁶	20,0	0,0	32,5	64,0		Ravels and 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 Urban Roads (Draft UTG), Committee of State Road Authorities 1993.
- 5 Erosion resistance : 1 is best 10 is poor.

7.1.2(ii) Alluvium

Alluvium was encountered in TP's 7, 13 to 15 and 24 as a surface horizon between 300mm and 1300mm thick. The distribution thereof is limited to the debris deposited by the non-perennial water courses bordering the canal. It consists of light brown fine sands to coarse sand with matrix supported fine gravels of quartz and very weak calcareous cementing in variable proportions. At the time of investigation the colluvium was dry and the consistency varied between very loose and medium dense. Although the soil composition of the alluvium is such that it is not specially subject to settlement, it can be regarded as recent, unconsolidated deposits. Considering the vertical extent of the alluvial deposits, it is regarded as the soil material on site most subject to settlement.

7.1.2(iii) Residual Granite

Residual granite was encountered in TP's 1 to 12, 15, 19, 20, 22, 23, 26, 27, 30 to 35. It underlies the colluvium and alluvium, occurring from depths between 100mm and 1300mm minimum, extending to 300mm to 1900mm maximum. The thickness of the horizon varied between 150mm and 1100mm in the test pits. The residual granite can be described as dirty white speckled dark grey varying to dark grey speckled white, micaceous or calcareous cemented, coarse sand containing fine gravels of quartz and cobbles of granite. The consistency of the residual granite varied between dense and very dense in the test pits. 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.

7.1.2(iv) Pedocretes

- *Nodular Calcrete* : Nodular calcrete was encountered in TP's 13, 14 and 28 underlying the transported surface deposits, but in TP 18 exposed as surface horizon. It was present between zero and 500mm deep minimum, extending to 300mm to 1300mm maximum. The nodular calcrete can be described as dirty white to grey white, rounded, fine to medium coarse, concretions contained in a matrix of fine sand, or as a cemented pedocrete. The consistency varies from medium dense to very dense. . 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.
- *Unconsolidated Calcrete* : Unconsolidated calcrete was encountered in TP's 19 and 24 underlying the transported surface deposits. It was present between 300mm and 900mm deep minimum, extending to 1100mm to 1300mm maximum. The unconsolidated powder calcrete can be described as dirty white, fine, calcareous sand. The consistency is medium

dense. The properties of the powder calcrete 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 14.7}. 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 7,73 and 8,38. 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 $0,02\text{Sm}^{-1}$ for the residual granite to $0,15\text{Sm}^{-1}$ for the residual granite and calcrete. The soluble salt content does therefore contribute significantly to the corrosivity of the soils.

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 are generally not present on site, but may occur in the vicinity of the canal on the western boundary of the property.

7.1.4 Materials Utilisation

7.1.4(i) Backfilling of Service Trenches

All materials, that is the alluvium, colluvium, pedogenic materials and residual soils 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.

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 in-situ materials to be generally of G6 quality. It can therefore be considered as suitable to be utilised for purposes of paved road or segmental block road construction. This type of construction is applicable to access roads to townships. For purpose of lightly trafficked roads such as local access roads, loops and culs-de sac it may be used for natural subbase construction.

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.

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 14.8} 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 compressible with cohesion (c_0) of 20,0kNm⁻² to 22kNm⁻² and the effective stress envelope approximately 32° to 35°.
- *Alluvium* : The alluvium is regarded as low compressible with cohesion (c_0) of 5,0kNm⁻² to 22kNm⁻² and the effective stress envelope approximately 30° to 35°.
- *Pedogenic Deposits* : The nodular calcrete is regarded as low compressible with cohesion (c_0) of 5,0kNm⁻² to 22kNm⁻² and the effective stress envelope approximately 30° to 35°.
- *Residual Granite* : The residual granite is regarded as negligibly to low compressible with cohesion (c_0) of 1kNm⁻² to 22kNm⁻² and the effective stress envelope approximately 30° to 38°.

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 is approximately $(7,5\pm 4,8) \times 10^{-6} \text{cms}^{-1}$.
- *Alluvium* : The permeability of the alluvium is regarded as semi-pervious to impervious. The soil permeability coefficient varies between $2,7 \times 10^{-6} \text{cms}^{-1}$ to $5,0 \times 10^{-7} \text{cms}^{-1}$.
- *Pedogenic Deposits* : The permeability of the pedogenic deposits is highly variable depending on the mode of deposition and regarded as semi-pervious to impervious. The soil permeability coefficient varies between $2,7 \times 10^{-6} \text{cms}^{-1}$ to $5,0 \times 10^{-7} \text{cms}^{-1}$.
- *Residual Granite* : The residual granite is regarded as pervious to impervious. The soil permeability coefficient varies between $2,7 \times 10^{-6} \text{cms}^{-1}$ to $5,0 \times 10^{-7} \text{cms}^{-1}$.

7.1.5(iii) Erosion Potential

All soil materials encountered during the investigation can be regarded as moderately to poorly resistant against erosion. The aspect of erosion potential is important in the area. It may be partially attributed to the low clay content of the soil materials. The net result of these

properties is poor founding conditions on the unconsolidated alluvial deposits and favourable founding conditions on thin horizons of colluvium soil.

7.2 Properties of Bedrock Granite

The TLB used to excavate the test pits did not penetrate bedrock to any significant extent and refusal of excavation occurred either within millimeters after encountering bedrock, or as very slow refusal of excavation in very dense residual granite sand tending to soft rock. 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.

Parametric calculations with Roclab software results for unweathered, moderately to widely jointed, hard rock to very hard rock as present in abundant outcrops on site, result in the following properties :

- Cohesion : 20,1MPa
- Friction Angle : 44°
- Tensile Strength : 0,38MPa
- Uni-axle Compressive Strength : 26,8MPa
- Young's Modulus : 55250,0 MPa

All which show a very sound rock.

7.3 Excavation Classification with Respect to Services

7.3.1 Hand Excavation

7.3.1(i) Colluvium and Alluvium

The colluvium and alluvium can be considered as suitable to be excavated by swing tools. However, especially in the alluvium and water courses the sidewalls of excavations can be prone to collapse.

7.3.1(ii) Pedocretic Deposits

Unconsolidated calcrete and calcretisation of the transported and residual soils usually contribute positively to the consistency of the in-situ materials, but cannot be regarded as pure pedocretic deposits per se. However, the nodular calcrete can be regarded as proper

pedocretes. The consistency of the nodular calcrete varies from medium dense to very dense. It will thus be possible to excavate the nodular calcrete initially with swing tools, but with an increase in consistency the provision of mechanical equipment will be required to remove it on an economical basis. For this purpose the minimum requirement will be the use of a 55kW TLB.

7.3.1(iii) *Residual Soils*

Residual granite is of medium dense to very dense consistency. In a condition of medium dense consistency it will be possible to excavate these materials manually ; in a state of dense consistency it will be possible to excavate it manually with considerable effort ; and if very dense, not at all and may as minimum require the use of a 55kW TLB. Even with such equipment, refusal of excavation (for all practical purposes) can be expected on the very dense residual granite tending to soft rock.

7.3.1(iv) *Bedrock*

Bedrock of granite 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* : Alluvium, colluvium and pedogenic deposits can be regarded as soft excavation. Residual granite can initially be regarded as soft excavation, with consistency thereof improving to very dense and gradually to weathered rock with depth. In the latter two conditions the presence of granitoid materials cannot be regarded as soft excavation anymore. Conditions of soft excavation were encountered in TP's 1 to 16, 18 to 24 and 26 to 35. The combined thickness of these strata varied between 150mm and 1900mm in the test pits, averaging 890mm prior to encountering conditions of intermediate or hard rock excavation.
- *Intermediate Excavation* : The presence of very dense residual soil and slightly weathered, medium hard rock, granite often resulted in conditions where very little progress in excavation was made with the TLB, resulting in extremely slow penetration through the granitoid materials. These conditions are regarded as intermediate excavation. Based on physical appearance and tactile conditions it was difficult to discern between the very dense residual soil and weathered granite and it remains an area of uncertainty. Conditions considered as intermediate excavation were encountered in TP's 1 to 16, 18 to 20, 22, 23,

26 to 28 and 31 to 34 from depths varying between 150mm and 1900mm minimum to 200mm and 2200mm maximum, averaging 150mm thick, prior to encountering hard rock excavation.

- *Hard Rock Excavation* : Refusal of excavation occurred in all the test pits. Three conditions are regarded as hard excavation :
 - Unweathered, very hard rock, granite resulting in virtually immediate refusal of excavation.
 - Slightly weathered, hard rock, granite resulting in very slow penetration indicating conditions of uneconomical excavation by the mechanical equipment used for the investigation.
 - Very dense, residual granite tending to medium hard rock resulting in very slow penetration indicating conditions of uneconomical excavation by mechanical equipment used for the investigation.

It is most likely that a 30 ton track mounted excavator will prove to be more suitable equipment for excavation than the 55kW TLB, achieving deeper levels of penetration prior to refusal. Be it as it may, refusal of excavation was encountered in all the test pits between depths of 50mm and 2200mm, averaging 970mm.

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.

7.3.3 Other Considerations

The site is characterized by the widely distributed of localized granite outcrops. Calculations show that some 48500m² comprising 9,7% of the land is covered by such outcrops. These conditions are illustrated on Figure 7 : Distribution of Rock Outcrops. It is important to realise that due to the mode of weathering of granite to corestones all of these areas cannot be regarded as hard rock excavation. This situation is illustrated by the profile of TP 24 located between closely spaced rock outcrops, but consists of 1500mm sand prior to encountering rock ; as well as TP 31 where variable conditions of excavation and rock levels were encountered in one test pit. Although a reliable indicator of the presence of boulders cannot be provided based on the available information, indications are that over and above the occurrence of hard rock excavation, Boulder Class A excavation must be expected.

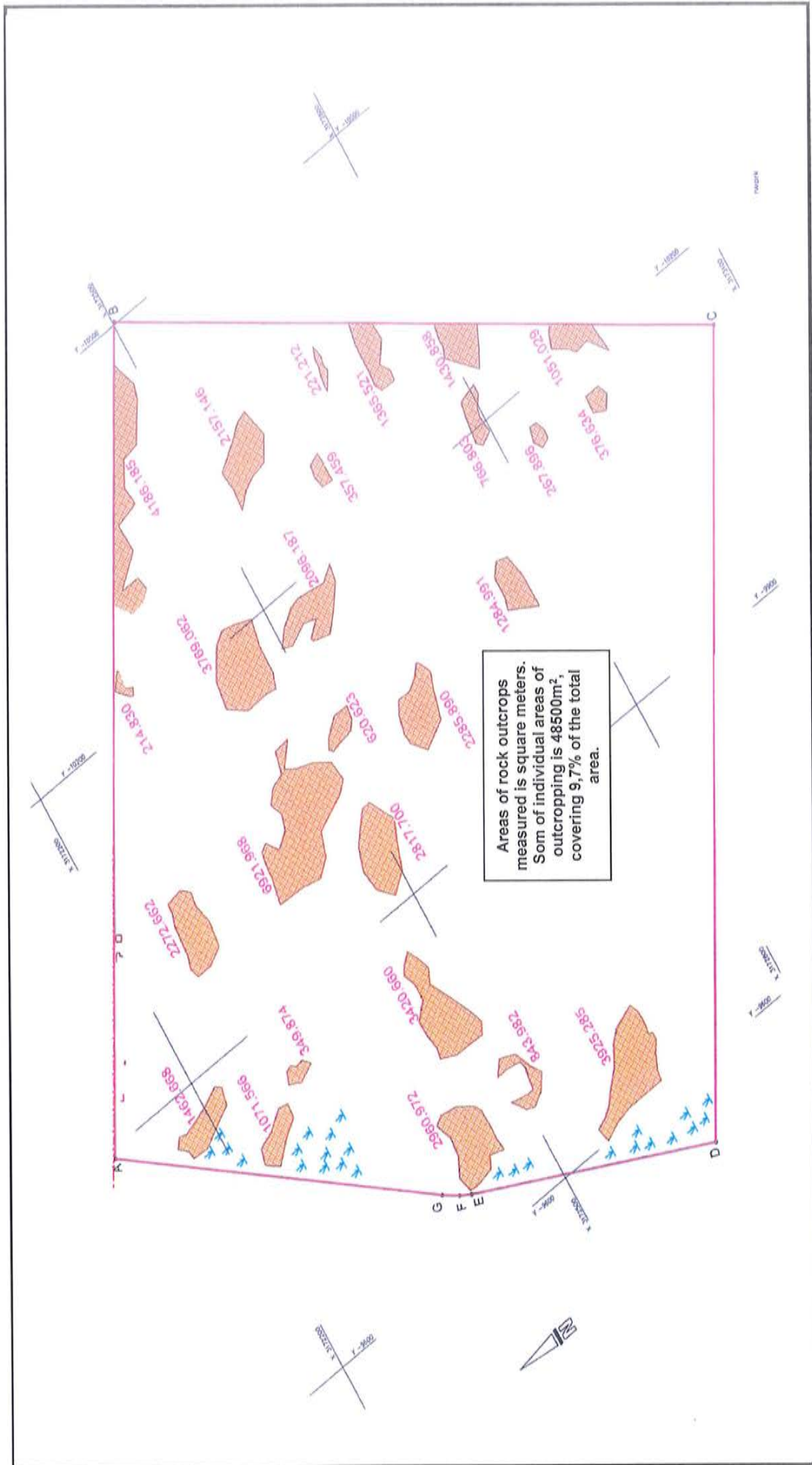


FIGURE 7

DISTRIBUTION OF ROCK OUTCROPS



7.4 Seismicity

7.4.1 Historical Seismic Data

An increase in the occurrence of tremors in the Kai !Garib was encountered up to late 2011. The Council of Geoscience was therefore appointed to compile a desktop study of the available information and to provide indications of the probability and intensity of tremors that may occur in the area. Such a report^{Reference 14.9} was made available on 25 July 2012.

The seismicity in the area is dominated by a cluster of seismic events. The events are of low to moderate magnitude with the highest having a magnitude of M_L 5,8 (M_L = Local Magnitude) which occurred on 21 February 1976. The largest events within the cluster near Augrabies were two M_L 4,9 earthquakes which occurred on 12 and 25 January 2011. Although Keimoes falls outside the cluster, it is within the sphere of influence.

The earliest recorded event in the area occurred in 1914 with a magnitude of M_L 3,0. Since then more than 1100 earthquakes have been recorded. Most of the events were recorded since 1979. The highest number of earthquakes was recorded in 2011 when 760 earthquakes were recorded within a swarm located in the in the Augrabies area. The earthquakes vary in magnitude from events of magnitude less than one to moderately sized events of which the largest had a magnitude M_L of 5,8. Most of the earthquakes had small magnitude values around 1,8.

Figure 2.2 from the report of the Council for Geoscience is reproduced here as Figure 8 : Historic Occurrences of Earthquakes in the Kai !Garib Area.

7.4.2 Site Specific Information

The closest source of seismic measurements to Plangeni under control of the Council for Geoscience is Tontelbos at $31^{\circ} 10' 12''S$ and $20' 30' 00''E$. Kijko^{Reference 14.10} indicates the following :

- 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 $10^{-3,8}$.
- A 10% probability exists that an earthquake with Peak Ground Acceleration exceeding of 0,07g may take place once in 50 years.

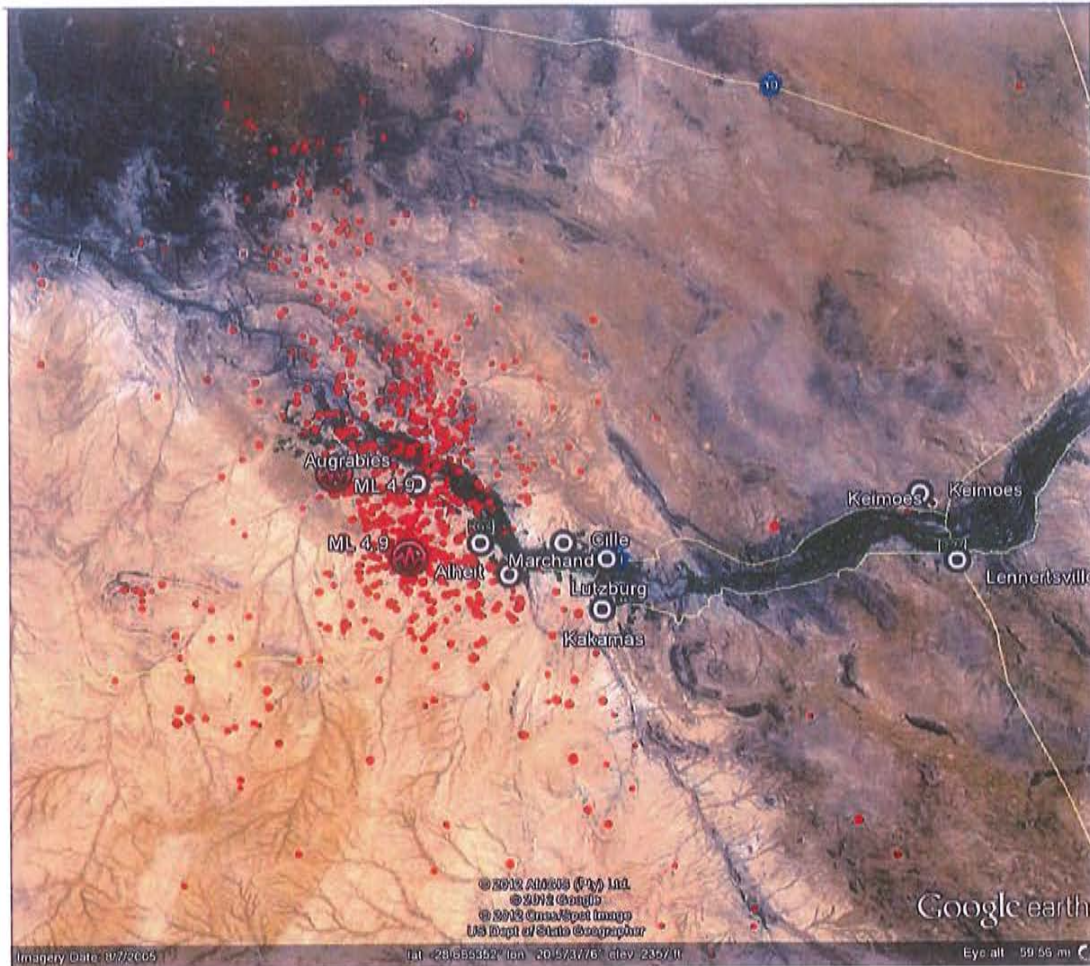


FIGURE 8 : HISTORIC OCCURRENCES OF EARTHQUAKES IN THE KAI IGARIB AREA

A 10% probability of an event with magnitude less than 100cms⁻² to take place once in 50 years is regarded as most favourable ; natural seismic activity with magnitude exceeding 100cms⁻² is regarded as unfavourable.

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

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.

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

8 DRAINAGE

On Figure 2 the presence of a network of drainage features are indicated. All these features consist of shallow (less than 500mm deep) sand filled features hosting non-perennial water courses. All the features drain westwards and the canal on the western limit of the site forms

a man-made obstacle, blocking flows from the drainage courses, resulting in areas of high soil moisture. These areas are indicated with blue arrows on the figure. The conditions are further detrimentally influenced by leakages from the canal.

The net result of the conditions is that although favourable natural founding conditions prevail as per the profiles of TP's 7, 21 and 22, conditions are detrimentally influenced by the presence of a man-made, artificial, high, temporary and cyclic perched water levels. During the time of investigation these gullies were dry, but enquiries with local specialists confirm that it is clear that these areas are subjected to the presence of temporary water seepage.

9 SITE CLASS DESIGNATIONS

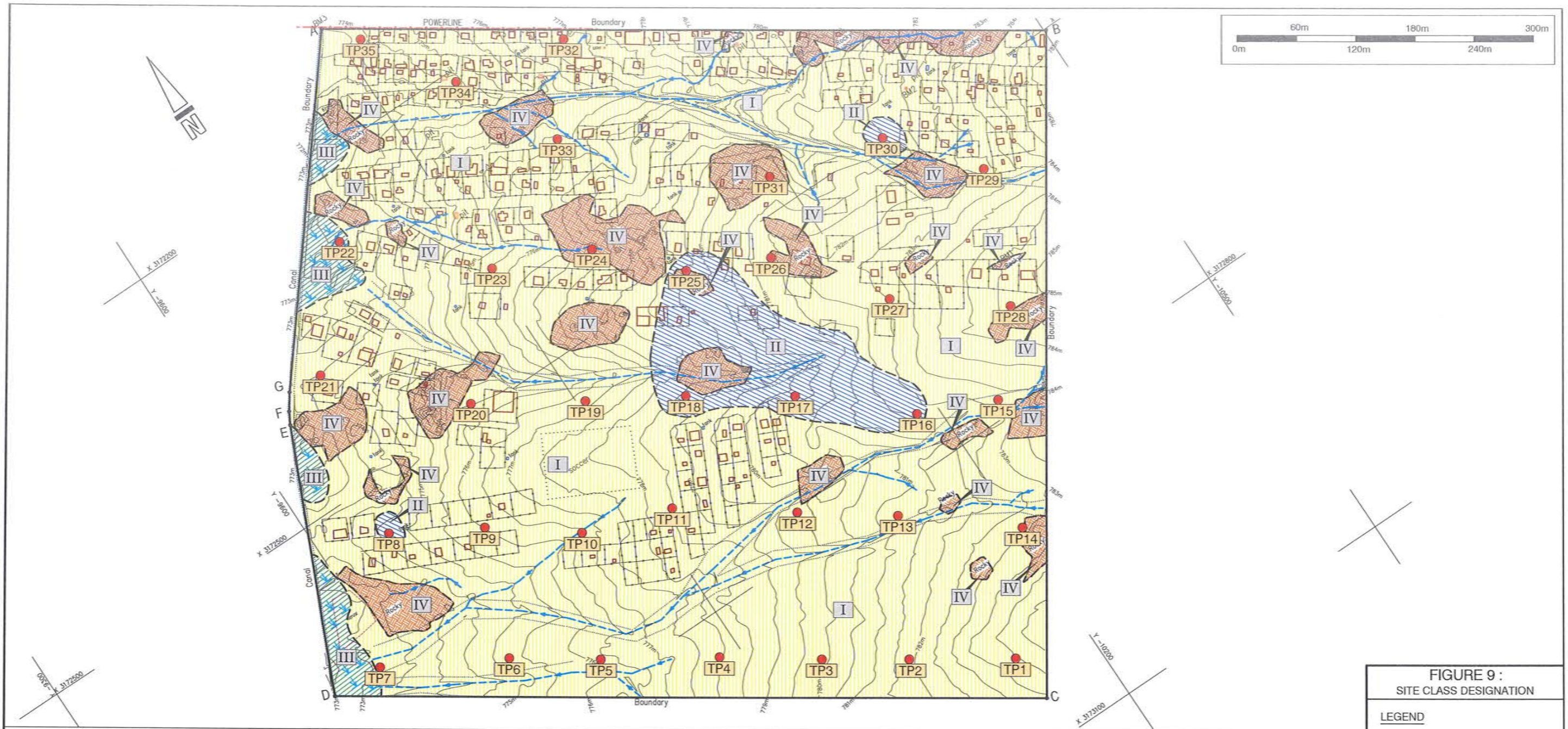
Based on the above discussions the property can be divided into seven zones characterized as follows as per the guidelines posted by SANS 10400 : Section H^{Reference 14.11} . The zonation is indicated on Figure 9 : Site Class Designation.

9.1 Geotechnical Zone I

This zone comprises 82,5% of the area investigated and covers the larger part of the site. It is characterized by the materials profiles of TP's 1 to 6, 9 to 15, 19 to 21, 23, 26 to 29 and 32 to 35. It consists of a horizon of colluvium less than 600mm thick overlying medium dense to very dense residual sand or nodular calcrete and at depth bedrock granite. Slope across the land is between 1,7% and 2,2%. 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 residual soil. As per the materials profile encountered in the test pits the combined thickness of the strata of nodular calcrete and residual soil 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.

9.2 Geotechnical Zone II

This zone comprises 5,4% of the area investigated and is present in three separate areas on site. It is characterized by the materials profiles of TP's 8, 16 to 18, 25 and 30. It consists of a superficial horizon of colluvium and residual soil less than 400mm thick overlying bedrock of granite. Slope across the land is less than 2,5%. 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. The area is thus zoned as "R" and regarded as stable.



**FIGURE 9 :
SITE CLASS DESIGNATION**

LEGEND

- TEST PIT POSITION
- ROCKY AREA
- MATERIAL BOUNDARY



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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
I	82,45	S	0mm to 10mm compression settlement	More than 400mm of colluvium or alluvium overlying medium dense to very dense nodular calcrete or residual granite	Normal	Normal strip foundations placed on medium dense residual granite or nodular calcrete Slab-on-the-ground foundations placed on medium dense to very dense residual granite or nodular calcrete	None	Favourable
II	5,48	R	Negligible	Less than 400mm of colluvium or alluvium overlying bedrock of granite	Normal	Normal strip foundations placed on bedrock of granite. Slab-on-the-ground foundations placed on bedrock of granite	Conditions of hard rock excavation	Intermediate
III	2,37	P(Water) alternatively	Undetermined	More than 400mm of colluvium or alluvium overlying medium dense to very dense nodular calcrete of residual granite	Not applicable	Reserve as public open space	Periodic flooding from non-perennial streams and artificial high ground water levels due to leakages from the canal	Poor
		S	0mm to 10mm compression settlement	More than 400mm of colluvium or alluvium overlying medium dense to very dense nodular calcrete of residual granite	Normal	Normal strip foundations placed on medium dense residual granite or nodular calcrete Slab-on-the-ground foundations placed on medium dense to very dense residual granite or nodular calcrete	The area can only be developed if measures can be implemented to eliminate the occurrence of seasonal flooding and seepage from leaking canal	Favourable
IV	9,70	P(Outcrops)	Highly variable	Corestones of granite contained in residual soil	Specifically designed for each individual house	The feasibility of developing each individual stand shall be determined on an economical and technical basis. All aspects of the structures shall be professionally designed. Alternative : Reserve as public open space	Conditions of boulder class A excavation. Conditions of hard rock excavation. Tension concentrations of strip foundations	Poor
			Negligible	Batholytic outcrops of very hard rock, granite	Specifically designed for each individual house	The feasibility of developing each individual stand shall be determined on an economical and technical basis. All aspects of the structures shall be professionally designed. Foundation design of slab-on-the-ground considered as preliminary proposal. Alternative : Reserve as public open space	Conditions of hard rock excavation	Poor

TASK: Plangeni Development
 JOB NAME:
 LIGGING SITE: Portion 30 of the Farm Blaauwskop 36
 CLIENT: Kai !Garib Municipality
 TEKENING NO: Figure 9 :
 DRAWING NO: Site Class Designation
 DATUM: 2 November 2020

9.3 Geotechnical Zone III

This zone comprises 2,4% of the area investigated. The zone is present in four separate areas along the western boundary of the property. It is characterized by the materials profiles of TP's 7 and 22. It consists of a horizon of transported sand less than 600mm thick overlying medium dense to very dense residual sand or nodular calcrete and at depth bedrock granite. Slope across the land is between 1,5% and 2,0%. 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 residual soil. As per the materials profile encountered in the test pits the combined thickness of the strata of nodular calcrete and residual soil is sufficient to dissipate the stresses induced by the foundations effectively.

However, the area is influenced by the periodic presence of water as discussed in Section 8 of this report. Potentially the area can be zoned as "S" and the materials strata can be regarded as compressible to a maximum of 10mm if the inundation of the area can be resolved. In the unresolved condition the area is zoned as "P(Water)" and conditions are regarded as unfavourable for residential development.

9.4 Geotechnical Zone IV

This zone comprises 9,7% of the area investigated. This zone is characterized by the numerous localized granite outcrops. It is important to realise that due to the mode of weathering of granite to corestones all of these areas cannot be regarded as a continuous presence of hard rock present as fairly level batholithic surfaces. This situation is illustrated by the profile of TP 24 located between closely spaced rock outcrops, but consists of 1500mm sand prior to encountering rock. In TP 31 variable conditions of excavation and rock levels were encountered in one test pit. On Photo 1 the two conditions can also be discerned. Picture 4 shows rock that was blasted from fairly level batholite occurrences, and Picture 5 shows the occurrence of corestones.

Potentially the areas can be zoned as R which can in principle be regarded as stable, but the highly undulating land surface due to the presence of boulders and outcrops detracts from the suitability thereof for residential development. The area is thus zoned as "P(Outcrops)".

10 FOUNDATION RECOMMENDATIONS AND SOLUTIONS

The foundation design alternatives and ancillary issues as discussed 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

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	82,5	S	0mm to 10mm compression settlement	More than 400mm of colluvium or alluvium overlying medium dense to very dense nodular calcrete or residual granite	Normal	Normal strip foundations placed on medium dense to very dense residual granite or nodular calcrete Slab-on-the-ground foundations placed on medium dense to very dense residual granite or nodular calcrete	None	Favourable
II	5,4	R	Negligible	Less than 400mm of colluvium or alluvium overlying bedrock of granite	Normal	Normal strip foundations placed on bedrock of granite Slab-on-the-ground foundations placed on bedrock of granite	Conditions of hard rock excavation	Intermediate
III	2,4	P(Water)	Undetermined	More than 400mm of colluvium or alluvium overlying medium dense to very dense nodular calcrete or residual granite	Not applicable	Reserve as public open space	Periodic flooding from non-perennial streams and artificial high ground water levels due to leakages from the canal	Poor
		alternatively S	0mm to 10mm compression settlement	More than 400mm of colluvium or alluvium overlying medium dense to very dense nodular calcrete or residual granite	Normal	Normal strip foundations placed on medium dense to very dense residual granite or nodular calcrete Slab-on-the-ground foundations placed on medium dense to very dense residual granite or nodular calcrete	The area can only be developed if measures can be implemented to eliminate the occurrence of seasonal flooding and seepage from the leaking canal.	Favourable
IV	9,7	P(Outcrops)	Highly variable	Corestones of granite contained in residual soil	Specifically designed for each individual house	The feasibility of developing each individual stand shall be determined on an economical and technical basis. All aspects of the structures shall be professionally designed. Alternative : Reserve as public open space.	Conditions of boulder class A excavation Conditions of hard rock excavation Tension concentrations in strip foundations	Poor
			Negligible	Batholytic outcrops of very hard rock, granite	Specifically designed for each individual house	The feasibility of developing each individual stand shall be determined on an economical and technical basis. All aspects of the structures shall be professionally designed. Foundation design of slab-on-the-ground considered as preliminary proposal. Alternative : Reserve as public open space.	Conditions of hard rock excavation	Poor

is used, the design must adhere strictly on the proposals of SANS 10400H. As geotechnical conditions favour the use of both 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.

10.1 Geotechnical Zone I

The zone is classed as S, meaning that less than 10mm of compression settlement may occur. Considering the limited slope across the land of approximately 2% only and the favourable geotechnical site classification as per Section 9 above, two foundation design alternatives are applicable to the zone.

The two options can be discussed as follows :

10.1.1 Strip Foundations

Foundations of 400mm wide placed directly on the medium dense to very dense residual granite or nodular 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.

10.1.2 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 to dense nodular calcrete or residual soil. 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.

10.2 Geotechnical Zone II

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 approximately 2% only and the favourable geotechnical site classification as per Section 9 above, two foundation design alternatives are applicable to the zone.

The two options can be discussed as follows :

10.2.1 Strip Foundations

Foundations of 400mm wide placed directly on bedrock of granite 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.

10.2.2 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 bedrock of granite. 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.

10.3 Geotechnical Zone III

Two scenarios must be considered for Geotechnical Zone III :

10.3.1 Prevailing Conditions

The prevailing conditions are defined by periodic inundation of the area by water of the non-perennial water courses ponding in the canal area limiting the disposal thereof. The condition is further exacerbated by seepage originating from leaks in the canal. These conditions may result in flooding of houses and damage to the structures caused by the combined influence of the high soluble salt content of the soil and the periodic flooding.

The conditions described above are not due to the natural environment, but of artificial origin. Should these conditions not be catered for, that is the leakages in the canal repaired and provision made for disposal of the ponding water, development shall not take place in the area. The provisional site class designation of P(Water) shall be maintained and the areas set aside as public open space.

10.3.2 Provision of Remedial Measures

Should remedial measures be implemented the four areas may be made available for residential development. Such remedial measures shall include features to prevent inundation of the areas and disposal of flood water from the water courses, as well as repairs to the canal. The issue at stake is which authority is responsible for such undertaking and who is responsible for maintenance of the canal.

In case the measures as mentioned above can be implemented successfully, a site class designation of "S" can be accepted, meaning that less than 10mm of compression settlement may occur. Slope across the land is between 1,5% and 2,0%. Considering the limited slope across the land and the favourable geotechnical site classification as per Section 9 above, two foundation design alternatives are applicable to the zone.

The two options can be discussed as follows :

10.3.2(i) Strip Foundations

Foundations of 400mm wide placed directly on the medium dense to very dense residual granite or nodular 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.

10.3.2(ii) 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 to dense nodular calcrete or residual soil. 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.

10.4 Geotechnical Zone IV

This zone poses a special set of problems. In principle founding of structures can take place in the area, but a careful technical appraisal should be made of individual erven to determine the feasibility of founding.

Problems that can be expected are the following :

10.4.1 Areas of Corestones

Expect conditions of Boulder Excavation Class A and difficult access due to the presence of surface boulders. Foundations will be subject to stress concentrations resulting in cracking of the superstructure if the foundations cannot accommodate the stress concentrations.

It is therefore recommended that each stand be considered individually and a decision made on the feasibility of utilisation. Foundations for structures shall be designed by a professional

engineer on an individual basis for each stand. The site classification of P(Rock Outcrops) is maintained and the development potential thereof is regarded as poor. Should it be considered as uneconomical to build on the stands, the areas should be set aside as public open space.

10.4.2 Batholithic Surfaces

These surfaces are present as fairly level areas of unweathered or lightly weathered granite spanning footprint areas of typical low cost houses. It may be possible to found under such conditions, but will require excavation of very hard rock.

To minimize excavations the solution of slab-on-the-ground foundations may be used for dwellings in area. Edge beams shall be placed directly on the rock. 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. However, professional advice shall be obtained regarding founding of the structures.

It is therefore recommended that each stand be considered individually and a decision made on the feasibility of utilisation. Foundations for structures shall be designed by a professional engineer on an individual basis for each stand. The site classification of P(Rock Outcrops) is maintained and the development potential thereof is regarded as poor. Should it be considered as uneconomical to build on the stands, the areas should be set aside as public open space.

11 SPECIAL PRECAUTIONARY MEASURES

Three issues that may impact the development of the site negatively need to be considered. These issues have been addressed in the applicable subsections of the report, but are highlighted here :

11.1 Soil Conductivity

The conductivity measurement of $0,15\text{Sm}^{-1}$ reported for samples of both the residual granite and the nodular calcrete is on the threshold^{Reference 14.12} of soluble salt contents that may result in problems as far as road construction is concerned. The occurrence of high soluble salt contents in soils is common in the Northern Cape and would not have raised any concern except that extensive damage to infrastructure occurs in an upmarket residential development close to Plangeni. Such damage consists of discoloring, lifting, and blistering of bituminous surfacing and disintegration of plastering on structures. One may speculate about the origin of

the high salt content, whether it can be related to paleo geological conditions, contaminated surface run-off from agricultural activities, or whether it originates from the chemical breakdown of bedrock granite or calcium carbonate in the form of amorphous nodules of calcrete, but it remains of academical interest.

On a preliminary basis the following is thus proposed :

11.1.1 Road Construction

- *Gravels Roads* : No precautionary measures need to be taken. In fact, the presence of a high soluble salt content may act as a dust palliative.
- *Paved Roads* : Should the material be used as stabilized base or subbase, it shall be treated with lime. The applicable lime content can be regarded as the minimum quantity required to maintain a minimum pH of 10 in laboratory testing. A better solution would be to design the access roads as concrete block pavement structures, which will have the additional benefit of providing employment opportunities for the local people.

11.1.2 Structures

Completely dry soils are considered to be non-aggressive towards concrete. Wet or damp soils may or may not be aggressive depending on the nature and concentration of water-soluble ions that are held in water in the pore spaces. The aggressiveness of soils depends therefore on the percentage and aggressiveness of the water present in the voids in the soil, and these may be subject to periodic fluctuations.

Because of the nearly static conditions that prevail at the soil-concrete interface of house foundations, Fulton^{Reference 14.13} proposes the chemical treatment of soils in this zone and it is feasible in some cases to reduce the corrosive potential of aggressive soils. This may be done by the addition of lime to backfilled soil around a concrete foundation. However, no guidelines are provided by the source neither are applicable fractions of treating agents mentioned.

11.1.3 Wet Services Installations

Although not common nowadays, the use of metallic pipes for water reticulation was practiced in the past. It is recommended that UPVC, PVC and Polycop pipes be used in this applicable applications. Even the use of metallic couplings must be avoided.

11.1.4 Additional Geotechnical Investigations

This geotechnical investigation determined that the possibility exist that damage may occur to pavements and structures caused by the soluble salt content of the soil, but can only be regarded providing a first indicator in this regard. The most authoritative publication^{Reference 14.14} in this regard proposes the following :

11.1.4(i) First Order Investigation

The investigation completed can be regarded as a first order investigation. The investigation identified the type of site and determined that ground conditions that may be aggressive to concrete prevail.

11.1.4(ii) Detailed Investigation

A detailed investigation shall be carried out to determine :

- Groundwater mobility (static, mobile, flowing).
- Concentrations of aggressive chemicals in soil and groundwater, including sulfates, sulfides, water-soluble magnesium and acids (indicators are pH, chloride and nitrate ions).

11.1.4(iii) Determine the Design Sulfate Class

Sulfate class determination is a five-level classification of sulfate concentration that is applied to individual series of tests on soil or groundwater. Separate sulfate classes may be derived from the characteristic values of sulfate determined from both water-extract sulfate tests and total potential sulfate tests on soil, and from sulfate tests on groundwater. The highest of the derived Sulphate classes is taken as the Design Sulphate Class for a location.

11/1/4(iv) Determine Aggressive Chemical Environment

The aggressive chemical environment for concrete class for the site is determined taking the Design Sulfate Class, type of site, water mobility and pH into account and produce a concrete specification and mix design suitable for the conditions.

11.2 Drainage

The issue of area-specific poor drainage has been discussed in Section 8 and Subsections 9.3 and 10.3 of this document. It must be stated without any ambiguity that these areas shall be kept as public open spaces if the drainage problems cannot be resolved in an engineered

and scientific way. Structures in Geotechnical Zone III especially may be subject to damage caused by soluble salt related properties if conditions of surface drainage are not attended to.

The natural non-perennial drainage channels on site are shallow and holds no obvious danger to the development of the area. However, a suitable distance, based on flood calculations shall be maintained between these channels and the stands.

11.3 Rock Outcrops

The potential effects of the rock outcrops on the development has been discussed in Subsections 9.4 and 10.4 of this report. The issue is that at the time of investigation several dwellings have already been erected on the granite outcrops. Cognizance must be taken of the difference between the solid rock outcrops and the presence of large corestones. Both occurrences result in specific problems for residential development. A decision must be made regarding the feasibility of development of such areas, considering the additional costs that will be incurred for hard rock excavation, boulder excavation and establishing services. The decision shall also include the human factor of relocating occupants from their existing houses.

12 CONCLUSIONS

The property is regarded as being of favourable to poor suitability for residential development. The factors that reduce the suitability of the land for development are :

- The presence of batholithic rock outcrops and large corestones close to the surface. The presence thereof will result in conditions of hard excavation and boulder excavation. While it is physically possible to establish housing units under these conditions, the decision to develop these areas shall be based on economical constraints.
- The presence of ponding in the area close to the canal. The ponding occurs due to the canal blocking the natural flow of the non-perennial water courses and is aggravated by seepage from leakages from the canal. The areas of ponding can only be utilized for erven and provision of housing if the drainage problems are solved.
- The residual soils and calcrete are highly corrosive. This is problematic in especially Geotechnical Zone III as the corrosive properties of soil are usually activated by the presence of interstitial water.

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 GFSSH-2)*, issued by the National Department of Housing in September 2002.

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	II	III (At present)	III (Rehabilitated)	IV (Boulders)	IV (Batholyte)
Site Class Designation				S	R	P(Water)	S	P(Outcrops)	P(Outcrops)
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						
Corrosive Soil ¹	Soil conductivity <0,01Sm ⁻¹ Soil pH >6	Soil conductivity <0,01Sm ⁻¹ to 0,05Sm ⁻¹ Soil pH 4,5 to 6	Soil conductivity > 0,05Sm ⁻¹ Soil pH <4,5						
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 Karoo 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						

Notes

1 This item is not included in GFSH-2. It is regarded as potential important to the development of Plangeni and recorded as a constraint.

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 Kakamas Terrane and the site is located on Kanoneiland granite of the Keimoes Suite that is intrusive into the terrane, as described by Moen. The granite is described as dark grey, speckled white rock with a high biotite content. The texture is coarse grained.

12.2 Soil Profile

12.2.1 Colluvium

Colluvial deposits are present as surface deposits in a surface horizon between 100mm to 600mm thick. It consists of pale light brown fine sands to coarse sand with contents of gravels and cobbles of granite or calcrete in variable proportions, but mostly matrix supported. The soil matrix is normally intact. The properties of the colluvium are thus such that it does not tend to excessive settlement, collapse or heave.

12.2.2 Alluvium

Alluvium is present as a surface horizon between 300mm and 1300mm thick. The distribution thereof is limited to the debris deposited by the non-perennial water courses bordering the canal. It consists of light brown, medium dense to very loose fine sands to coarse sand with matrix supported fine gravels of quartz and very weak calcareous cementing in variable proportions. Although the soil composition of the alluvium is such that it is not specially subject to settlement, it can be regarded as recent, unconsolidated deposits. Considering the vertical extent of the alluvial deposits, it is regarded as the soil material on site most subject to settlement.

12.2.3 Residual Granite

Residual granite underlies the colluvium and alluvium, occurring from depths between 100mm and 1300mm minimum, extending to 300mm to 1900mm maximum. The residual granite can be described as dirty white speckled dark grey varying to dark grey speckled white, micaceous or calcareous cemented, coarse sand containing fine gravels of quartz and cobbles of granite. The consistency of the residual granite varied between dense and very dense in the test pits. It can thus accommodate stresses imposed by conventional housing structures without undue settlement.

12.2.4 Pedogenic Deposits

- *Nodular Calcrete* : Nodular calcrete generally underlies the transported surface deposits. It was present between zero and 500mm deep minimum, extending to 300mm to 1300mm maximum. The nodular calcrete can be described as dirty white to grey white, rounded, fine to medium coarse, concretions contained in a matrix of fine sand, or as a cemented pedocrete. The consistency varies from medium dense to very dense. It can thus accommodate stresses imposed by conventional housing structures without undue settlement.
- *Unconsolidated Calcrete* : Unconsolidated calcrete underlies the transported surface deposits. It was present between 300mm and 900mm deep minimum, extending to 1100mm to 1300mm maximum. The unconsolidated powder calcrete can be described as dirty white, fine, calcareous sand. The consistency is medium dense. The properties of the powder calcrete are thus such that it does not tend to excessive settlement.

12.3 Groundwater

12.3.1 Perched Water

Perched groundwater was not encountered on site. Conditions are such that perched will generally not occur in the area.

12.3.2 Permanent Groundwater

Groundwater is expected to occur at depths between 20 meters and 30 meters in fractures restricted to a zone directly below the water table. The presence of permanent water has no influence on the geotechnical conditions on site.

12.4 Conditions of Excavation

On average over the entire site it is most likely that a 30 ton track mounted excavator will prove to be more suitable equipment for excavation than the 55kW TLB, achieving deeper levels of penetration prior to refusal. Refusal of excavation was encountered in all the test pits between depths of 50mm and 2200mm, averaging 970mm. The implication of this is that should trenches require excavated depths to 1000mm, 3% of the excavation may be classified as hard, requiring drilling and blasting. Should the required depth of excavation increase to 1500mm, 35% 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 that can be regarded as hard rock excavation that is highly variable as follows :

- Unweathered, very hard rock, granite resulting in virtually immediate refusal of excavation.
- Slightly weathered, hard rock, granite resulting in very slow penetration indicating conditions of uneconomical excavation by the mechanical equipment used for the investigation.
- Very dense, residual granite tending to medium hard rock resulting in very slow penetration indicating conditions of uneconomical excavation by mechanical equipment used for the investigation.

Conditions of Boulder Class A excavation could be identified in one test pit only, but should the presence of outcrops be taken into account, the volume of such excavation may be significant.

As for individual areas, the following is applicable :

12.4.1 Geotechnical Zone I

This zone is classified as S. Refusal of excavation was encountered in all the test pits between depths of 500mm and 1500mm, averaging 1050mm. The implication of this is that should trenches require excavated depths to 1000mm, zero of the excavation may be classified as hard, requiring drilling and blasting. Should the required depth of excavation increase to 1500mm, 30% of the excavation may be classified as hard.

12.4.2 Geotechnical Zone II

This zone is classified as R. Refusal of excavation was encountered in all the test pits between depths of 50mm and 400mm, averaging 225mm. The implication of this is that should trenches require excavated depths to 1000mm, 77,5% of the excavation may be classified as hard, requiring drilling and blasting. Should the required depth of excavation increase to 1500mm, 85% of the excavation may be classified as hard.

12.4.3 Geotechnical Zone III

In its present condition this zone is classified as P(Water). If remedial measures can be successfully applied to resolve the artificially created drainage problems a zonation of S is applicable. Refusal of excavation was encountered in all the test pits between depths of 1300mm and 2200mm, averaging 1750mm. The implication of this is that conditions of hard

rock excavation will not be encountered to trench depths of 1500mm. However, cognizance must be taken of the fact that in the present state conditions of wet excavation may be present.

12.4.4 Geotechnical Zone IV

This zone is classified as P(Outcrops). Minimal test pitting could be conducted in these areas. The test pitting conducted may not represent actual conditions due to the highly undulating rock profile as illustrated by the profile of TP 31. It is thus proposed on a preliminary basis to allow for 50% hard rock excavation and 50% boulder class A excavation in this zone.

12.5 Site Class Designation

12.5.1 Geotechnical Zone I

This zone comprises 82,5% of the area investigated and covers the larger part of the site. The soil profile consists of a horizon of colluvium less than 600mm thick overlying medium dense to very dense residual sand or nodular calcrete and at depth bedrock granite. Slope across the land is between 1,7% and 2,2%. As per the materials profile encountered in the test pits the combined thickness of the strata of nodular calcrete and residual soil 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.

12.5.2 Geotechnical Zone II

This zone comprises 5,4% of the area investigated and is present in three separate areas on site. The soil profile consists of a superficial horizon of colluvium and residual soil less than 400mm thick overlying bedrock of granite. Slope across the land is less than 2,5%. 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. The area is thus zoned as "R" and regarded as stable.

12.5.3 Geotechnical Zone III

This zone comprises 2,4% of the area investigated. The zone is present in four separate areas along the western boundary of the property. The profile consists of a horizon of transported sand less than 600mm thick overlying medium dense to very dense residual sand or nodular calcrete and at depth bedrock granite. Slope across the land is between 1,5% and 2,0%. As per the materials profile encountered in the test pits the combined thickness of the

strata of nodular calcrete and residual soil is sufficient to dissipate the stresses induced by the foundations effectively. However, the area is influenced by the periodic presence of water originating from blocking the natural water courses and seepage from the canal. Damage to structures by occur due to soil moisture triggering the corrosivity of the soil. Potentially the area can be zoned as "S" and the materials strata can be regarded as compressible to a maximum of 10mm if the inundation of the area can be resolved. In the unresolved condition the area is zoned as "P(Water)" and conditions are regarded as unfavourable for residential development.

12.5.4 Geotechnical Zone IV

This zone comprises 9,7% of the area investigated. This zone is characterized by the numerous localized granite outcrops. Such outcrops consist of areas of exposed corestones and areas of hard rock present as fairly level batholithic surfaces. Potentially the areas can be zoned as R which can in principle be regarded as stable, but the highly undulating land surface due to the presence of boulders and outcrops detracts from the suitability thereof for residential development. The area is thus zoned as "P(Outcrops)".

12.6 Land Slope

The average slope across the larger part of the land between 1,5% and 2,5%, but highly variable in Geotechnical Zone IV. The land lope does not detract from the development potential of the area.

No steep slopes are present on the property.

12.7 Areas Subject to Flooding

Blockages of the natural water courses occur on the western perimeter of the property close to the canal. The combination of such blocking and seepage from leakages of the canal results in periodical inundation of four areas close to the canal.

It is thus concluded that attention be given to the presence of these conditions as they may influence the future development of the area.

12.8 Materials Utilization

- *Trench Backfilling* : None of the materials are suitable for selected fill or pipe bedding. All materials can be used for normal backfill.

- *Layerworks for Paved or Segmental Block Paving* : The residual soils are suitable for the construction of in-situ selected and subbase for lightly trafficked streets.
- *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 0,07g. A low risk for the development of earth tremors therefore exist.
- *Soil Corrosivity* : The in-situ soils and pedocretes are highly corrosive due a high soluble salts content.
- *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 10 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.

The following is recommended :

- *Geotechnical Zones I and II* : In these zones where more than one alternative for foundation design is provided, the property developer can base his choice on financial constraints.
- *Geotechnical Zone III* : Unless remedial measures are put in place to ensure that flooding of the area does not occur, no development shall take place. If remedial measures can be applied successfully foundation and structural design suitable to accommodate 10mm time related settlement shall be provided for.
- *Geotechnical Zone IV* : In principle it is possible to build successfully in these rocky conditions, but it will come at a cost. It is recommended that these areas only be developed if the demand for houses exceed the availability of stands in Zones I and II. The conditions in each stand will have to be designed for on an individual basis.

13.2 Areas Subject to Flooding

13.2.1 Presence of Non-perennial Gullies

Five shallow non-perennial gully areas have been identified. Although these areas are not subject to continuous flooding, such events may result in damage to infrastructure if not designed for. It is recommended that the flood characteristics of these water courses be determined and a safe area between the future houses and the gullies maintained. Having stated this, it is recognized that a geotechnical document is not a guideline for hydraulic design for urban development.

13.2.2 Areas of Ponding

These areas are zoned separately as Geotechnical Zone III. The rehabilitation of these areas is not necessarily the responsibility of the local municipal authority or the property developer. Should it be necessary to locate erven in this zone, the land shall be rehabilitated to allow safe development thereof. Such rehabilitation shall consist of repairs of the leaks in the canal and providing sufficient channeling for the non-perennial streams to eliminate ponding in the canal area.

13.3 Materials Utilization

- *Trench Backfill* : The in-situ materials may be used for normal backfill of trenches. Material for pipe bedding and selected backfill shall be obtained from commercial sources.
- *Layerworks for Paved or Segmental Block Paving* : Material for base construction must be obtained from commercial sources. Depending on the pavement design, selected layerworks and subbase material may consist of in-situ derived soils. 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. Special attention must be paid to the chemical properties of the soils to avoid future damage caused by chemically aggressive materials.
- *Wearing Course for Gravel Roads in Urban Areas* : Material for the construction of a gravel wearing course may be sourced from the in-situ soils. However it is not the perfect material, but the "perfect" material for this purpose is very hard to obtain in the area.

13.4 Conditions of Excavation

Although manual excavation is possible through the colluvium and alluvium, and to some extent through the residual soil, 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 for the very dense pedocretes and residual granite need to be removed. It is recommended that adequate provision be made for hard rock and boulder class A excavation. In Geotechnical Zone III provision must be made for excavation in wet conditions. Workers in the trenches shall be protected against collapse by either reducing slopes of the excavations to 1(V) : 2(H) or the provision of shoring.

13.5 Corrosive Soil

The results of materials testing undertaken for this investigation indicate that all soil materials are highly to very highly corrosive. Potentially, this has an influence on pavement design, installation of wet services and house construction. However, the corrosive character of soil is only triggered by the presence of soil moisture, but the condition that soil moisture will never be present cannot be guaranteed.

The presence of different types of soluble salts result in different types of damage to infrastructure. It is therefore recommended that additional testing be conducted to identify the types of corrosive material present, be it sulfides, sulfates or chloride, and provide the correct protection against corrosion that may result due to the presence of these materials.

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FJ Breytenbach, Pr Eng (920166)
For Cedar Land Geotechnical Consult (Pty) Ltd

2 November 2020

**REPORT ON THE GEOTECHNICAL CONDITIONS
ON PORTION 30 OF PORTION 29 OF THE FARM
BLAAUWS KOP 36, DISTRICT KENHARDT**

2020/J011/MCP


ADDENDUM A: TEST PIT PROFILES







<p>TRIAL HOLE: 1</p> <p>PROJECT: PROPOSED PLANGENI DEVELOPMENT</p> <p>LOGGED BY: FJB</p> <p>SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36</p> <p>CLIENT: KAI !GARIP MUNICIPALITY</p> <p>DATE LOGGED: 7/10/2020</p> <p>LOCATION: 28°40'22,0" S 21°06'12,9" E</p>	<p><i>Cedar Land Geotechnical Consult (Pty) Ltd</i></p> <p>P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za</p>
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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				<p><u>NOTES:</u></p> <p>1 No seepage water encountered.</p> <p>2 Refusal of excavation at 1000 mm due to very slow penetration on medium hard rock, granite.</p>
0.20		Dry, pale light brown, medium dense, intact, coarse SAND and matrix supported, angular cobbles of granite. Colluvium.				
0.40		Dry, dirty white speckled dark grey, dense, micaceous, coarse SAND and matrix supported, angular cobbles of granite. Residual granite.				
0.60						
0.80						
1.00		Dirty white, speckled dark grey, massive, coarse grained, slightly weathered, micaceous, medium hard rock to hard rock, GRANITE.				<ul style="list-style-type: none"> ∇ Water encountered ↓ Water level ⊥ Bottom of hole - - - Approximate material change • Disturbed sample ■ Undisturbed sample
1.20						

<p>Contractor: ALS Plant Hire</p> <p>Date Drilled: 7/10/2020</p> <p>Machine: Bell 315SK</p>	<p>Hole Diameter: 600 mm</p> <p>Water Depth:</p> <p>Sheet: 1 of 1</p>
SOIL PROFILE: TEST PIT 1	FIGURE: A1

<p>TRIAL HOLE: 2</p> <p>PROJECT: PROPOSED PLANGENI DEVELOPMENT</p> <p>LOGGED BY: FJB</p> <p>SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36</p> <p>CLIENT: KAI !GARIP MUNICIPALITY</p> <p>DATE LOGGED: 7/10/2020</p> <p>LOCATION: 28°40'20,1" S 21°06'09,6" E</p>	<p><i>Cedar Land Geotechnical Consult (Pty) Ltd</i></p> <p>P O Box 607 Ceres 6835</p> <p>Cell: 082 570 2767</p> <p>Email: cedarland.frans@breede.co.za</p>
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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				<p><u>NOTES:</u></p> <p>1 No seepage water encountered.</p> <p>2 Refusal of excavation at 1200 mm due to very slow penetration on very dense, coarse sand.</p>
0.20		Dry, pale light brown, medium dense, intact, coarse SAND and matrix supported, angular cobbles of granite and dirty white, medium coarse, subangular and subrounded gravel sized calcrete concretions. Colluvium.				
0.40		Dry, dirty white speckled dark grey, dense, micaceous, coarse SAND and matrix supported, angular cobbles of granite. Residual granite.				
0.60						
0.80						
1.00						
1.20		Dry, dirty white, very dense, strongly calcareous cemented, coarse SAND. Residual granite.				

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

<p>Contractor: ALS Plant Hire</p> <p>Date Drilled: 7/10/2020</p> <p>Machine: Bell 315SK</p>	<p>Hole Diameter: 600 mm</p> <p>Water Depth:</p> <p>Sheet: 1 of 1</p>
SOIL PROFILE: TEST PIT 2	FIGURE: A2

TRIAL HOLE: 3

PROJECT: PROPOSED PLANGENI DEVELOPMENT

LOGGED BY: FJB

SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36

DATE LOGGED: 7/10/2020

CLIENT: KAI !GARIP MUNICIPALITY

LOCATION: 28°40'18,5" S 21°06'06,9" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607

Ceres

6835

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 No seepage water encountered. 2 Refusal of excavation at 1300 mm due to very slow penetration on medium hard rock, granite.
0.20		Dry, pale light brown, loose, intact, fine SAND and matrix supported, coarse, rounded gravel sized calcrete concretions. Colluvium.				
0.40		Dry, light brown mottled dirty white, dense, calcareous cemented, fine SAND with subvertical lenses (50 mm to 100 mm wide) of dirty white, speckled dark grey, overall well-graded, micaceous sand. Residual granite.				
0.60			U9427	0,3-1,1	●	
0.80						
1.00		Dirty white, speckled dark grey, massive, coarse grained, slightly weathered, micaceous, medium hard rock to hard rock, GRANITE.				
1.20						∇ Water encountered ▼ Water level ▬ Bottom of hole - - - Approximate material change ● Disturbed sample ■ Undisturbed sample
1.40						

Contractor: ALS Plant Hire

Date Drilled: 7/10/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

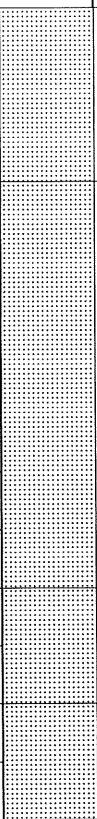






Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 3

FIGURE: A3

<p>TRIAL HOLE: 4</p> <p>PROJECT: PROPOSED PLANGENI DEVELOPMENT</p> <p>LOGGED BY: FJB</p> <p>SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36</p> <p>DATE LOGGED: 7/10/2020</p> <p>CLIENT: KAI IGARIP MUNICIPALITY</p> <p>LOCATION: 28°40'16,6" S 21°06'03,8" E</p>	<p><i>Cedar Land Geotechnical Consult (Pty) Ltd</i></p> <p>P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za</p>
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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				<p><u>NOTES:</u></p> <p>1 No seepage water encountered.</p> <p>2 Refusal of excavation at 1400 mm due to very slow penetration on very dense, coarse sand.</p>
0.20		Dry, pale light brown, loose, intact, fine SAND and matrix supported, coarse, rounded, gravel sized, calcrete concretions. Colluvium.				
0.40		Dry, light brown mottled dirty white, dense, calcareous cemented, fine SAND. Residual granite.				
0.60						
0.80						
1.00		Dry, dirty white speckled dark grey, dense, micaceous, coarse SAND and matrix supported, angular cobbles of granite. Residual granite.				<p>  Water encountered  Water level  Bottom of hole  Approximate material change  Disturbed sample  Undisturbed sample </p>
1.20	Dry, dirty white, very dense, strongly calcareous cemented, coarse SAND. Residual granite.					
1.40						
1.60						

<p>Contractor: ALS Plant Hire</p> <p>Date Drilled: 7/10/2020</p> <p>Machine: Bell 315SK</p>	<p>Hole Diameter: 600 mm</p> <p>Water Depth:</p> <p>Sheet: 1 of 1</p>
SOIL PROFILE: TEST PIT 4	FIGURE: A4

TRIAL HOLE: 5	<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: PROPOSED PLANGENI DEVELOPMENT	
LOGGED BY: FJB	
SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36	
DATE LOGGED: 7/10/2020	
CLIENT: KAI IGARIP MUNICIPALITY	
LOCATION: 28°40'14,5" S 21°06'00,1" E	

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 No seepage water encountered. 2 Refusal of excavation at 600 mm due to very slow penetration on medium hard rock, granite.
0.20		Dry, pale light brown, medium dense, intact, coarse SAND and matrix supported, angular cobbles of granite. Colluvium.				
0.40		Dry, light grey brown, medium dense, micaceous SAND and matrix supported, coarse, angular gravels of granite. Residual granite.				
0.60		Dirty white, speckled dark grey, massive, coarse grained, slightly weathered, micaceous, medium hard rock to hard rock, GRANITE.				
0.80						√ Water encountered ↓ Water level ▾ Bottom of hole --- Approximate material change • Disturbed sample ■ Undisturbed sample
1.00						

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

<p>TRIAL HOLE: 6</p> <p>PROJECT: PROPOSED PLANGENI DEVELOPMENT</p> <p>LOGGED BY: FJB</p> <p>SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36</p> <p>DATE LOGGED: 7/10/2020</p> <p>CLIENT: KAI IGARIP MUNICIPALITY</p> <p>LOCATION: 28°40'12,8" S 21°05'57,3" E</p>	<p><i>Cedar Land Geotechnical Consult (Pty) Ltd</i></p> <p>P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za</p>
--	--

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				<p><u>NOTES:</u></p> <p>1 No seepage water encountered.</p> <p>2 Refusal of excavation at 800 mm due to very slow penetration on medium hard rock, granite.</p>
0.20		Dry, pale light brown, medium dense, intact, coarse SAND and matrix supported, angular cobbles of granite. Colluvium.				
0.40		Dry, pale light grey brown, medium dense, calcareous cemented SAND and matrix supported, coarse, angular gravels of granite. Residual granite.				
0.60		Dirty white, speckled dark grey, massive, coarse grained, slightly weathered, micaceous, medium hard rock to hard rock, GRANITE.	U9428	0,2-0,8		
0.80						
1.00						

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

<p>Contractor: ALS Plant Hire</p> <p>Date Drilled: 7/10/2020</p> <p>Machine: Bell 315SK</p>	<p>Hole Diameter: 600 mm</p> <p>Water Depth:</p> <p>Sheet: 1 of 1</p>
SOIL PROFILE: TEST PIT 6	FIGURE: A6

TRIAL HOLE: 7	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i>
PROJECT: PROPOSED PLANGENI DEVELOPMENT	P O Box 607
LOGGED BY: FJB	Ceres
SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36	6835
	Cell: 082 570 2767
	Email:
CLIENT: KAI !GARIP MUNICIPALITY	cedarland.frans@breede.co.za
DATE LOGGED: 7/10/2020	
LOCATION: 28°40'10,7" S 21°05'53,1" E	

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 No seepage water encountered. 2 Refusal of excavation at 2200 mm due to very slow penetration on medium hard rock, granite.
0.20		Dry, light brown, very loose, intact, fine SAND. Alluvium. Tree roots are present in the horizon.				
0.40						
0.60						
0.80		Dry, pale light grey brown mottled white, medium dense, intact, fine SAND and matrix supported, fine, gravel sized, rounded calcrete concretions. Alluvium. Tree roots are present in the horizon.				
1.00						
1.20						
1.40		Dry, dirty white speckled dark grey, dense, micaceous, coarse SAND and matrix supported, angular cobbles of granite. Residual granite.				
1.60						
1.80						
2.00		Dirty white, speckled dark grey, massive, coarse grained, slightly weathered, micaceous, medium hard rock to hard rock, GRANITE.				
2.20						
2.40						

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

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 7/10/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1
SOIL PROFILE: TEST PIT 7	FIGURE: A7

TRIAL HOLE: 8

PROJECT: PROPOSED PLANGENI DEVELOPMENT

LOGGED BY: FJB

SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36

DATE LOGGED: 7/10/2020

CLIENT: KAI IGARIP MUNICIPALITY

LOCATION: 28°40'07,2" S 21°05'56,1" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607

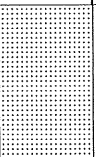


Ceres







6835

Cell: 082 570 2767

Email:

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 No seepage water encountered. 2 Refusal of excavation at 350 mm due to very slow penetration on hard rock, granite.
		Dry, pale light brown, medium dense, intact, coarse SAND and matrix supported, angular cobbles of granite. Colluvium.				
0.20		Dry, dirty white speckled dark grey, dense, micaceous, coarse SAND and matrix supported, angular cobbles of granite. Residual granite.				
		Dirty white, speckled dark grey, massive, coarse grained, slightly weathered, micaceous, hard rock, GRANITE.				
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: 7/10/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

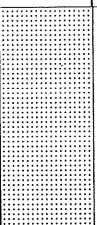
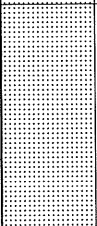
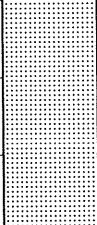

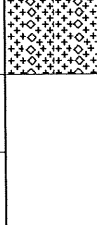







Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 8

FIGURE: A8

TRIAL HOLE: 9	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i>
PROJECT: PROPOSED PLANGENI DEVELOPMENT	P O Box 607
LOGGED BY: FJB	Ceres
SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36	6835
DATE LOGGED: 7/10/2020	Cell: 082 570 2767
CLIENT: KAI !GARIP MUNICIPALITY	Email: cedarland.frans@breede.co.za
LOCATION: 28°40'08,8" S 21°05'59,2" E	

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 No seepage water encountered. 2 Refusal of excavation at 1000 mm due to very slow penetration on medium hard rock, granite.
0.20		Dry, pale light brown, medium dense, intact, coarse SAND and matrix supported, angular cobbles of granite. Colluvium.				
0.40		Dry, dirty white speckled dark grey, dense, micaceous, coarse SAND and matrix supported, angular cobbles of granite. Residual granite.				
0.60			U9429	0,3-0,9		
0.80						
1.00		Dirty white, speckled dark grey, massive, coarse grained, slightly weathered, micaceous, medium hard rock to hard rock, GRANITE.				 Water encountered  Water level  Bottom of hole  Approximate material change  Disturbed sample  Undisturbed sample
1.20						

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 7/10/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1
SOIL PROFILE: TEST PIT 9	FIGURE: A9

TRIAL HOLE: 10

PROJECT: PROPOSED PLANGENI DEVELOPMENT

LOGGED BY: FJB

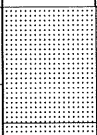
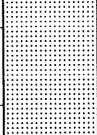
SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36







DATE LOGGED: 7/10/2020

CLIENT: KAI !GARIP MUNICIPALITY

LOCATION: 28°40'10,7" S 21°06'02,1" E

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Consult (Pty) Ltd*
P O Box 607
Ceres
6835
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 No seepage water encountered. 2 Refusal of excavation at 500 mm due to very slow penetration on medium hard rock, granite.
0.20		Dry, pale light brown, loose, intact, fine SAND with matrix supported, fine, rounded quartz gravels and medium coarse, subangular gravels of banded ironstone and coarse, angular gravels of granite. Colluvium.				
0.40		Dry, dirty white speckled dark grey, dense, relic jointed and calcareous cemented, coarse SAND and matrix supported, angular cobbles of granite. Residual granite.				
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: 7/10/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 10

FIGURE: A10

TRIAL HOLE: 11

PROJECT: PROPOSED PLANGENI DEVELOPMENT

LOGGED BY: FJB

SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36

DATE LOGGED: 7/10/2020

CLIENT: KAI IGARIP MUNICIPALITY

LOCATION: 28°40'11,7" S 21°06'05,4" E

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P O Box 607

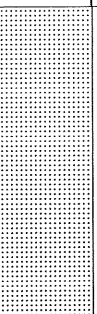
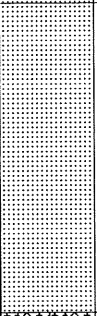

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 No seepage water encountered. 2 Refusal of excavation at 900 mm on hard rock, granite.
0.20		Dry, light brown, loose, intact, fine SAND with matrix supported, fine to medium coarse, rounded, gravel sized, calcrete concretions. Colluvium.				
0.40		Dry, dark grey mottled dirty white, very dense, coarse, micaceous SAND tending to clast supported, fine, subangular gravels of quartz. Residual granite.				
0.80		Dark grey brown speckled white, massive, very coarse grained, slightly weathered, micaceous, hard rock, GRANITE.				
1.00						∇ Water encountered ↓ Water level ▾ Bottom of hole --- Approximate material change • Disturbed sample ■ Undisturbed sample
1.20						

Contractor: ALS Plant Hire

Date Drilled: 7/10/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 11

FIGURE: A11

TRIAL HOLE: 12

PROJECT: PROPOSED PLANGENI DEVELOPMENT

LOGGED BY: FJB

SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36

DATE LOGGED: 7/10/2020

CLIENT: KAI IGARIP MUNICIPALITY

LOCATION: 28°40'14,1" S 21°06'09,2" E

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Consult (Pty) Ltd

P O Box 607

Ceres

6835

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 No seepage water encountered. 2 Refusal of excavation at 1300 mm due to very slow penetration on medium hard rock, granite.
		Dry, pale light brown, medium dense, intact, coarse SAND and matrix supported, angular cobbles of granite. Colluvium.				
0.20		Dry, light grey and light brown mottled white, very dense, calcrete cemented, micaceous gravelly SAND. Residual granite.				
0.40						
0.60			U9430	0,1-1,1	●	
0.80						
1.00						
1.20		Dirty white, speckled dark grey, massive, coarse grained, slightly weathered, micaceous, medium hard rock to hard rock, GRANITE.				√ Water encountered ↓ Water level ▾ Bottom of hole - - - Approximate material change ● Disturbed sample ■ Undisturbed sample
1.40						

Contractor: ALS Plant Hire

Date Drilled: 7/10/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 12

FIGURE: A12

TRIAL HOLE: 13

PROJECT: PROPOSED PLANGENI DEVELOPMENT

LOGGED BY: FJB

SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36

DATE LOGGED: 7/10/2020

CLIENT: KAI IGARIP MUNICIPALITY

LOCATION: 28°40'16,0" S 21°06'12,2" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607

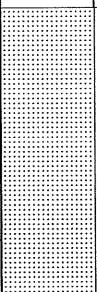

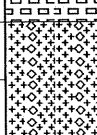
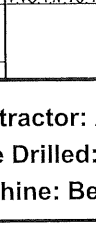
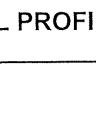


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Email:

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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				<p><u>NOTES:</u></p> <p>1 No seepage water encountered.</p> <p>2 Refusal of excavation at 1500 mm due to very slow penetration on medium hard rock, granite.</p>
0.20		Dry, light brown, very loose, intact, fine SAND and matrix supported, fine, rounded gravels of quartz. Alluvium.				
0.40		Light grey white, fine to medium coarse, rounded and subrounded, gravel sized, very dense, nodules of CALCRETE. Pedogenic deposits.				
0.60						<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>
0.80						
1.00						
1.20						
1.40		Dirty white, speckled dark grey, massive, coarse grained, slightly weathered, micaceous, medium hard rock to hard rock, GRANITE.				
1.60						

Contractor: ALS Plant Hire

Date Drilled: 7/10/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

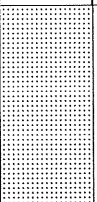
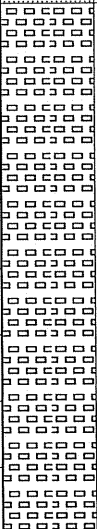

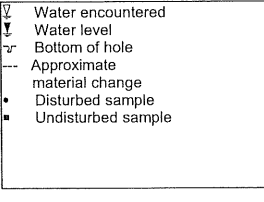





Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 13

FIGURE: A13

TRIAL HOLE: 14		<i>Cedar Land Geotechnical Consult (Pty) Ltd</i>
PROJECT: PROPOSED PLANGENI DEVELOPMENT		P O Box 607
LOGGED BY: FJB		Ceres
SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36		6835
DATE LOGGED: 7/10/2020		Cell: 082 570 2767
CLIENT: KAI IGARIP MUNICIPALITY		Email: cedarland.frans@breede.co.za
LOCATION: 28°40'18,6" S 21°06'15,8" E		

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 No seepage water encountered. 2 Refusal of excavation at 1200 mm due to very slow penetration on medium hard rock, granite.
0.20		Dry, light brown, very loose, intact, fine SAND and matrix supported, fine, rounded gravels of quartz. Alluvium.				
0.40		Light grey white, fine to medium coarse, rounded and subrounded, gravel sized, medium dense, nodules of CALCRETE. Pedogenic deposits.				
0.60						
0.80						
1.00						
1.20		Dirty white, speckled dark grey, massive, coarse grained, slightly weathered, micaceous, medium hard rock to hard rock, GRANITE.				 <ul style="list-style-type: none">  Water level  Bottom of hole  Approximate material change  Disturbed sample  Undisturbed sample
1.40						



Contractor: ALS Plant Hire Date Drilled: 7/10/2020 Machine: Bell 315SK	Hole Diameter: 600 mm Water Depth: Sheet: 1 of 1
SOIL PROFILE: TEST PIT 14	FIGURE: A14

TRIAL HOLE: 15	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i>
PROJECT: PROPOSED PLANGENI DEVELOPMENT	P O Box 607
LOGGED BY: FJB	Ceres
SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36	6835
	Cell: 082 570 2767
DATE LOGGED: 7/10/2020	Email:
CLIENT: KAI IGARIP MUNICIPALITY	cedarland.frans@breede.co.za
LOCATION: 28°40'14,7" S 21°06'17,7" E	

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 No seepage water encountered. 2 Refusal of excavation at 1400 mm due to very slow penetration on medium hard rock, granite.
0.20		Dry, light brown, very loose, fine SAND. Alluvium. Tree roots are present in the horizon.	U9431	0-0,6		
0.40						
0.60		Dry, light brown, very loose, intact, fine SAND and matrix supported, fine, rounded gravels of quartz. Alluvium.				
0.80		Dry, dark grey brown speckled white, very dense, coarse, micaceous SAND. Residual granite.				
1.00						
1.20		Dirty white, speckled dark grey, massive, coarse grained, slightly weathered, micaceous, medium hard rock to hard rock, GRANITE.				
1.40						
1.60						

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 7/10/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1
SOIL PROFILE: TEST PIT 15	FIGURE: A15


TRIAL HOLE: 16	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i>
PROJECT: PROPOSED PLANGENI DEVELOPMENT	P O Box 607
LOGGED BY: FJB	Ceres
SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36	6835
	Cell: 082 570 2767
DATE LOGGED: 7/10/2020	Email:
CLIENT: KAI IGARIP MUNICIPALITY	cedarland.frans@breede.co.za
LOCATION: 28°40'13,6" S 21°06'14,9" E	







Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 No seepage water encountered. 2 Refusal of excavation at 200 mm on hard rock, granite.
		Dry, pale light brown, medium dense, intact, coarse SAND and matrix supported, angular cobbles of granite. Colluvium.				
0.20		Dark grey brown speckled white, massive, very coarse grained, slightly weathered, micaceous, hard rock, GRANITE.				
0.40						
0.60						
0.80						

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

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

TRIAL HOLE: 17	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i>
PROJECT: PROPOSED PLANGENI DEVELOPMENT	P O Box 607
LOGGED BY: FJB	Ceres
SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36	6835
	Cell: 082 570 2767
DATE LOGGED: 7/10/2020	Email:
CLIENT: KAI IGARIP MUNICIPALITY	cedarland.frans@breede.co.za
LOCATION: 28°40'10,9" S 21°06'11,5" E	

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface Dark grey brown speckled white, massive, very coarse grained, slightly weathered, micaceous, very hard rock, <i>GRANITE</i> . Rock outcrop.				NOTES: 1 No seepage water encountered. 2 Refusal of excavation at 50 mm on very hard rock, granite.
0.20						
0.40						
0.60						
0.80						

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

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 7/10/2020	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</i>
PROJECT: PROPOSED PLANGENI DEVELOPMENT	P O Box 607
LOGGED BY: FJB	Ceres
SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36	6835
	Cell: 082 570 2767
	Email: cedarland.frans@breede.co.za
CLIENT: KAI IGARIP MUNICIPALITY	
DATE LOGGED: 7/10/2020	
LOCATION: 28°40'08,9" S 21°06'08,1" E	

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 No seepage water encountered. 2 Refusal of excavation at 400 mm due to very slow penetration on medium hard rock, granite.
0.20		Abundant, clast supported, fine, gravel sized, nodules of <i>CALCRETE</i> in a matrix of dry, fine, light brown sand. Overall consistency is medium dense. Pedogenic deposits.				
0.40		Dirty white, speckled dark grey, massive, coarse grained, slightly weathered, micaceous, medium hard rock to hard rock, <i>GRANITE</i> .	U9432	0-0.4		
0.60						
0.80						

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

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 7/10/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1
SOIL PROFILE: TEST PIT 18	FIGURE: A18

<p>TRIAL HOLE: 19</p> <p>PROJECT: PROPOSED PLANGENI DEVELOPMENT</p> <p>LOGGED BY: FJB</p> <p>SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36</p> <p>DATE LOGGED: 7/10/2020</p> <p>CLIENT: KAI IGARIP MUNICIPALITY</p> <p>LOCATION: 28°40'07,2" S 21°06'04,9" E</p>	<p><i>Cedar Land Geotechnical Consult (Pty) Ltd</i></p> <p>P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za</p>
---	--

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				<p><u>NOTES:</u></p> <p>1 No seepage water encountered.</p> <p>2 Refusal of excavation at 1400 mm due to very slow penetration on medium hard rock, granite.</p>
0.20		Dry, pale light brown, medium dense, intact, coarse SAND and matrix supported, angular cobbles of granite. Colluvium.				
0.40		Dry, dirty white speckled dark grey, dense, micaceous, coarse SAND and matrix supported, angular cobbles of granite. Residual granite.				
0.60		Dry, dull light red, medium dense, fine, calcareous SAND. Unconsolidated pedogenic deposits.				
0.80		Dry, dirty white speckled dark grey, dense, micaceous, coarse SAND and matrix supported, angular cobbles of granite. Residual granite.				
1.00		Dry, dull light red, medium dense, fine, calcareous SAND. Unconsolidated pedogenic deposits.				
1.20		Dirty white, speckled dark grey, massive, coarse grained, slightly weathered, micaceous, medium hard rock to hard rock, GRANITE.				
1.40						<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>
1.60						

<p>Contractor: ALS Plant Hire</p> <p>Date Drilled: 7/10/2020</p> <p>Machine: Bell 315SK</p>	<p>Hole Diameter: 600 mm</p> <p>Water Depth:</p> <p>Sheet: 1 of 1</p>
SOIL PROFILE: TEST PIT 19	FIGURE: A19

TRIAL HOLE: 20

PROJECT: PROPOSED PLANGENI DEVELOPMENT

LOGGED BY: FJB

SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36

DATE LOGGED: 7/10/2020

CLIENT: KAI IGARIP MUNICIPALITY

LOCATION: 28°40'05,2" S 21°06'01,3" E

*Cedar Land Geotechnical
Consult (Pty) Ltd*
P O Box 607
Ceres
6835
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				<p><u>NOTES:</u></p> <p>1 No seepage water encountered.</p> <p>2 Refusal of excavation at 1300 mm due to very slow penetration on medium hard rock, granite.</p>
0.20		Dry, pale light brown, medium dense, intact, coarse SAND and matrix supported, angular cobbles of granite. Colluvium.				
0.40		Dry, dirty white speckled dark grey, dense, micaceous, coarse SAND and matrix supported, angular cobbles of granite. Residual granite.				
0.60						
0.80						
1.00						
1.20		Dirty white, speckled dark grey, massive, coarse grained, slightly weathered, micaceous, medium hard rock to hard rock, GRANITE.				
1.40						
1.60						

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




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

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







SOIL PROFILE: TEST PIT 20

FIGURE: A20

TRIAL HOLE: 21	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i>
PROJECT: PROPOSED PLANGENI DEVELOPMENT	P O Box 607
LOGGED BY: FJB	Ceres
SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36	6835
	Cell: 082 570 2767
DATE LOGGED: 7/10/2020	Email:
CLIENT: KAI IGARIP MUNICIPALITY	cedarland.frans@breede.co.za
LOCATION: 28°40'01,7" S 21°05'57,2" E	

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 No seepage water encountered. 2 Refusal of excavation at 650 mm on very hard rock, granite.
0.20		Dry, dull light brown, medium dense, intact, fine SAND and matrix supported, fine, subrounded, gravel sized, calcrete concretions. Overall well-graded, gravelly sand. Colluvium.	U9433	0-0,6		
0.40						
0.60		Dark grey brown speckled white, massive, very coarse grained, unweathered, micaceous, very hard rock, GRANITE.				
0.80						
1.00						

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 7/10/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1
SOIL PROFILE: TEST PIT 21	FIGURE: A21




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

TRIAL HOLE: 22	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i>
PROJECT: PROPOSED PLANGENI DEVELOPMENT	P O Box 607
LOGGED BY: FJB	Ceres
SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36	6835
	Cell: 082 570 2767
DATE LOGGED: 7/10/2020	Email:
CLIENT: KAI !GARIP MUNICIPALITY	cedarland.frans@breede.co.za
LOCATION: 28°39'58,4" S 21°06'00,5" E	

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 No seepage water encountered. 2 Refusal of excavation at 1300 mm due to very slow penetration on medium hard rock, granite.
0.20		Dry, pale light brown, medium dense, intact, coarse SAND and matrix supported, angular cobbles of granite. Colluvium.				
0.40		Dry, dirty white speckled dark grey, dense, micaceous, coarse SAND and matrix supported, angular cobbles of granite and lenses of light brown, fine sand (<100mm wide) and calcareous, fine sand (<50mm wide). Residual granite.				
0.60						
0.80						
1.00						
1.20		Dirty white, speckled dark grey, massive, coarse grained, slightly weathered, micaceous, medium hard rock to hard rock, GRANITE.				
1.40						▽ Water encountered ▼ Water level ▽ Bottom of hole --- Approximate material change • Disturbed sample ■ Undisturbed sample
1.60						

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 7/10/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1
SOIL PROFILE: TEST PIT 22	FIGURE: A22

TRIAL HOLE: 23	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i>
PROJECT: PROPOSED PLANGENI DEVELOPMENT	P O Box 607
LOGGED BY: FJB	Ceres
SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36	6835
	Cell: 082 570 2767
	Email:
CLIENT: KAI IGARIP MUNICIPALITY	cedarland.frans@breede.co.za
LOCATION: 28°40'01,9" S 21°06'04,7" E	

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 No seepage water encountered. 2 Refusal of excavation at 700 mm due to very slow penetration on medium hard rock, granite.
0.20		Dry, pale light brown, medium dense, intact, coarse SAND and matrix supported, angular cobbles of granite. Colluvium.				
0.40		Abundant, clast supported, angular COBBLES of granite in a matrix of dry, dirty white, fine, gravel sized, calcareous concretions. Overall consistency is very dense. Residual granite.				
0.60		Dirty white, speckled dark grey, massive, coarse grained, slightly weathered, micaceous, medium hard rock to hard rock, GRANITE.				
0.80						
1.00						
1.20						
1.40						
1.60						

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 7/10/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1
SOIL PROFILE: TEST PIT 23	FIGURE: A23

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

<p style="text-align: center;">TRIAL HOLE: 24</p> <p>PROJECT: PROPOSED PLANGENI DEVELOPMENT</p> <p style="text-align: center;">LOGGED BY: FJB</p> <p>SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36</p> <p style="text-align: center;">DATE LOGGED: 7/10/2020</p> <p>CLIENT: KAI IGARIP MUNICIPALITY</p> <p style="text-align: center;">LOCATION: 28°40'03,2" S 21°06'08,2" E</p>	<p style="text-align: center;"><i>Cedar Land Geotechnical Consult (Pty) Ltd</i></p> <p style="text-align: center;">P O Box 607 Ceres 6835</p> <p style="text-align: center;">Cell: 082 570 2767</p> <p style="text-align: center;">Email: cedarland.frans@breede.co.za</p>
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Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 No seepage water encountered. 2 Refusal of excavation at 1500 mm due to very slow penetration on very dense, calcareous sand with calcareous concretions.
0.20		Dry, pale light brown, very loose, intact, fine SAND. Alluvium.				
0.40		Dry, dirty white, medium dense, calcareous cemented, fine SAND. Overall well-graded sand. Unconsolidated pedogenic deposits.				
0.80			U9434	0,3-1,3	●	
1.00						
1.20						
1.40		Dry, dirty white, very dense, calcareous, fine SAND and matrix supported, fine, subrounded calcareous concretions. Pedogenic deposits.				√ Water encountered ↓ Water level ▾ Bottom of hole --- Approximate material change ● Disturbed sample ■ Undisturbed sample
1.60						

<p>Contractor: ALS Plant Hire</p> <p>Date Drilled: 7/10/2020</p> <p>Machine: Bell 315SK</p>	<p>Hole Diameter: 600 mm</p> <p>Water Depth:</p> <p>Sheet: 1 of 1</p>
SOIL PROFILE: TEST PIT 24	FIGURE: A24

TRIAL HOLE: 25	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i>
PROJECT: PROPOSED PLANGENI DEVELOPMENT	P O Box 607
LOGGED BY: FJB	Ceres
SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36	6835
	Cell: 082 570 2767
DATE LOGGED: 7/10/2020	Email:
CLIENT: KAI IGARIP MUNICIPALITY	cedarland.frans@breede.co.za
LOCATION: 28°40'05,5" S 21°06'10,7" E	

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00	✕	Ground Surface				NOTES: 1 No seepage water encountered. 2 Refusal of excavation at 50 mm on very hard rock, granite.
		Dark grey brown speckled white, massive, very coarse grained, slightly weathered, micaceous very hard rock, <i>GRANITE</i> . Rock outcrop.				
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 Date Drilled: 7/10/2020 Machine: Bell 315SK	Hole Diameter: 600 mm Water Depth: Sheet: 1 of 1
SOIL PROFILE: TEST PIT 25	FIGURE: A25

<p>TRIAL HOLE: 26</p> <p>PROJECT: PROPOSED PLANGENI DEVELOPMENT</p> <p>LOGGED BY: FJB</p> <p>SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36</p> <p>DATE LOGGED: 7/10/2020</p> <p>CLIENT: KAI IGARIP MUNICIPALITY</p> <p>LOCATION: 28°40'06,7" S 21°06'13,6" E</p>	<p><i>Cedar Land Geotechnical Consult (Pty) Ltd</i></p> <p>P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za</p>
---	--

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				<p><u>NOTES:</u></p> <p>1 No seepage water encountered.</p> <p>2 Refusal of excavation at 700 mm due to very slow penetration on medium hard rock, granite.</p>
0.20		Abundant, clast supported, angular <i>BOULDERS</i> of dark grey speckled white, unweathered, very hard rock, granite, in a matrix of dry, light red brown, fine sand. Overall consistency is very dense. Residual granite.				
0.40						
0.60		Dirty white, speckled dark grey, massive, coarse grained, slightly weathered, micaceous, medium hard rock to hard rock, <i>GRANITE</i> .				
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						

<p>Contractor: ALS Plant Hire</p> <p>Date Drilled: 7/10/2020</p> <p>Machine: Bell 315SK</p>	<p>Hole Diameter: 600 mm</p> <p>Water Depth:</p> <p>Sheet: 1 of 1</p>
SOIL PROFILE: TEST PIT 26	FIGURE: A26

TRIAL HOLE: 27

PROJECT: PROPOSED PLANGENI DEVELOPMENT

LOGGED BY: FJB

SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36

DATE LOGGED: 7/10/2020

CLIENT: KAI IGARIP MUNICIPALITY

LOCATION: 28°40'10,0" S 21°06'16,4" E

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Consult (Pty) Ltd

P O Box 607

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6835

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 No seepage water encountered. 2 Refusal of excavation at 900 mm due to very slow penetration on medium hard rock, granite.
0.20		Dry, dirty white, loose, intact, fine SAND and matrix supported, fine, gravel sized calcrete concretions. Colluvium.				
0.40		Dry, dirty white mottled black, very dense, calcareous cemented, very coarse, micaceous SAND. Residual granite.	U9435	0,2-0,7	●	
0.80		Dirty white, speckled dark grey, massive, coarse grained, slightly weathered, micaceous, medium hard rock to hard rock, GRANITE.				
1.00						∇ Water encountered ▼ Water level ▽ Bottom of hole --- Approximate material change ● Disturbed sample ■ Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 7/10/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 27

FIGURE: A27

TRIAL HOLE: 28

PROJECT: PROPOSED PLANGENI DEVELOPMENT

LOGGED BY: FJB

SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36

DATE LOGGED: 7/10/2020

CLIENT: KAI IGARIP MUNICIPALITY

LOCATION: 28°40'12,4" S 21°06'20,0" E

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Consult (Pty) Ltd

P O Box 607

Ceres

6835

Cell: 082 570 2767

Email:

cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				<p><u>NOTES:</u></p> <p>1 No seepage water encountered.</p> <p>2 Refusal of excavation at 1000 mm due to very slow penetration on medium hard rock, granite.</p>
0.20		Dry, pale light brown, intact, loose, fine SAND. Colluvium.				
0.40		Dry, dirty white, very dense, coarse, gravel sized nodules of CALCRETE. Pedogenic deposits.				
0.60						
0.80						
1.00		Dirty white, speckled dark grey, massive, coarse grained, slightly weathered, micaceous, medium hard rock to hard rock, GRANITE.				
1.20						

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

Contractor: ALS Plant Hire

Date Drilled: 7/10/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

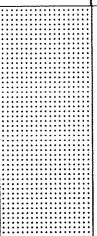
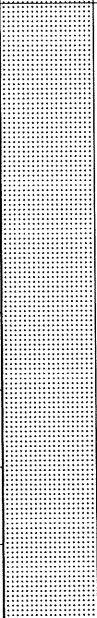
Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 28

FIGURE: A28

TRIAL HOLE: 29	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i>
PROJECT: PROPOSED PLANGENI DEVELOPMENT	P O Box 607
LOGGED BY: FJB	Ceres
SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36	6835
DATE LOGGED: 7/10/2020	Cell: 082 570 2767
CLIENT: KAI !GARIP MUNICIPALITY	Email: cedarland.frans@breede.co.za
LOCATION: 28°40'08,2" S 21°06'22,0" E	

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 No seepage water encountered. 2 Refusal of excavation at 1100 mm due to very slow penetration on very dense, micaceous sand with cobbles of granite.
0.20		Dry, dirty white, loose, intact, fine SAND and matrix supported, fine, gravel sized calcrete concretions. Colluvium.				
0.40		Dry, dirty white speckled dark grey, very dense, micaceous, coarse SAND and matrix supported, angular, cobbles of granite. Residual granite.				√ Water encountered ↓ Water level ▽ Bottom of hole --- Approximate material change • Disturbed sample ■ Undisturbed sample
0.60						
0.80						
1.00						
1.20						

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 7/10/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1
SOIL PROFILE: TEST PIT 29	FIGURE: A29

<p style="text-align: center;">TRIAL HOLE: 30</p> <p>PROJECT: PROPOSED PLANGENI DEVELOPMENT</p> <p style="text-align: center;">LOGGED BY: FJB</p> <p>SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36</p> <p style="text-align: center;">DATE LOGGED: 7/10/2020</p> <p>CLIENT: KAI IGARIP MUNICIPALITY</p> <p style="text-align: center;">LOCATION: 28°40'05,5" S 21°06'19,5" E</p>	<p style="text-align: center;"><i>Cedar Land Geotechnical Consult (Pty) Ltd</i></p> <p>P O Box 607 Ceres 6835</p> <p>Cell: 082 570 2767</p> <p>Email: cedarland.frans@breede.co.za</p>
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Depth (m)	Legend	PROFILE	SAMPLE			Remarks												
			Number	Type	Symbol													
0.00		Ground Surface				<p><u>NOTES:</u></p> <p>1 No seepage water encountered.</p> <p>2 Immediate refusal at 300 mm on dirty white, speckled dark grey, massive, coarse grained, unweathered, micaceous, very hard rock, granite.</p>												
0.20		Dry, dirty white, loose, intact, fine SAND and matrix supported, fine, gravel sized calcrete concretions. Colluvium.	U9436	0-0,3	●													
0.40		Dry, dirty white speckled dark grey, dense, micaceous, coarse SAND and matrix supported, angular, cobbles of granite. Residual granite.				<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 15px; text-align: center;">√</td> <td>Water encountered</td> </tr> <tr> <td style="width: 15px; text-align: center;">Y</td> <td>Water level</td> </tr> <tr> <td style="width: 15px; text-align: center;">~</td> <td>Bottom of hole</td> </tr> <tr> <td style="width: 15px; text-align: center;">---</td> <td>Approximate material change</td> </tr> <tr> <td style="width: 15px; text-align: center;">●</td> <td>Disturbed sample</td> </tr> <tr> <td style="width: 15px; text-align: center;">■</td> <td>Undisturbed sample</td> </tr> </table>	√	Water encountered	Y	Water level	~	Bottom of hole	---	Approximate material change	●	Disturbed sample	■	Undisturbed sample
√	Water encountered																	
Y	Water level																	
~	Bottom of hole																	
---	Approximate material change																	
●	Disturbed sample																	
■	Undisturbed sample																	
0.60																		
0.80																		
1.00																		
1.20																		

<p>Contractor: ALS Plant Hire</p> <p>Date Drilled: 7/10/2020</p> <p>Machine: Bell 315SK</p>	<p>Hole Diameter: 600 mm</p> <p>Water Depth:</p> <p>Sheet: 1 of 1</p>
<p>SOIL PROFILE: TEST PIT 30</p>	<p>FIGURE: A30</p>

TRIAL HOLE: 31

PROJECT: PROPOSED PLANGENI DEVELOPMENT

LOGGED BY: FJB

SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36

DATE LOGGED: 7/10/2020

CLIENT: KAI !GARIP MUNICIPALITY

LOCATION: 28°40'04,5" S 21°06'15,2" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607

Ceres

6835

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 No seepage water encountered. 2 <u>Northern face of test pit:</u> refusal of excavation at 1400 mm due to very slow penetration on medium hard rock, granite. 3 <u>Southern face of test pit:</u> refusal of excavation at 50 mm on very hard rock, granite.
0.20		<u>Northern face of test pit:</u> Dry, dirty white, loose, intact, fine SAND and matrix supported, fine, gravel sized, calcrete concretions. Colluvium.				
0.40		Dry, light grey brown speckled white, dense, micaceous, coarse SAND and matrix supported, subangular, cobbles of granite. Residual granite.				
0.60						
0.80						
1.00						
1.20						
1.40		Dirty white, speckled dark grey, massive, coarse grained, slightly weathered, micaceous, medium hard rock to hard rock, GRANITE.				▽ Water encountered ↓ Water level ~ Bottom of hole --- Approximate material change • Disturbed sample ■ Undisturbed sample
1.60		<u>Southern face of test pit:</u> <u>0 - 50 mm:</u> Dark grey brown speckled white, massive, very coarse grained, slightly weathered, micaceous, very hard rock, GRANITE. Rock outcrop.				
1.80						

Contractor: ALS Plant Hire

Date Drilled: 7/10/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 31

FIGURE: A31

TRIAL HOLE: 32

PROJECT: PROPOSED PLANGENI DEVELOPMENT

LOGGED BY: FJB


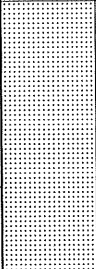

SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36







DATE LOGGED: 7/10/2020

CLIENT: KAI !GARIP MUNICIPALITY

LOCATION: 28°39'59,8" S 21°06'14,2" E

*Cedar Land Geotechnical
Consult (Pty) Ltd*
P O Box 607
Ceres
6835
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 No seepage water encountered. 2 Refusal of excavation at 500 mm due to very slow penetration on medium hard rock, granite.
		Dry, pale light brown, intact, loose, fine SAND. Colluvium.				
0.20		Dry, dirty white speckled dark grey, very dense, micaceous, coarse SAND and matrix supported, angular, cobbles of granite. Residual granite.				
0.40		Dirty white, speckled dark grey, massive, coarse grained, slightly weathered, micaceous, medium hard rock to hard rock, GRANITE.				
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: 7/10/2020
Machine: Bell 315SK

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

SOIL PROFILE: TEST PIT 32

FIGURE: A32

TRIAL HOLE: 33

PROJECT: PROPOSED PLANGENI DEVELOPMENT

LOGGED BY: FJB

SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36

DATE LOGGED: 7/10/2020

CLIENT: KAI !GARIP MUNICIPALITY

LOCATION: 28°39'59,6" S 21°06'09,4" E

Cedar Land Geotechnical

Consult (Pty) Ltd

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6835

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Email:

cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 No seepage water encountered. 2 Refusal of excavation at 1400 mm due to very slow penetration on medium hard rock, granite.
0.20		Dry, pale light brown, intact, loose, fine SAND. Colluvium.				
0.40		Dry, dirty white speckled dark grey, very dense, micaceous, coarse SAND and matrix supported, angular, cobbles of granite and a lens of dirty white, calcareous sand between 700 mm and 850 mm deep. Residual granite.				
0.60			U9437	0,2-1,3	●	
0.80						
1.00						
1.20						
1.40		Dirty white, speckled dark grey, massive, coarse grained, slightly weathered, micaceous, medium hard rock to hard rock, GRANITE.				∇ Water encountered ↓ Water level ▾ Bottom of hole --- Approximate material change ● Disturbed sample ■ Undisturbed sample
1.60						

Contractor: ALS Plant Hire

Date Drilled: 7/10/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 33

FIGURE: A33

TRIAL HOLE: 34

PROJECT: PROPOSED PLANGENI DEVELOPMENT

LOGGED BY: FJB

SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36

DATE LOGGED: 7/10/2020

CLIENT: KAI !GARIP MUNICIPALITY

LOCATION: 28°39'56,2" S 21°06'07,4" 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 No seepage water encountered. 2 Refusal of excavation at 1500 mm due to very slow penetration on very dense, micaceous sand with cobbles of granite.
0.20		Dry, pale light brown, intact, loose, fine SAND. Colluvium.				
0.40		Dry, dirty white speckled dark grey, very dense, micaceous, coarse SAND and matrix supported, angular, cobbles of granite and random veins of light red brown, fine sand. Residual granite.				
0.60						
0.80						
1.00						
1.20						
1.40		Dry, dirty white speckled dark grey, very dense, micaceous, coarse SAND and matrix supported, angular cobbles of granite. Residual granite.				
1.60						

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

Contractor: ALS Plant Hire

Date Drilled: 7/10/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 34

FIGURE: A34

TRIAL HOLE: 35

PROJECT: PROPOSED PLANGENI DEVELOPMENT

LOGGED BY: FJB

SITE: PORTION 30 OF THE FARM BLAAUWSKOP NO 36

DATE LOGGED: 7/10/2020

CLIENT: KAI IGARIP MUNICIPALITY

LOCATION: 28°39'53,3" S 21°06'05,3" E

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cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 No seepage water encountered. 2 Refusal of excavation at 1100 mm due to very slow penetration on very dense, micaceous sand with cobbles of granite.
0.20		Dry, pale light brown, intact, loose, fine SAND. Colluvium.				
0.40		Dry, dirty white speckled dark grey, very dense, micaceous, coarse SAND and matrix supported, angular, cobbles of granite. Residual granite.				
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: 7/10/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 35

FIGURE: A35

**REPORT ON THE GEOTECHNICAL CONDITIONS ON
PORTION 30 OF PORTION 29 OF THE FARM
BLAAUWS KOP 36, DISTRICT KENHARDT**

2020/J032/MCP_01

ADDENDUM B: RESULTS OF MATERIALS TESTING

Job Request No.: RU3667
 Cedar Land Geotechnical Consult (Pty) Ltd
 PO Box 607
 Ceres
 6835
 Attention : Frans Breytenbach

Date Reported : 2020-10-20

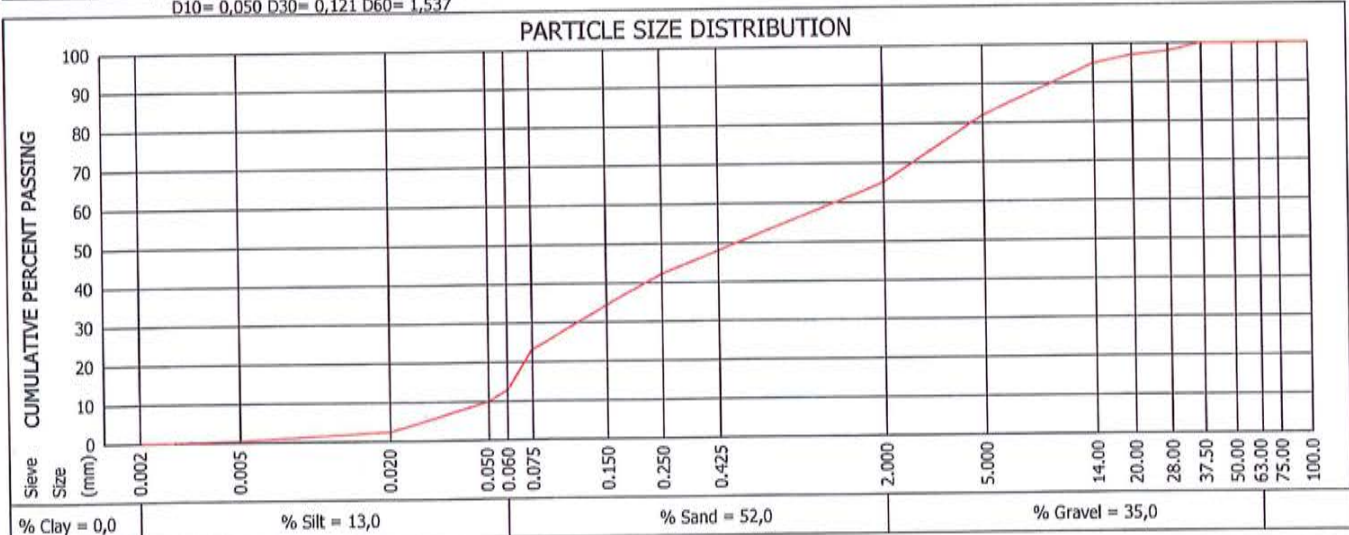
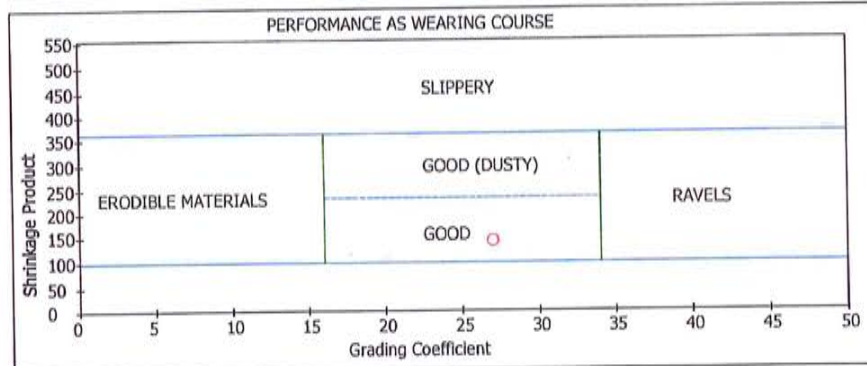
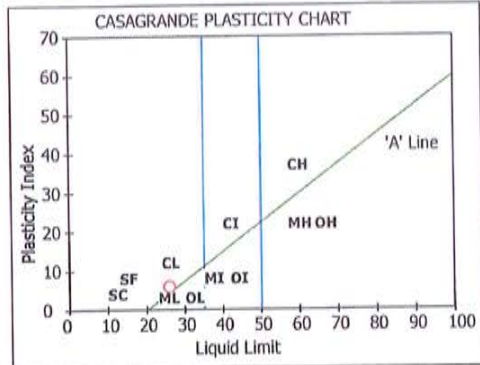
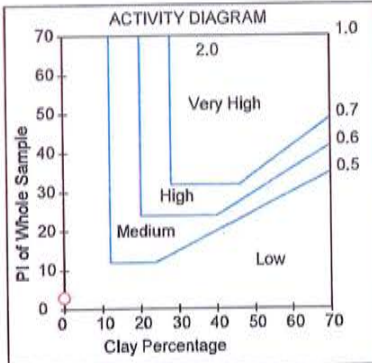
Project : Blaauwskop (Plangeni)

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

Sample No.	: U9427
Position	: TP3
Layer Type	: 300-1100mm
Sample Colour	: Light Brown Gravel
Sample Type	: Mix Weathered Calcre

Sieve Size(mm)	% Passing	Soil Mortar		
100.0	100	2.000 - 0.425	26	
75.00	100	0.425 - 0.250	8	
63.00	100	0.250 - 0.150	12	
50.00	100	0.150 - 0.075	18	
37.50	100	< 0.075	36	
28.00	98	Effective Size	0,050	
20.00	97	Uniformity Coefficient	30,7	
14.00	95	Curvature Coefficient	0,2	
5.000	82	Oversize Index	0,0	
2.000	65	Shrinkage Product	144,0	
0.425	48	Grading Coefficient	27,1	
0.250	42	Grading Modulus	1,60	
0.150	34	Atterberg Limits	Liquid Limit	26
0.075	23		Plasticity Index	6
0.060	13		Linear Shrinkage	3,0
0.050	10		PI < 0.075	
0.020	2,4	Unified Soil Classification	SM-SC	
0.005	0,4	US Highway Classification	A-1-b(0)	
0.002	0,0			

D10= 0,050 D30= 0,121 D60= 1,537



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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 Report compiled by : Juraine Okkies

Date Reported : 2020-10-15

Job Request No.: RU3667
 Cedar Land Geotechnical Consult (Pty) Ltd
 PO Box 607
 Ceres
 6835

Project : Blaauwskop (Plangeni)

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.	U9428
HOLE NO./ Km / CHAINAGE	TP6
ROAD NO./ NAME Line 1	S28° 40' 12,8"
ROAD NO./ NAME Line 2	E21° 05' 57,3"
LAYER TESTED/SAMPLED	200-800mm
SAMPLE DEPTH	200-800mm
DATE SAMPLED	2020-10-06
COLOUR OF SAMPLE	Light Greyish Brown
TYPE OF SAMPLE	Mix Granite Calcrete

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	95
	50.0 mm	95
	37.5 mm	91
	28.0 mm	89
	20.0 mm	87
	14.0 mm	84
	5.0 mm	63
	2.0 mm	41
	0.425 mm	22
0.075 mm	8	
GM %	2,3	

SOIL MORTAR ANALYSIS (SANS 3001-PR5:2011)

COARSE SAND	2.000 - 0.425	47
COARSE FINE SAND	0.425 - 0.250	11
MEDIUM FINE SAND	0.250 - 0.150	11
FINE FINE SAND	0.150 - 0.075	12
SILT CLAY	0.075	20

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

ATTERBERG LIMITS (%) SANS GR10,GR11	LIQUID LIMIT	26
	PLASTICITY INDEX	2,8
	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 %	6,7
	MDD (kg/m³)	2091
	COMP MC %	6,7
SWELL % @	MOD NRB PRO	0,00 0,02 0,03
	100 %	65
	98 %	51
C.B.R. SANS GR40	97 %	46
	95 %	36
	93 %	29
	90 %	20
STABILISER IN LAB	Not Applicable	
TEST TYPE	CBR	
SAMPLING METHOD	TMH 5	
WEATHER WHEN SAMPLED	Cold	

Deviation from Test Method :
 Remarks and Notes :

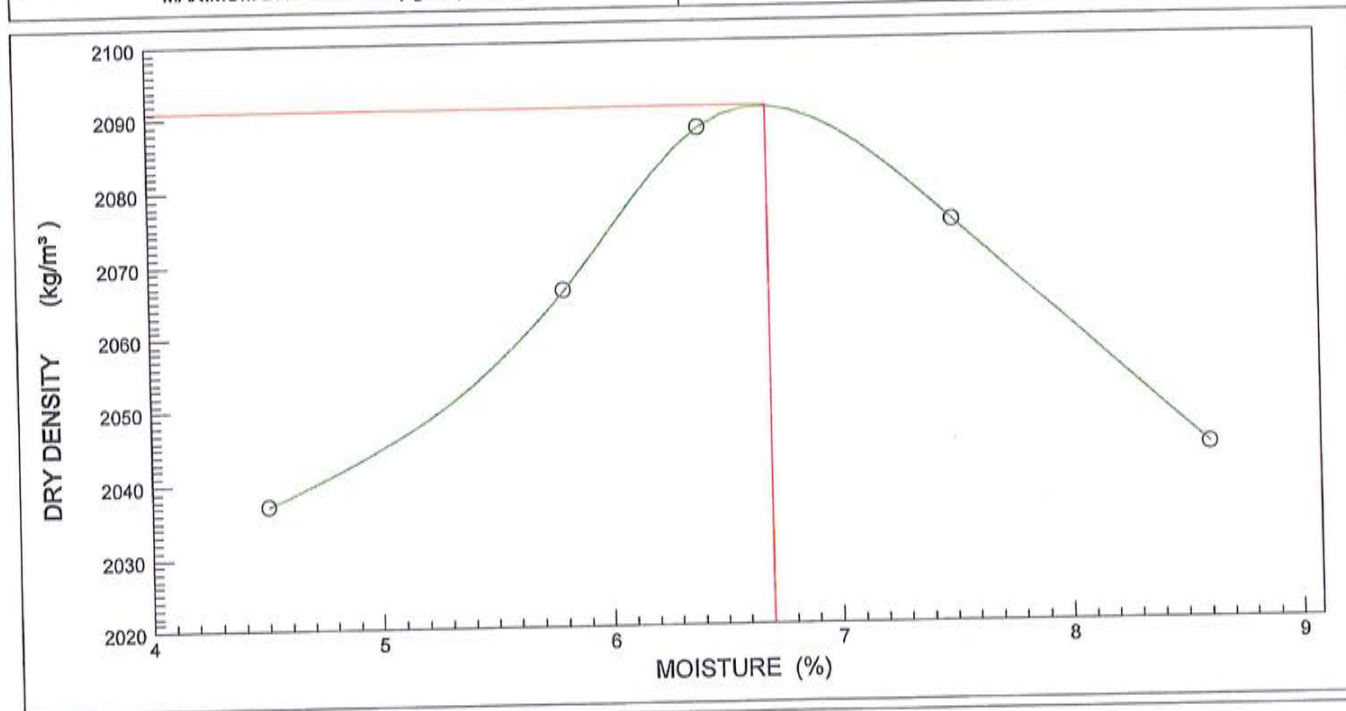
Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
 The test results reported relate to the samples tested.
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 Report compiled by : Juraine Okkies

Determination Maximum Dry Density & Optimum Moisture Content Test Report

SANS 3001 - GR20/GR30

SAMPLE NO.	U9428
CONTAINER FOR SAMPLING	Black Nylon Bags
SIZE / APPROX. MASS OF SAMPLE	82kg
MOISTURE CONDITION OF SAMPLE	Moist
LAYER TESTED / SAMPLED FROM	400-800mm
MATERIAL DESCRIPTION	Mix W.Calcrete + W. Quartz
HOLE NO./ km / CHAINAGE	TP6
ROAD NO.	Not Specified
DATE RECEIVED	2020-10-06
DATE SAMPLED	2020-10-06
CLIENT MARKING	
COLOUR AND TYPE	Light Greyish Brown Gravel

POINT NO.	1	2	3	4	5			
DRY DENSITY (kg/m ³)	2037	2066	2088	2075	2044			
MOISTURE (%)	4,5	5,8	6,4	7,5	8,6			
MAXIMUM DRY DENSITY (kg/m ³) : 2091				OPTIMUM MOISTURE CONTENT (%) : 6.7				



Deviation from Test Method :
 Remarks and Notes :

Opinions and interpretations are not included in our scope of works. (T0296)
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 Report compiled by : Juraine Okkies

Job Request No.: RU3667
 Cedar Land Geotechnical Consult (Pty) Ltd
 PO Box 607
 Ceres
 6835
 Attention : Frans Breytenbach

Date Reported : 2020-10-20

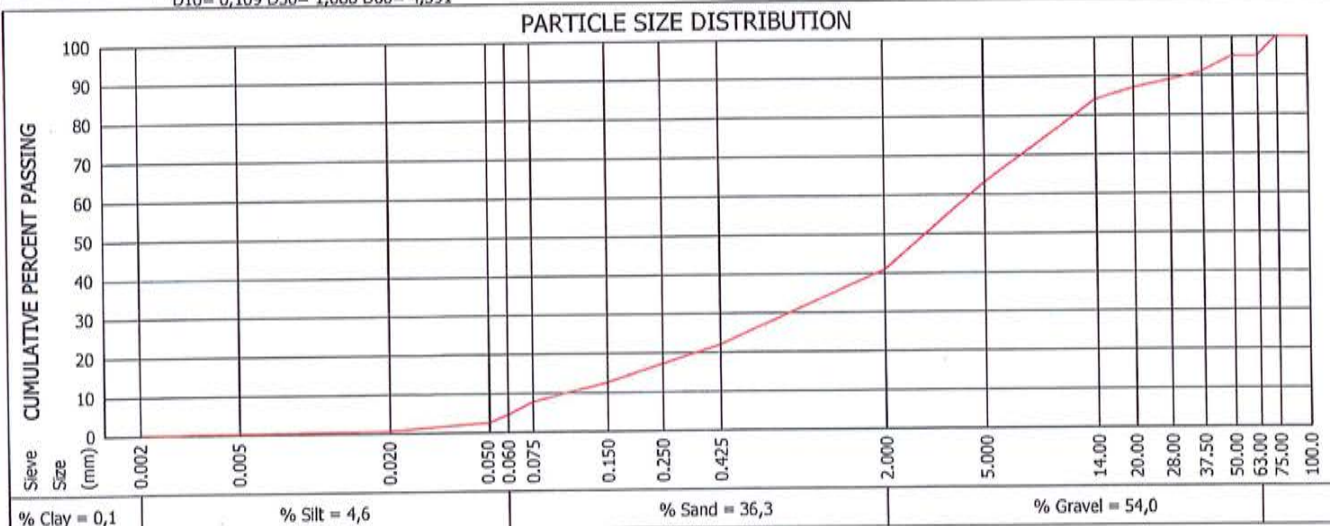
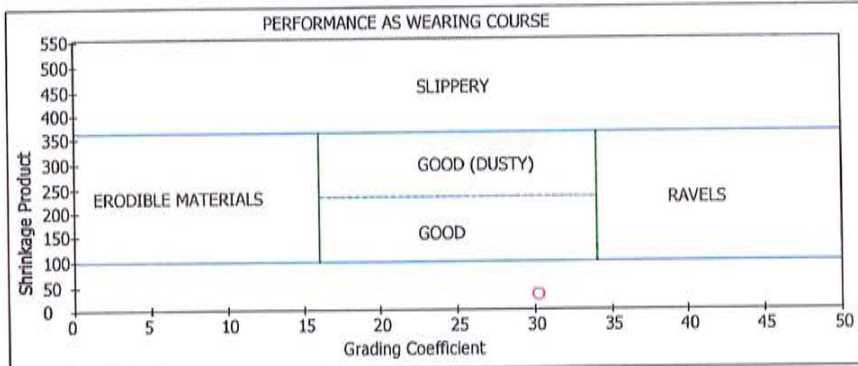
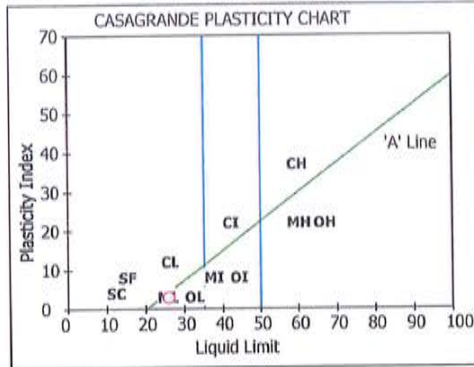
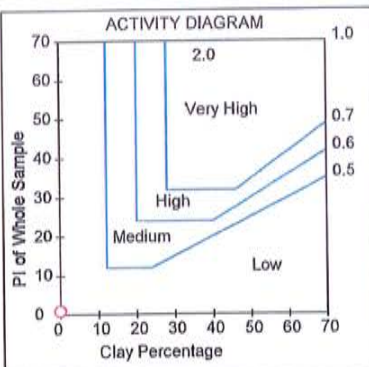
Project : Blaauwskop (Plangeni)

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

Sample No.	: U9428
Position	: TP6
Layer Type	: 400-800mm
Sample Colour	: Light Greyish Brown
Sample Type	: Mix W. Granite + Cal

Sieve Size (mm)	% Passing	Soil Mortar		
2.000	47	2.000 - 0.425		47
0.425	11	0.425 - 0.250		11
0.250	11	0.250 - 0.150		11
0.150	12	0.150 - 0.075		12
< 0.075	20			20
Effective Size	0,109			
Uniformity Coefficient	42,1			
Curvature Coefficient	2,4			
Oversize Index	4,0			
Shrinkage Product	33,0			
Grading Coefficient	30,2			
Grading Modulus	2,30			
Liquid Limit	26	Atterberg Limits		
Plasticity Index	3,0			
Linear Shrinkage	1,5			
PI < 0.075				
Unified Soil Classification	SW-SM			
US Highway Classification	A-1-a(0)			


D10 = 0,109 D30 = 1,088 D60 = 4,591



Deviation from Test Method :
 Remarks and Notes : Chemistry: pH = 8.33 [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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 Technical Signatory

Date Reported : 2020-10-20

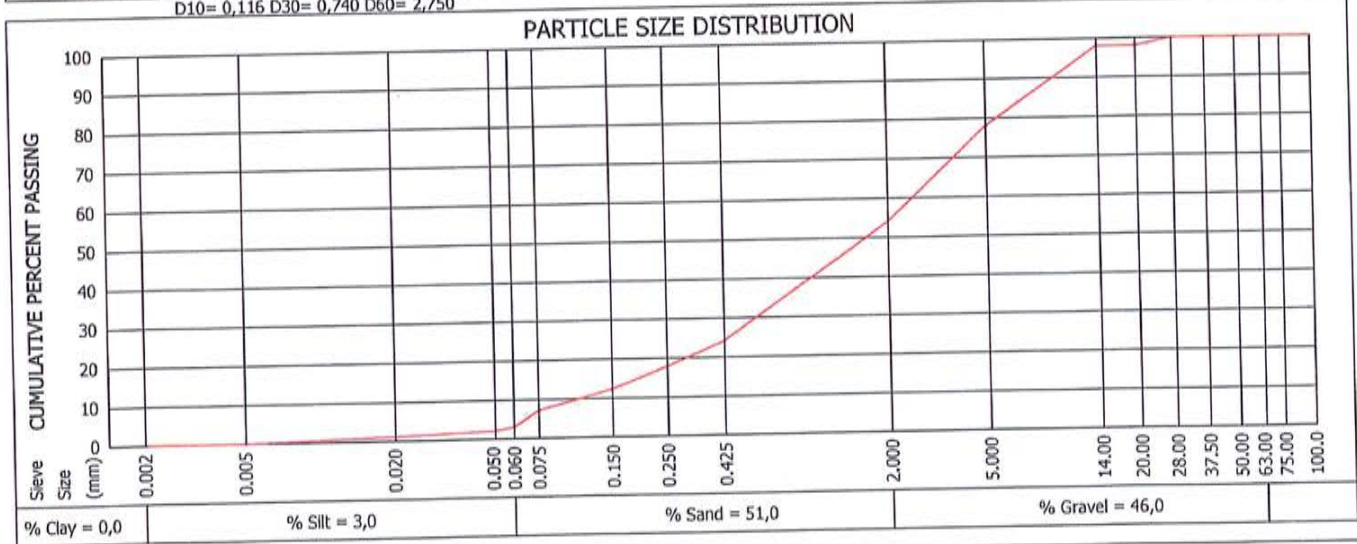
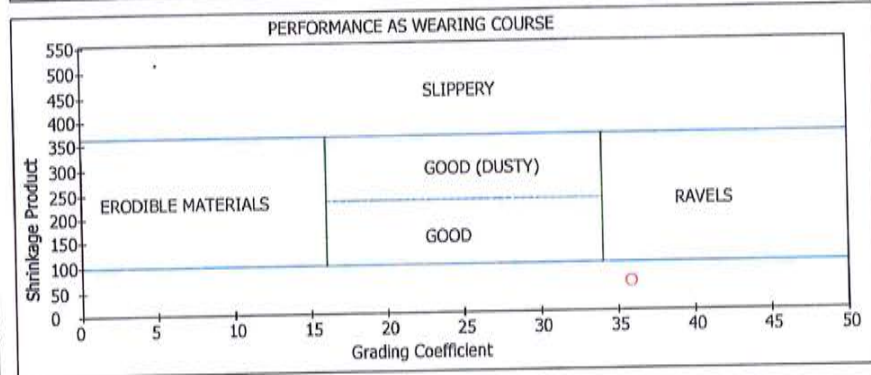
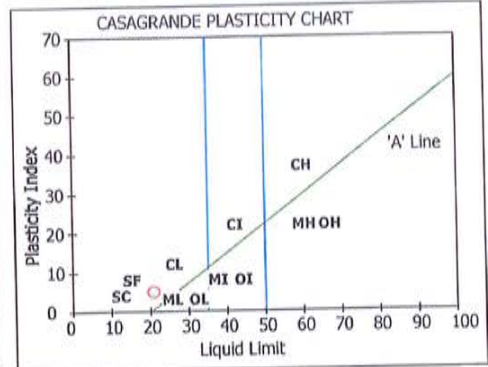
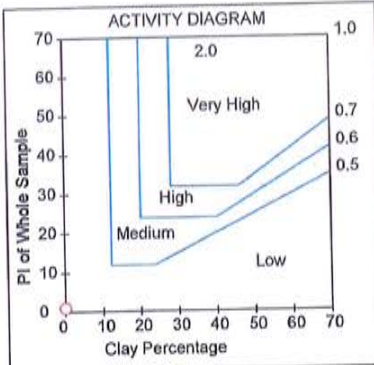
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 Cedar Land Geotechnical Consult (Pty) Ltd
 PO Box 607
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 6835
 Attention : Frans Breytenbach

Project : Blaauwskop (Plangeni)

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

Sample No. : U9429
 Position : TP9
 Layer Type : 300-900mm
 Sample Colour : Dark Greyish Brown G
 Sample Type : Mix W.Granite+OccCal


Sieve Size(mm)	% Passing	Soil Mortar	2.000 - 0.425	55
100.0	100		0.425 - 0.250	12
75.00	100		0.250 - 0.150	10
63.00	100		0.150 - 0.075	10
50.00	100		< 0.075	13
37.50	100	Effective Size		0,116
28.00	100	Uniformity Coefficient		23,7
20.00	98	Curvature Coefficient		1,7
14.00	98	Oversize Index		0,0
5.000	78	Shrinkage Product		60,0
2.000	54	Grading Coefficient		35,9
0.425	24	Grading Modulus		2,10
0.250	18	Atterberg Limits	Liquid Limit	21
0.150	12		Plasticity Index	5
0.075	7,2		Linear Shrinkage	2,5
0.060	3,0		PI < 0.075	
0.050	2,0	Unified Soil Classification		SW-SM-SC
0.020	1,1	US Highway Classification		A-1-b(0)
0.005	0,0	D10= 0,116 D30= 0,740 D60= 2,750		
0.002	0,0			



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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 Prog.ver 10.7 (2019/11/07)


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 Technical Signatory

Date Reported : 2020-10-20

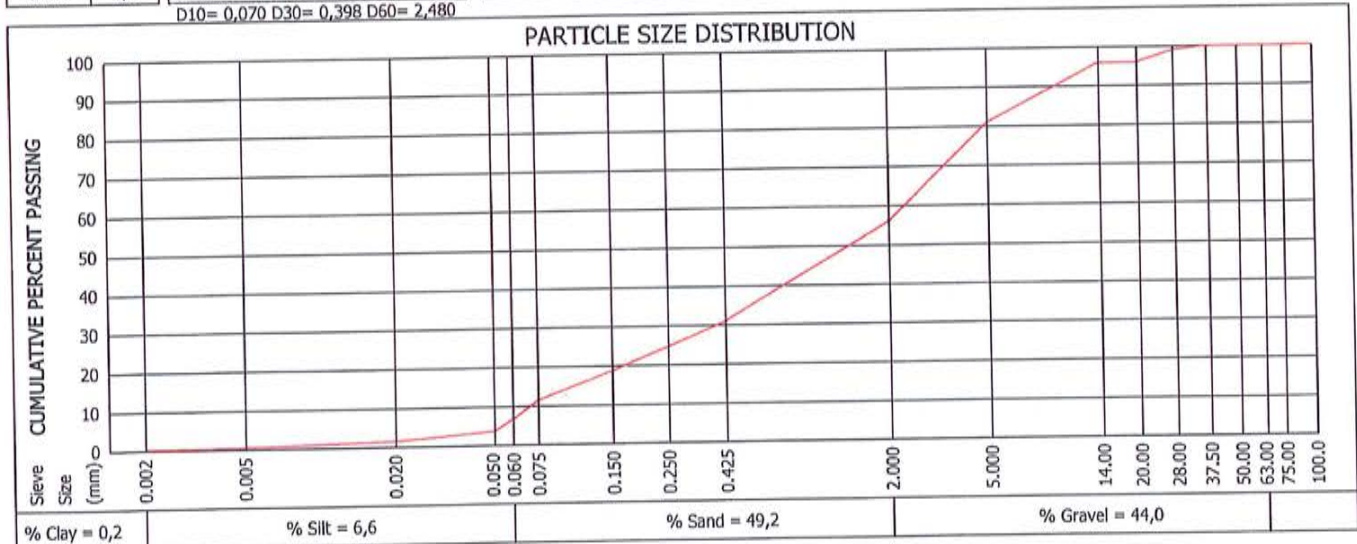
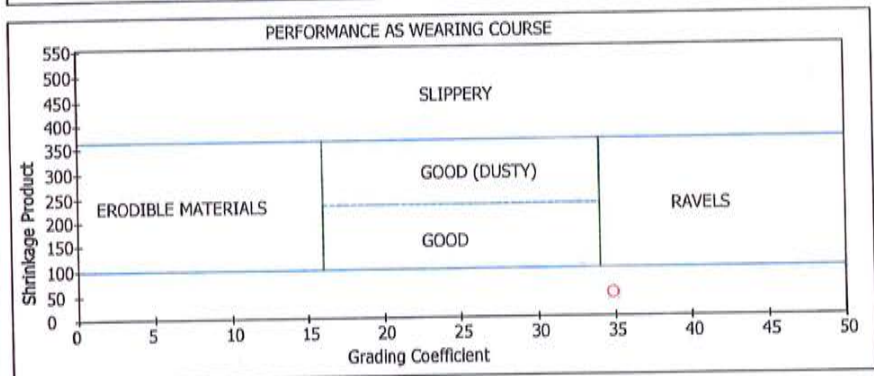
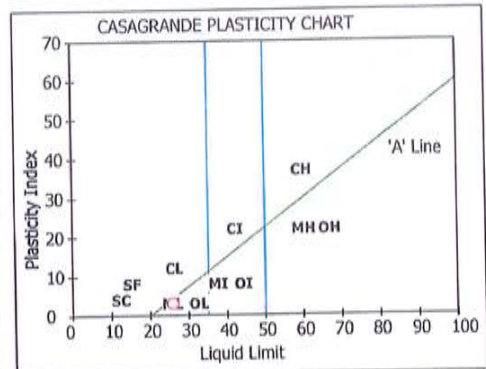
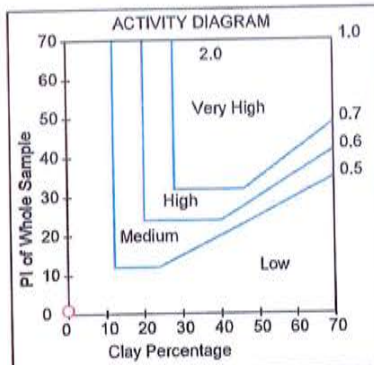
Job Request No.: RU3667
 Cedar Land Geotechnical Consult (Pty) Ltd
 PO Box 607
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 6835
 Attention : Frans Breytenbach

Project : Blaauwskop (Plangeni)

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

Sample No.	: U9430
Position	: TP12
Layer Type	: 100-1100mm
Sample Colour	: Light Greyish Brown
Sample Type	: Mix W. Granite + Cal

Sieve Size(mm)	% Passing	Soil Mortar		
100.0	100	2.000 - 0.425	45	
75.00	100	0.425 - 0.250	11	
63.00	100	0.250 - 0.150	11	
50.00	100	0.150 - 0.075	14	
37.50	100	< 0.075	20	
28.00	99	Effective Size	0,070	
20.00	96	Uniformity Coefficient	35,4	
14.00	96	Curvature Coefficient	0,9	
5.000	81	Oversize Index	0,0	
2.000	56	Shrinkage Product	46,5	
0.425	31	Grading Coefficient	34,8	
0.250	25	Grading Modulus	2,00	
0.150	19	Atterberg Limits	Liquid Limit	26
0.075	11		Plasticity Index	3.0
0.060	6,8		Linear Shrinkage	1.5
0.050	3,6		PI < 0.075	
0.020	1,5	Unified Soil Classification	SW-SM	
0.005	0,4	US Highway Classification	A-1-b(0)	
0.002	0,2	D10= 0,070 D30= 0,398 D60= 2,480		



Deviation from Test Method :
 Remarks and Notes : Chemistry: pH = 7.73 [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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 Attention : Frans Breytenbach

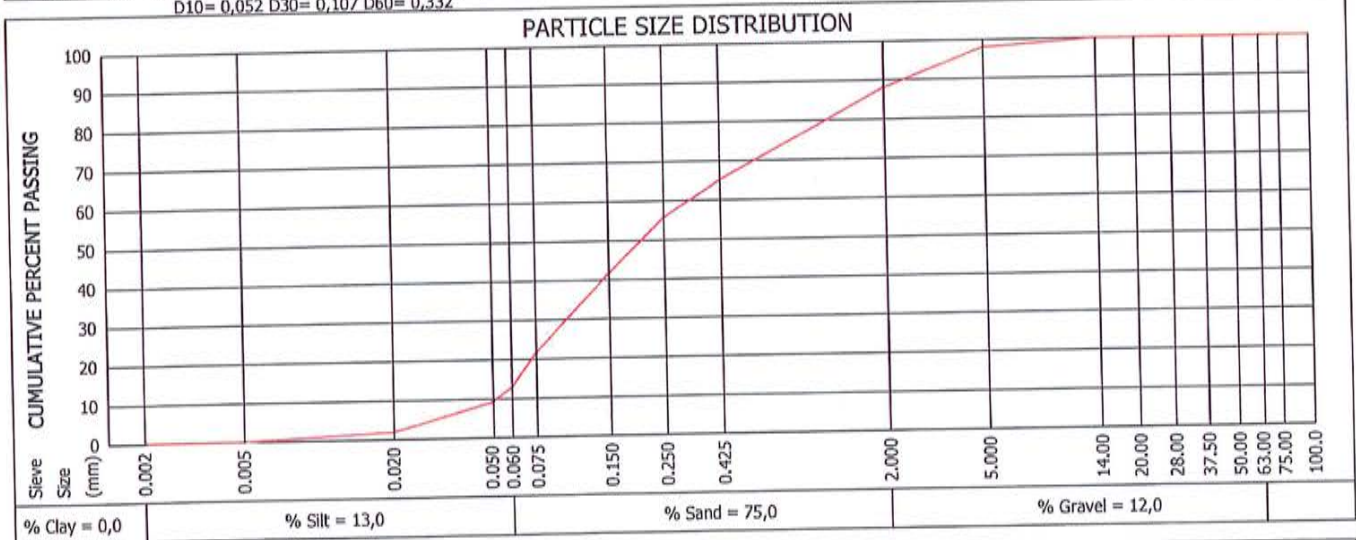
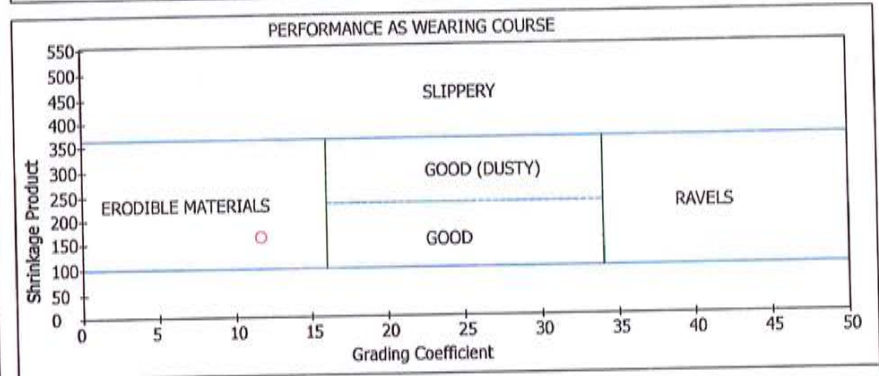
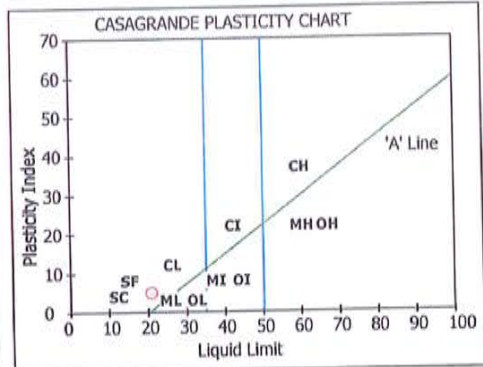
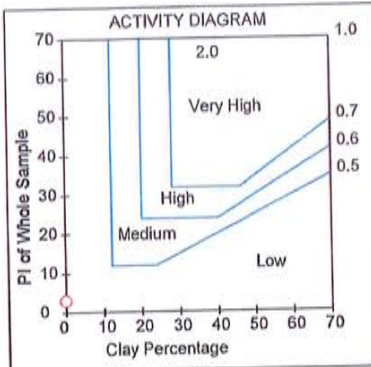
Date Reported : 2020-10-20

Project : Blaauwskop (Plangeni)

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

Sample No. : U9431
 Position : TP15
 Layer Type : 0-600mm
 Sample Colour : Orange Brown Gravel
 Sample Type : Quartzitic Sand

Sieve Size(mm)	% Passing	Soil Mortar	2.000 - 0.425	26
100.0	100		0.425 - 0.250	11
75.00	100		0.250 - 0.150	16
63.00	100		0.150 - 0.075	22
50.00	100		< 0.075	25
37.50	100	Effective Size		0,052
28.00	100	Uniformity Coefficient		6,4
20.00	100	Curvature Coefficient		0,7
14.00	100	Oversize Index		0,0
5.000	98	Shrinkage Product		162,5
2.000	88	Grading Coefficient		11,8
0.425	65	Grading Modulus		1,30
0.250	56	Atterberg Limits	Liquid Limit	21
0.150	42		Plasticity Index	5
0.075	22		Linear Shrinkage	2.5
0.060	13		PI < 0.075	
0.050	9,1		Unified Soil Classification	SM-SC
0.020	1,8	US Highway Classification	A-2-4(0)	
0.005	0,0	D10= 0,052 D30= 0,107 D60= 0,332		
0.002	0,0			



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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 Report compiled by : Juraine Okkies

Job Request No.: RU3667
 Cedar Land Geotechnical Consult (Pty) Ltd
 PO Box 607
 Ceres
 6835

Project : Blaauwskop (Plangeni)

Date Reported : 2020-10-15

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.	U9432
HOLE NO./ Km / CHAINAGE	T18
ROAD NO./ NAME Line 1	S28° 40' 08,9"
ROAD NO./ NAME Line 2	E21° 06' 08,1"
LAYER TESTED/SAMPLED	0-400mm
SAMPLE DEPTH	0-400mm
DATE SAMPLED	2020-10-06
COLOUR OF SAMPLE	Light Brown
TYPE OF SAMPLE	Mix Granite Calcrete

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	97
	37.5 mm	94
	28.0 mm	93
	20.0 mm	91
	14.0 mm	90
	5.0 mm	71
	2.0 mm	49
	0.425 mm	36
0.075 mm	18	
GM %	2,0	

SOIL MORTAR ANALYSIS (SANS 3001-PR5:2011)

COARSE SAND	2.000 - 0.425	27
COARSE FINE SAND	0.425 - 0.250	7
MEDIUM FINE SAND	0.250 - 0.150	12
FINE FINE SAND	0.150 - 0.075	18
SILT CLAY	0.075	36

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

ATTERBERG LIMITS (%) SANS GR10,GR11	LIQUID LIMIT	25
	PLASTICITY INDEX	3,2
	LINEAR SHRINKAGE	2,0
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 %	9,0
	MDD (kg/m³)	2079
	COMP MC %	9,4
SWELL % @	MOD NRB PRO	0,01 0,03 0,06
	100 %	70
	98 %	52
C.B.R. SANS GR40	97 %	45
	95 %	34
	93 %	25
	90 %	16

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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 Report compiled by : Juraine Okkies

Determination Maximum Dry Density & Optimum Moisture Content Test Report

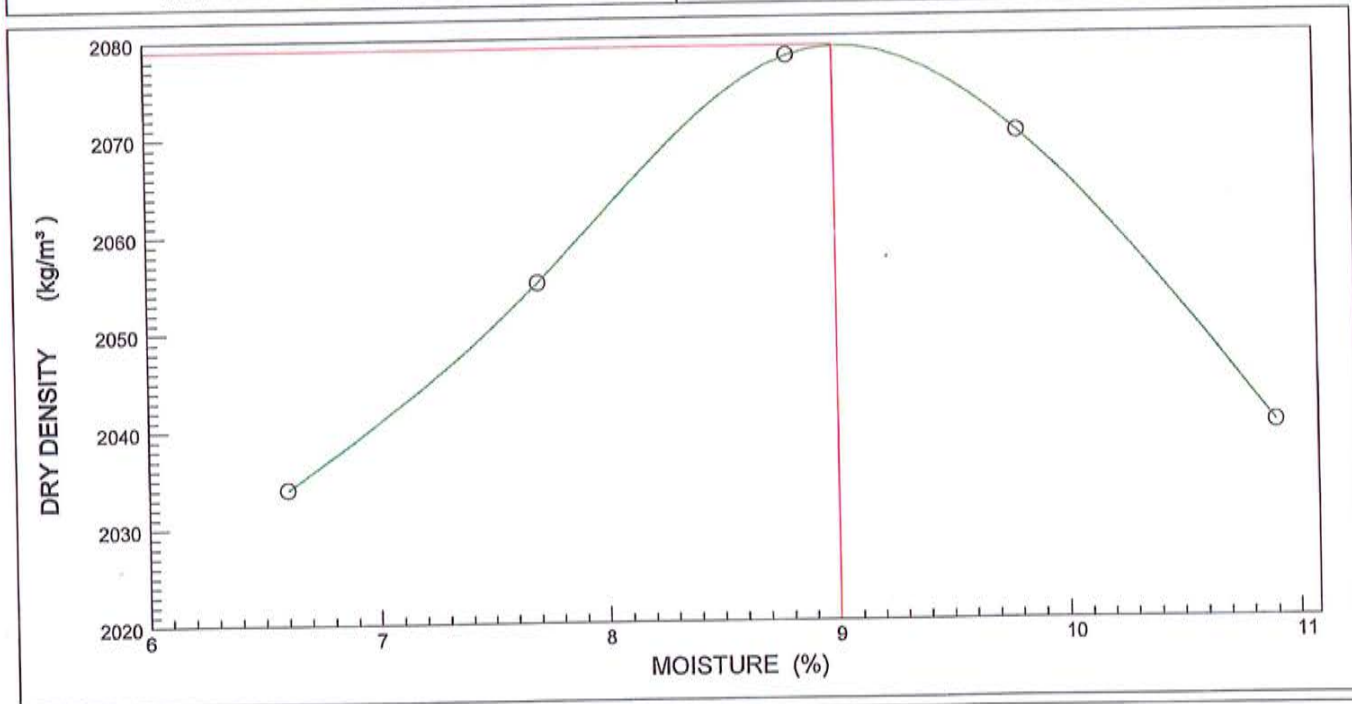
SANS 3001 - GR20/GR30

SAMPLE NO.	U9432
CONTAINER FOR SAMPLING	Black Nylon Bags
SIZE / APPROX. MASS OF SAMPLE	94kg
MOISTURE CONDITION OF SAMPLE	Moist
LAYER TESTED / SAMPLED FROM	0-400mm
MATERIAL DESCRIPTION	Mix W.Calcrete + W. Granitestone
HOLE NO./ km / CHAINAGE	TP18
ROAD NO.	Not Specified
DATE RECEIVED	2020-10-06
DATE SAMPLED	2020-10-06
CLIENT MARKING	
COLOUR AND TYPE	Light Greyish Brown Gravel

POINT NO.	1	2	3	4	5			
DRY DENSITY (kg/m ³)	2034	2055	2078	2070	2040			
MOISTURE (%)	6,6	7,7	8,8	9,8	10,9			

MAXIMUM DRY DENSITY (kg/m³) : 2079

OPTIMUM MOISTURE CONTENT (%) : 9,0



Deviation from Test Method :
 Remarks and Notes :

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 Report compiled by : Juraine Okkies

Date Reported : 2020-10-20

Job Request No.: RU3667
 Cedar Land Geotechnical Consult (Pty) Ltd
 PO Box 607
 Ceres
 6835
 Attention : Frans Breytenbach

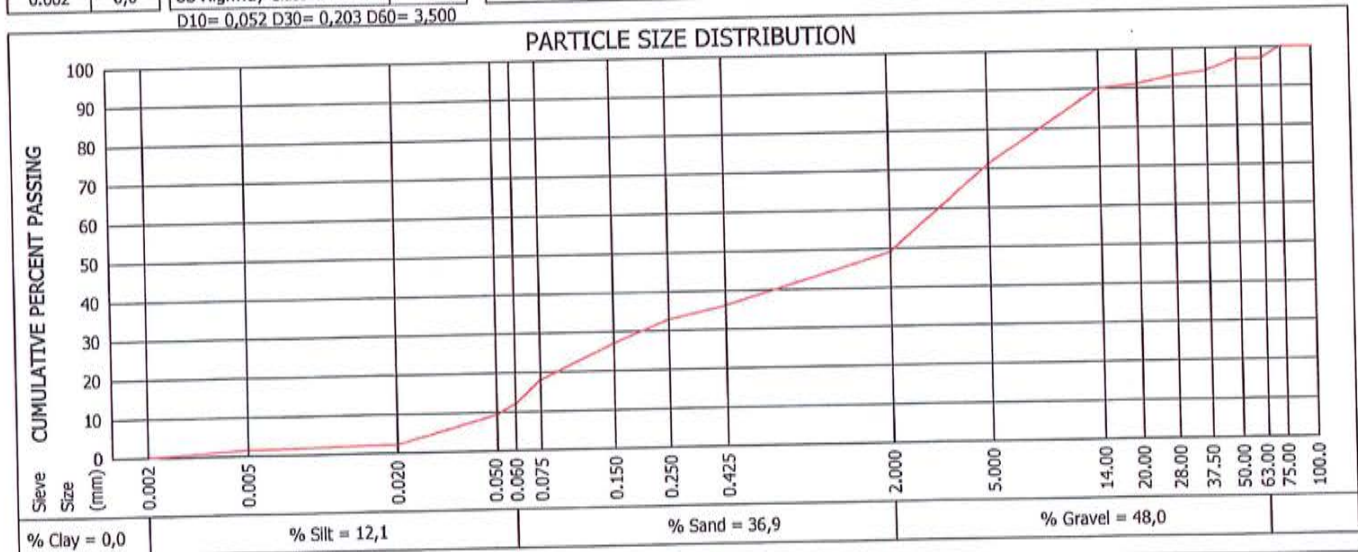
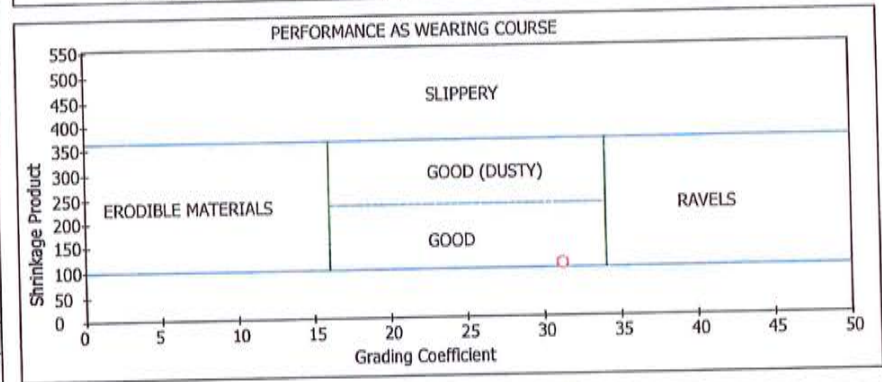
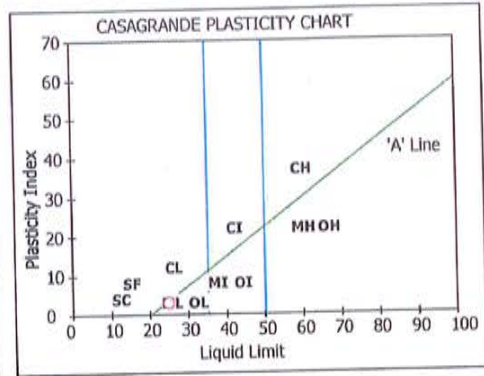
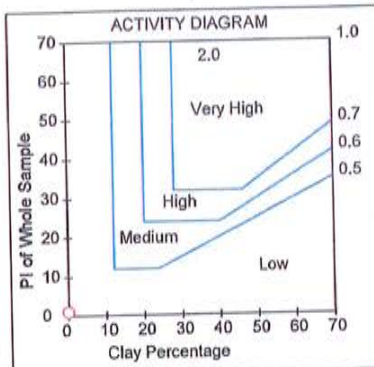
Project : Blaauwskop (Plangeni)

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

Sample No.	: U9432
Position	: TP18
Layer Type	: 0-400mm
Sample Colour	: Light Brown Gravel
Sample Type	: Mix W. Granite + Cal

Sieve Size(mm)	% Passing	Soil Mortar		
100.0	100	2.000 - 0.425	27	
75.00	100	0.425 - 0.250	7	
63.00	97	0.250 - 0.150	12	
50.00	97	0.150 - 0.075	18	
37.50	94	< 0.075	36	
28.00	93	Effective Size	0,052	
20.00	91	Uniformity Coefficient	67,3	
14.00	90	Curvature Coefficient	0,2	
5.000	71	Oversize Index	3,0	
2.000	49	Shrinkage Product	108,0	
0.425	36	Grading Coefficient	31,2	
0.250	33	Grading Modulus	2,00	
0.150	27	Atterberg Limits	Liquid Limit	25
0.075	18		Plasticity Index	3.0
0.060	12		Linear Shrinkage	3.0
0.050	9,3		PI < 0.075	
0.020	2,1	Unified Soil Classification	SM	
0.005	1,4	US Highway Classification	A-1-b(0)	
0.002	0,0			


D10= 0,052 D30= 0,203 D60= 3,500



Deviation from Test Method :
 Remarks and Notes : Chemistry: pH = 8.10 [SANS 5854] & Conductivity = 0.15 S/m [SANS 6240]

Opinions and interpretations are not included in our scope of works. (T0296)
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 Report compiled by : Juraine Okkies

sanas
 Testing Laboratory
 Accreditation No. T0296
 Prog.ver 10.7 (2019/11/07)


 D Juckers
 Technical Signatory

Job Request No.: RU3667
 Cedar Land Geotechnical Consult (Pty) Ltd
 PO Box 607
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 6835
 Attention : Frans Breytenbach

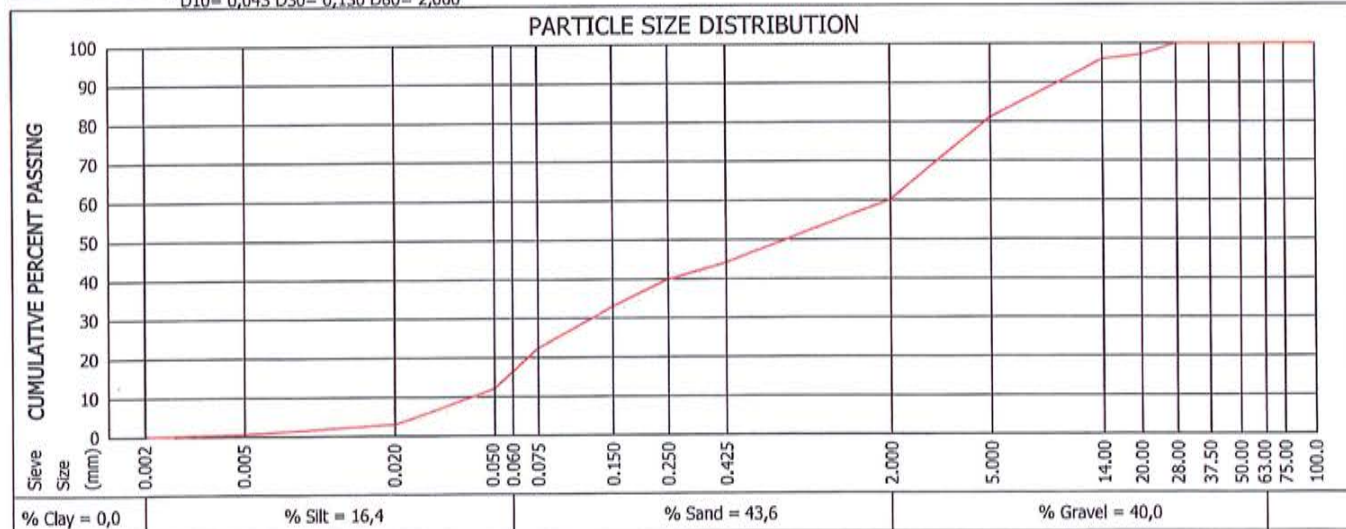
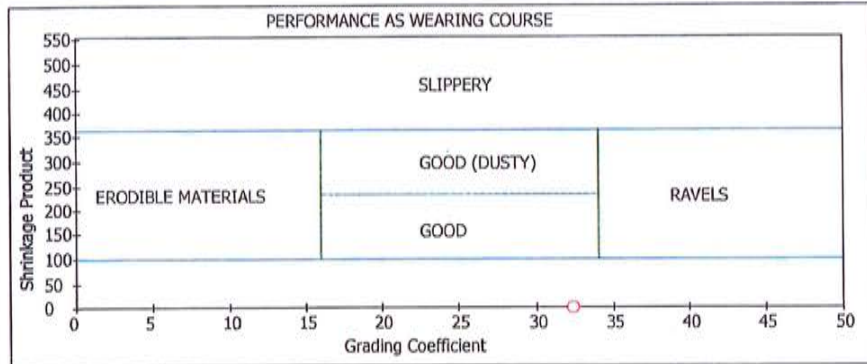
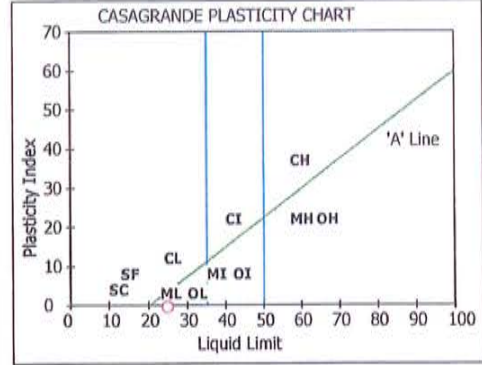
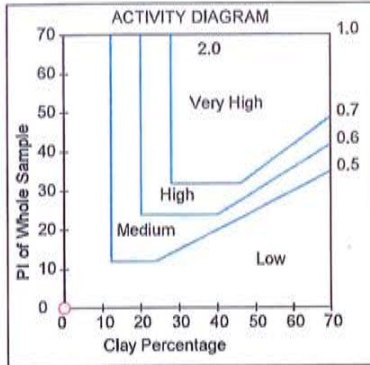
Date Reported : 2020-10-20

Project : Blaauwskop (Plangeni)

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

Sample No. : U9433
 Position : TP21
 Layer Type : 0-600mm
 Sample Colour : Light Brown Gravel
 Sample Type : Mix Weathered Calcre

Sieve Size(mm)	% Passing	Soil Mortar	2.000 - 0.425	27
100.0	100		0.425 - 0.250	7
75.00	100		0.250 - 0.150	11
63.00	100		0.150 - 0.075	18
50.00	100		< 0.075	36
37.50	100	Effective Size		0,043
28.00	100	Uniformity Coefficient		46,5
20.00	97	Curvature Coefficient		0,2
14.00	96	Oversize Index		0,0
5.000	81	Shrinkage Product		0,0
2.000	60	Grading Coefficient		32,4
0.425	44	Grading Modulus		1,70
0.250	40	Atterberg Limits	Liquid Limit	25
0.150	33		Plasticity Index	0,0
0.075	22		Linear Shrinkage	0,0
0.060	16		PI < 0.075	
0.050	12	Unified Soil Classification		SM
0.020	2,9	US Highway Classification		A-1-b(0)
0.005	0,5	D10= 0,043 D30= 0,130 D60= 2,000		
0.002	0,0			



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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 Report compiled by : Juraine Okkies

Date Reported : 2020-10-20

Job Request No.: RU3667
 Cedar Land Geotechnical Consult (Pty) Ltd
 PO Box 607
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 6835
 Attention : Frans Breytenbach

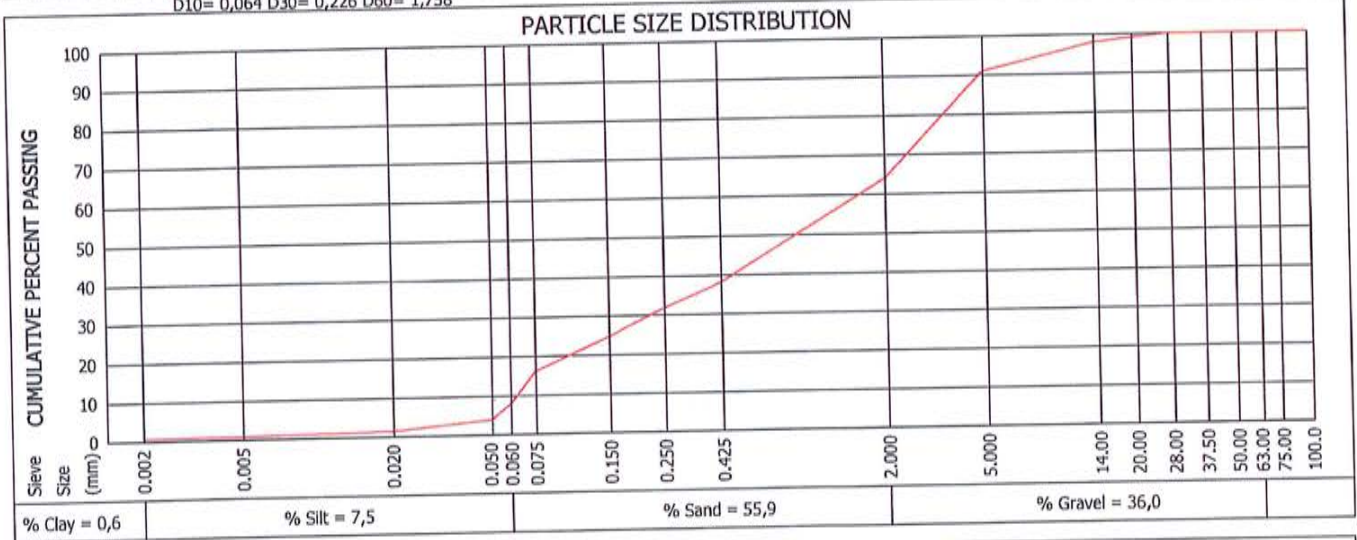
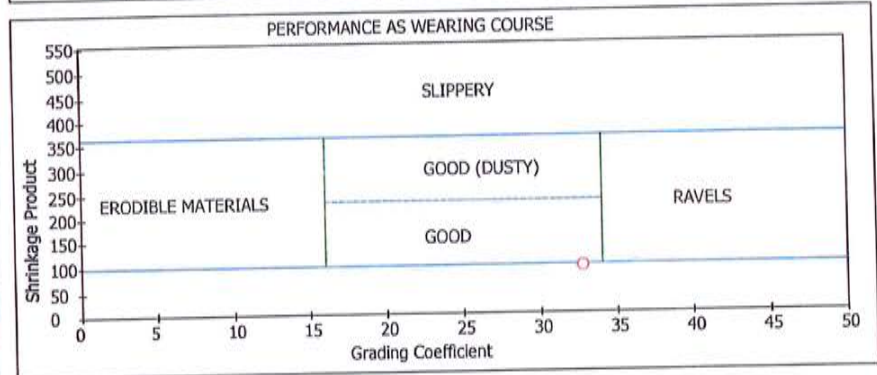
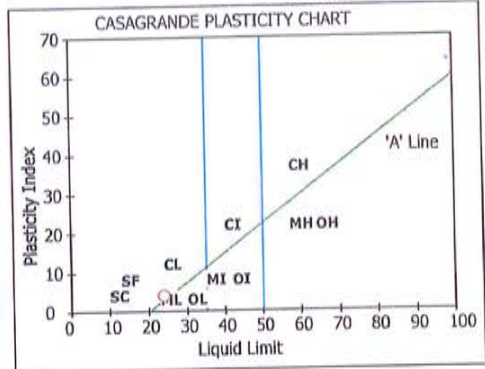
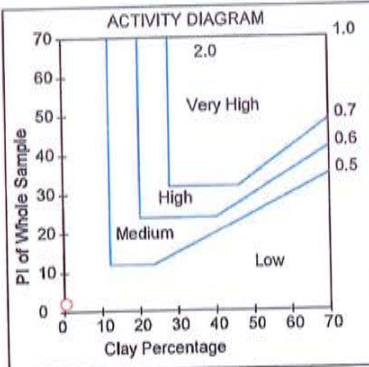
Project : Blaauwskop (Plangeni)

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

Sample No.	: U9434
Position	: TP24
Layer Type	: 300-1300mm
Sample Colour	: Light Brown Gravel
Sample Type	: Mix Weathered Granit

Sieve Size(mm)	% Passing	Soil Mortar		
100.0	100	2.000 - 0.425	40	
75.00	100	0.425 - 0.250	11	
63.00	100	0.250 - 0.150	11	
50.00	100	0.150 - 0.075	13	
37.50	100	< 0.075	25	
28.00	100	Effective Size	0,064	
20.00	99	Uniformity Coefficient	27,5	
14.00	98	Curvature Coefficient	0,5	
5.000	91	Oversize Index	0,0	
2.000	64	Shrinkage Product	95,0	
0.425	38	Grading Coefficient	32,8	
0.250	32	Grading Modulus	1,80	
0.150	25	Atterberg Limits	Liquid Limit	24
0.075	16		Plasticity Index	4
0.060	8,1		Linear Shrinkage	2,5
0.050	3,9		PI < 0.075	
0.020	1,4	Unified Soil Classification	SM-SC	
0.005	0,8	US Highway Classification	A-1-b(0)	
0.002	0,6			

D10= 0,064 D30= 0,226 D60= 1,758



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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 Report compiled by : Juraine Okkies

Job Request No.: RU3667
 Cedar Land Geotechnical Consult (Pty) Ltd
 PO Box 607
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 6835
 Attention : Frans Breytenbach

Date Reported : 2020-10-20

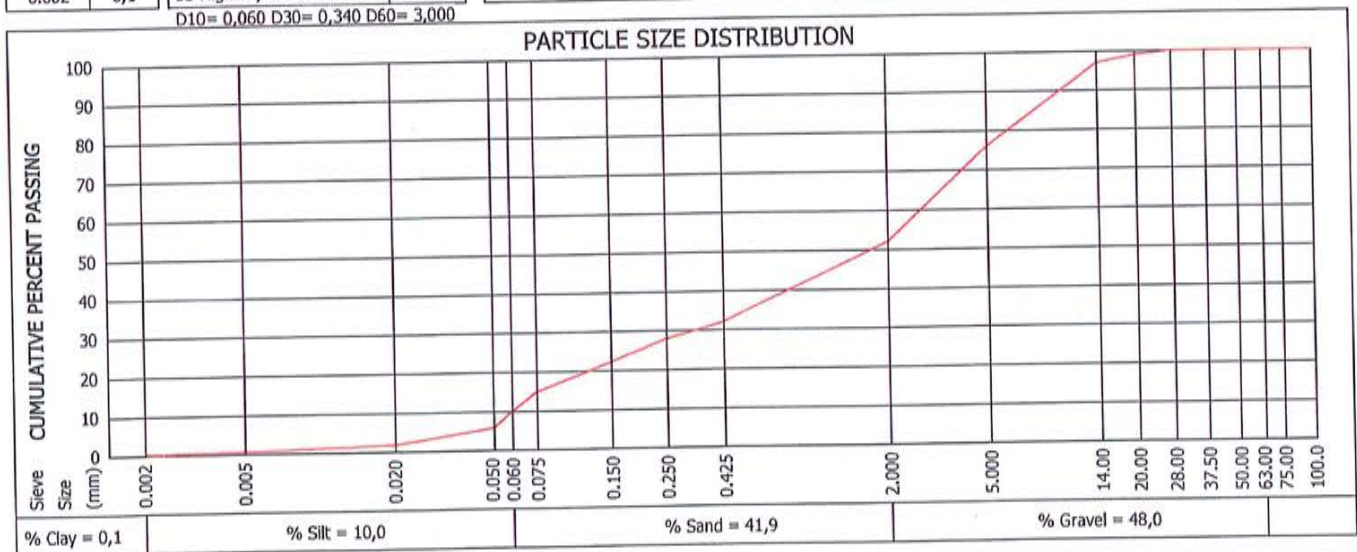
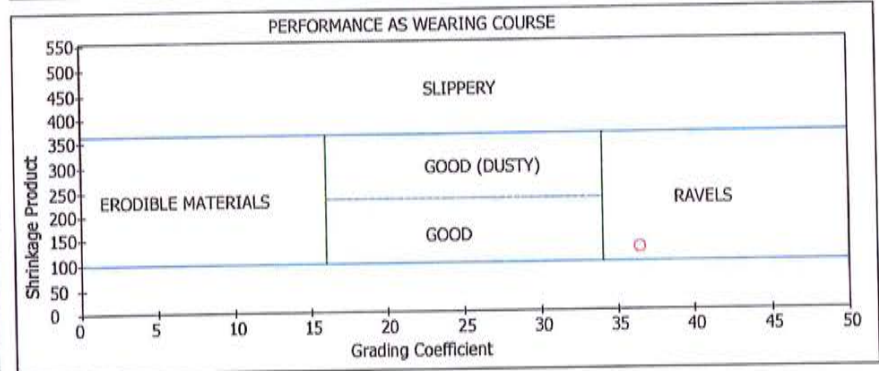
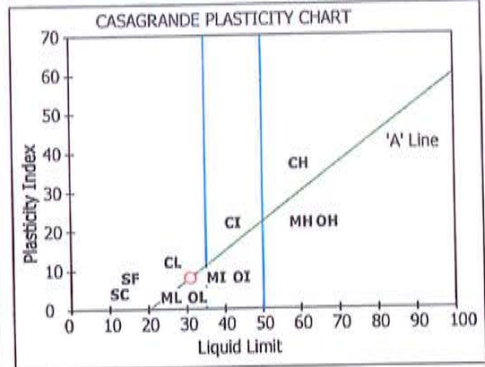
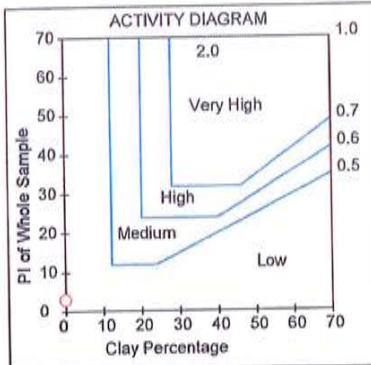
Project : Blaauwskop (Plangeni)

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

Sample No.	: U9435
Position	: TP27
Layer Type	: 200-700mm
Sample Colour	: Light Brown Gravel
Sample Type	: Mix W.Granite+OccCal

Sieve Size(mm)	% Passing	Soil Mortar	2.000 - 0.425	38
100.0	100		0.425 - 0.250	9
75.00	100		0.250 - 0.150	11
63.00	100		0.150 - 0.075	14
50.00	100		< 0.075	29
37.50	100	Effective Size		0,060
28.00	100	Uniformity Coefficient		50,0
20.00	99	Curvature Coefficient		0,6
14.00	97	Oversize Index		0,0
5.000	76	Shrinkage Product		128,0
2.000	52	Grading Coefficient		36,5
0.425	32	Grading Modulus		2,00
0.250	28	Atterberg Limits	Liquid Limit	31
0.150	22		Plasticity Index	8
0.075	15		Linear Shrinkage	4,0
0.060	10		PI < 0.075	
0.050	5,7	Unified Soil Classification		SM
0.020	1,7	US Highway Classification		A-2-4(0)
0.005	0,4			
0.002	0,1			

D10= 0,060 D30= 0,340 D60= 3,000



Deviation from Test Method :
 Remarks and Notes : Chemistry: pH = 8.29 [SANS 5854] & Conductivity = 0.08 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

Job Request No.: RU3667
 Cedar Land Geotechnical Consult (Pty) Ltd
 PO Box 607
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 6835

Date Reported : 2020-10-15

Project : Blaauwskop (Plangeni)

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.	U9436		
HOLE NO/ Km / CHAINAGE	T30		
ROAD NO./ NAME Line 1	S28° 40' 05,5"		
ROAD NO./ NAME Line 2	E21° 06' 19,5"		
LAYER TESTED/SAMPLED	0-300mm		
SAMPLE DEPTH	0-300mm		
DATE SAMPLED	2020-10-06		
COLOUR OF SAMPLE	Light Greyish Brown		
TYPE OF SAMPLE	Mix W. Granitestone		

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		
	50.0 mm	100	
	37.5 mm	97	
	28.0 mm	93	
	20.0 mm	91	
	14.0 mm	86	
	5.0 mm	70	
	2.0 mm	48	
0.425 mm	28		
0.075 mm	11		
GM %	2,1		

SOIL MORTAR ANALYSIS (SANS 3001-PR5:2011)

COARSE SAND	2.000 - 0.425	41	
COARSE FINE SAND	0.425 - 0.250	10	
MEDIUM FINE SAND	0.250 - 0.150	11	
FINE FINE SAND	0.150 - 0.075	16	
SILT CLAY	0.075	23	

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

ATTERBERG LIMITS (%) SANS GR10,GR11	LIQUID LIMIT	21	
	PLASTICITY INDEX	1,9	
	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 %	6,4	
	MDD (kg/m³)	2098	
	COMP MC %	6,3	
SWELL % @	MOD NRB PRO	0,00 0,02 0,04	
	100 %	86	
C.B.R. SANS GR40	98 %	66	
	97 %	58	
	95 %	44	
	93 %	34	
	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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 Report compiled by : Juraine Okkies

Determination Maximum Dry Density & Optimum Moisture Content Test Report

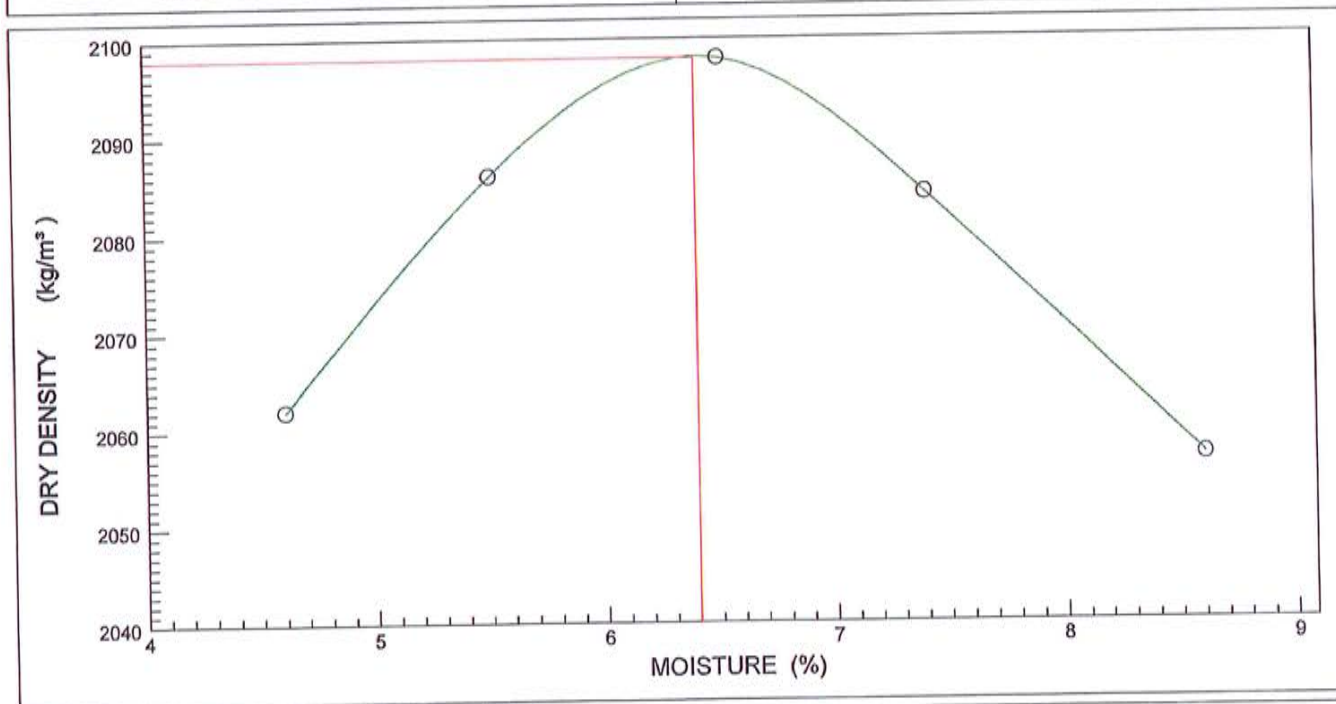
SANS 3001 - GR20/GR30

SAMPLE NO.	U9436
CONTAINER FOR SAMPLING	Black Nylon Bags
SIZE / APPROX. MASS OF SAMPLE	83kg
MOISTURE CONDITION OF SAMPLE	Moist
LAYER TESTED / SAMPLED FROM	0-400mm
MATERIAL DESCRIPTION	Mix W.Calcrete + W. Granitestone
HOLE NO./ km / CHAINAGE	TP30
ROAD NO.	Not Specified
DATE RECEIVED	2020-10-06
DATE SAMPLED	2020-10-06
CLIENT MARKING	
COLOUR AND TYPE	Light Greyish Brown Gravel

POINT NO.	1	2	3	4	5			
DRY DENSITY (kg/m ³)	2062	2086	2098	2084	2057			
MOISTURE (%)	4,6	5,5	6,5	7,4	8,6			

MAXIMUM DRY DENSITY (kg/m³) : 2098

OPTIMUM MOISTURE CONTENT (%) : 6,4



Deviation from Test Method :
 Remarks and Notes :

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 Attention : Frans Breytenbach

Date Reported : 2020-10-20

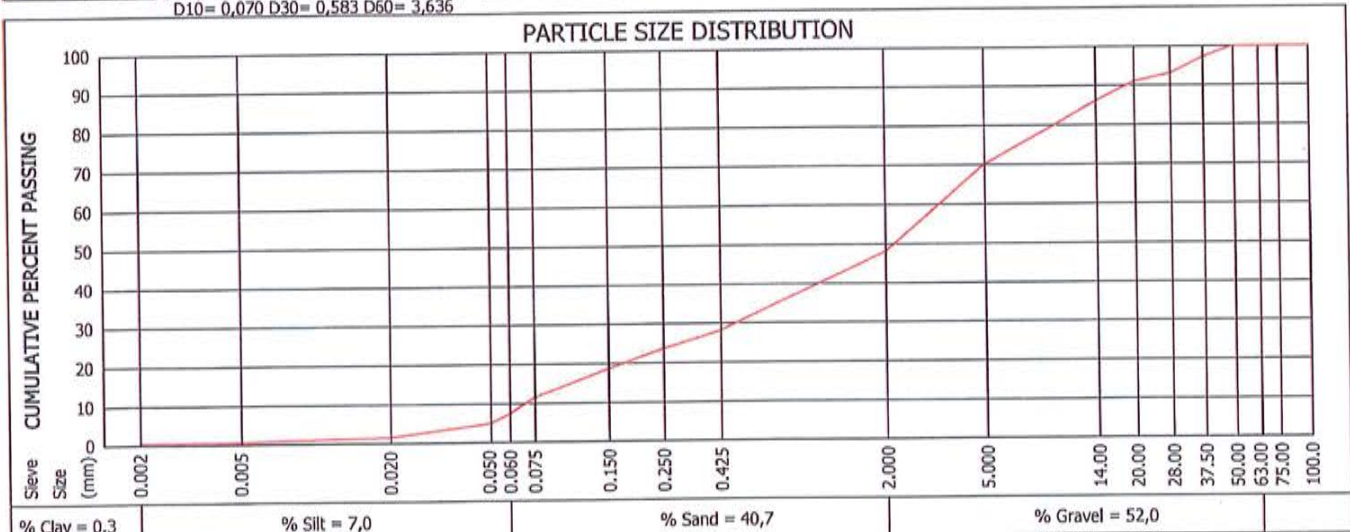
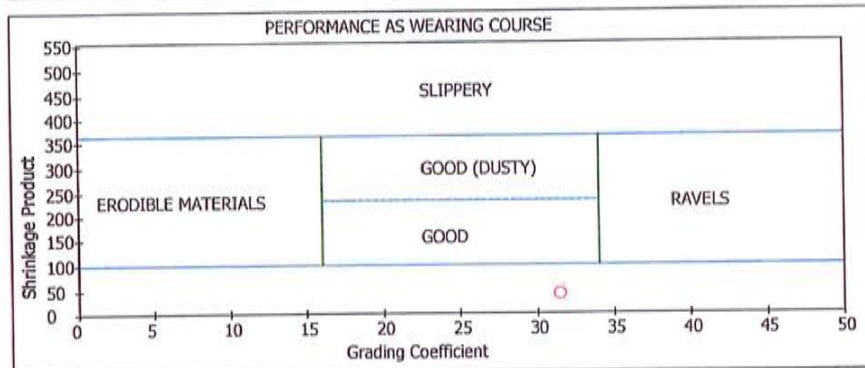
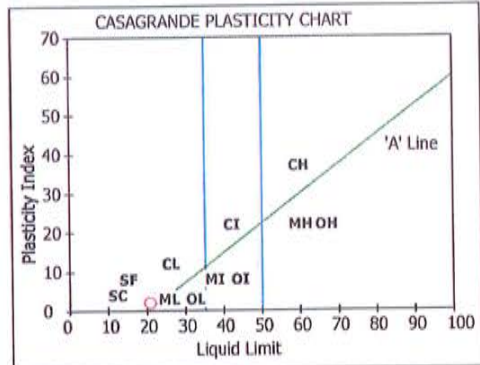
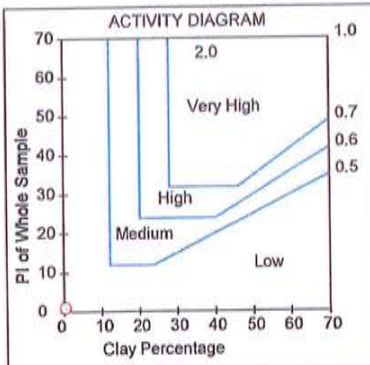
Project : Blaauwskop (Plangeni)

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

Sample No.	: U9436
Position	: TP30
Layer Type	: 0-300mm
Sample Colour	: Light Greyish Brown
Sample Type	: Mix W.Granitestone

Sieve Size(mm)	% Passing	Soil Mortar		
100.0	100	2.000 - 0.425		41
75.00	100	0.425 - 0.250		10
63.00	100	0.250 - 0.150		11
50.00	100	0.150 - 0.075		16
37.50	97	< 0.075		23
28.00	93	Effective Size		0,070
20.00	91	Uniformity Coefficient		51,9
14.00	86	Curvature Coefficient		1,3
5.000	70	Oversize Index		3,0
2.000	48	Shrinkage Product		42,0
0.425	28	Grading Coefficient		31,5
0.250	24	Grading Modulus		2,10
0.150	19	Atterberg Limits	Liquid Limit	21
0.075	11		Plasticity Index	2.0
0.060	7,3		Linear Shrinkage	1.5
0.050	4,8		PI < 0.075	
0.020	1,4	Unified Soil Classification		SW-SC
0.005	0,4	US Highway Classification		A-1-a(0)
0.002	0,3			

D10= 0,070 D30= 0,583 D60= 3,636



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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 Report compiled by : Juraine Okkies

Job Request No.: RU3667
 Cedar Land Geotechnical Consult (Pty) Ltd
 PO Box 607
 Ceres
 6835
 Attention : Frans Breytenbach

Date Reported : 2020-10-20

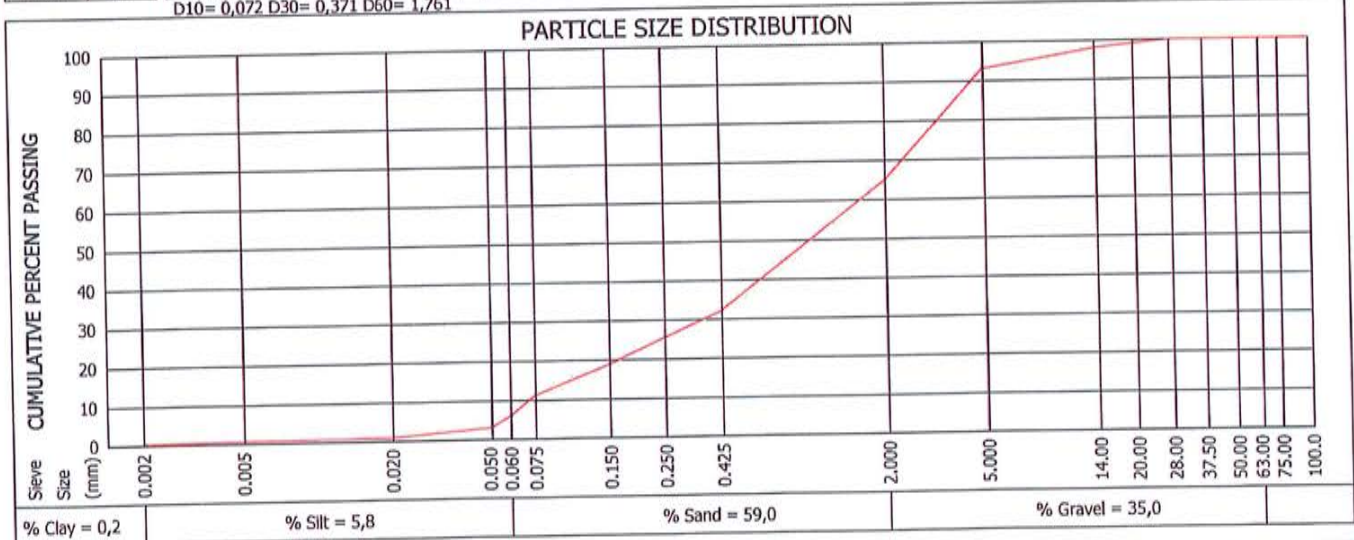
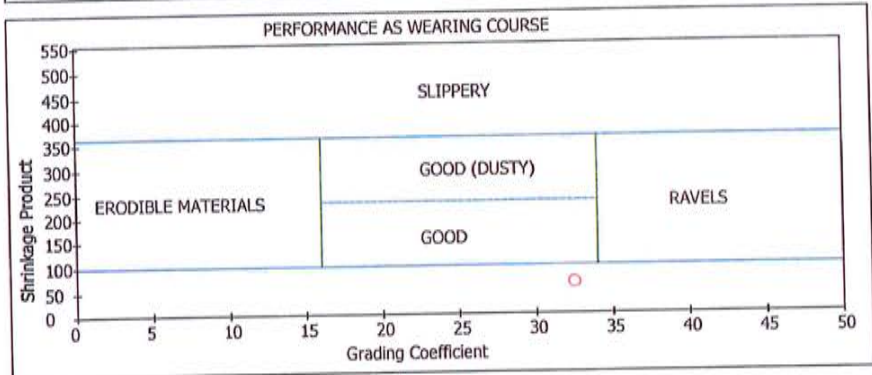
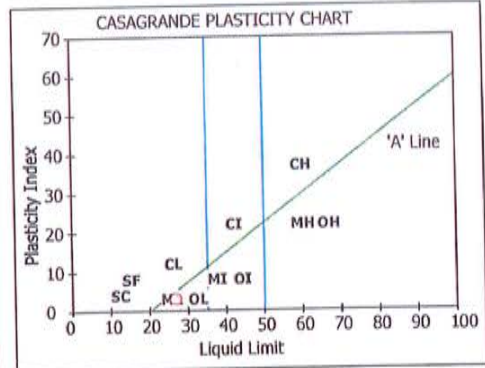
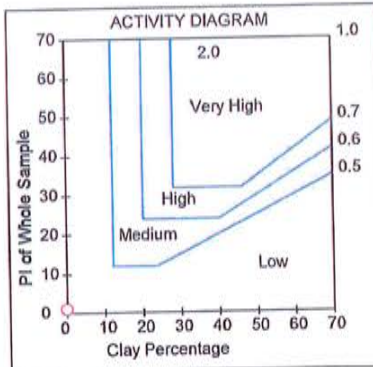
Project : Blaauwskop (Plangeni)

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

Sample No.	: U9437
Position	: TP33
Layer Type	: 200-1300mm
Sample Colour	: Greyish Brown Gravel
Sample Type	: Mix W.Granite+OccCal

Sieve Size(mm)	% Passing	Soil Mortar	2.000 - 0.425	50
100.0	100		0.425 - 0.250	10
75.00	100		0.250 - 0.150	10
63.00	100		0.150 - 0.075	12
50.00	100		< 0.075	17
37.50	100	Effective Size		0,072
28.00	100	Uniformity Coefficient		24,5
20.00	99	Curvature Coefficient		1,1
14.00	98	Oversize Index		0,0
5.000	93	Shrinkage Product		64,0
2.000	65	Grading Coefficient		32,5
0.425	32	Grading Modulus		1,90
0.250	26	Atterberg Limits	Liquid Limit	27
0.150	19		Plasticity Index	3.0
0.075	11		Linear Shrinkage	2.0
0.060	6,0		PI < 0.075	
0.050	3,0		Unified Soil Classification	SW-SM
0.020	0,9	US Highway Classification	A-1-b(0)	
0.005	0,5			
0.002	0,2			


D10= 0,072 D30= 0,371 D60= 1,761



Deviation from Test Method :
 Remarks and Notes : Chemistry: pH = 8.38 [SANS 5854] & Conductivity = 0.02 S/m [SANS 6240]

Opinions and interpretations are not included in our scope of works. (T0296)
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 The test results reported relate to the samples tested.
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 Report compiled by : Juraine Okkies

sanas
 Testing Laboratory
 Accreditation No. T0296
 Prog.ver 10.7 (2019/11/07)


 D Juckers
 Technical Signatory