Report 2020/10

Report on a Phase 1 Geotechnical Site Investigation for the proposed KSL Student Lifestyle Precinct on Portion 191 of the farm Tweefontein 915LS- Limpopo Province

Prepared for: KPD Property Development
PO Box 1217
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Att: S Bosch/K van der Merwe

July 2020

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REPORT ON A PHASE 1 GEOTECHNICAL SITE INVESTIGATION FOR THE PROPOSED KSL STUDENT LIFESTYLE PRECINCT ON PORTION 191 OF THE FARM TWEEFONTEIN 915LS- LIMPOPO PROVINCE

1. INTRODUCTION

A Phase 1 Geotechnical Site Investigation was undertaken at the request of S'thembiso Bosch of KPD Property Development in Polokwane. The investigation was undertaken in support of the proposed KSL Student Lifestyle Precinct situated on Portion 191 of the farm Tweefontein 915-LS; seen to fall within the eastern portions of the Polokwane, Limpopo Province.

Foundation conditions are determined through surface geological mapping, trial pitting to expose the subsurface profile, soil profiling and soil sampling for testing. The above actions are in accordance with the stated requirements in the Code of Practice on geotechnical site investigations (SAICE, 2010).

The objectives of the investigation were:

(i) To determine the geology and the relevant mechanical properties of the soil and rock horizons present on site.
(ii) To give general foundation recommendations.
(iii) To comment on the excavation characteristics and possible uses of the materials underlying the site for installation of services as well as for use in layer works in paving and roads.
(iv) To comment on site water management aspects particularly pertaining to shallow groundwater or seepage.

2. AVAILABLE INFORMATION

At the time of the investigation the 1:250 000 Geological Sheet 2328 Pietersburg, 1:50 000 topocadastral map 2329 DC Mankweng and satellite images were available.

The guideline and specification documents by the South African Institute of Engineering and Environmental Geologists and South African Institution for Civil Engineers (1997), the National Department of Housing (2002) and the National Home Building Manual (NHBRC, 2015) were also consulted.

3. SITE DESCRIPTION

The investigated site is located within the central portions of the Limpopo Province; within the eastern extent of the provinces' capital, Polokwane. On a more localised scale, the site is seen to fall within the northern portions of the Dalmada Agricultural Holdings (Figure 1, Appendix A).

The investigated Portion 191 of the farm Tweefontein 915-LS is located immediately south east of the Northern Academy Primary School and is accessible via the sealed Romulus Drive. The new development area incorporates a roughly rectangular shaped parcel of land with a surface area of approximately 21 ha.

This parcel of land was investigated to assist with the design and construction of the proposed new KSL Student Lifestyle Precinct; entailing the construction of numerous single- and double- storey structures and associated township infrastructure (road network, parking areas, services and cafeteria structures). The exact extent and nature of the planned development is currently unknown.

The parcel of land in question was seen to be predominantly undeveloped at the time of this investigation. Scattered portions of the sites' surface were seen to have been reworked through trivial sand mining activities and intermittent uncontrolled dumping.
Extensive intercalated schist and gneiss bedrock outcrops were present across the central and south eastern portions of the site.

The regional setting is seen to display a relatively uniform surface morphology; broken sporadically by minor ridges. The site is seen to fall along the north western side slope of one such ridge. For this reason; the regional slope is towards the minor valley to the north west with local variations due to localised bedrock outcrops and artificially induced topographic anomalies.

As seen during the field work phase of the investigation, the majority of the site is seen to host a continuous gentle sloping surface, with average slopes of between 2 and 6 degrees. The south eastern to eastern portions of the site were seen to display the highest elevations of approximately 1355 meters above mean sea level (mamsl); decreasing to an elevation of approximate 1330 mamsl in the far western to north western portions (as calculated through the use of google Earth PRO ™).

As a whole, the degree of sloping was seen to decrease in a north westerly direction across the site. A rocky ridge and associated variable steep slope (6 to 12 degrees) was seen to traverse the entire south eastern portion of the site. This area was avoided as requested by the Client due to its geomorphological nature in relation to the proposed development.

The overall gentle sloping nature of the sites' surface will result in low energy surface run-off (sheet-flow), following the natural contour of the site. The gentle sloping nature across the majority of the site will aid surface water infiltration into the underlying soils, rather than rapid surface water flow.

According to the available information (Topocadastral Map 2329 CC Mankweng- Figure 2, Appendix A), there are no natural drainage structures traversing the investigated site. The closest mapped drainage feature is the non-perennial river- and associated dams- located approximately 300m north west of the site. Surface runoff will be channelled away artificially due to the presence of surficial infrastructure between the site and the surrounding major natural drainage systems in the area.

Small scale topographic anomalies are present across the site due to the artificial reworking of the sites surface. The artificial reworking of the sites' surface affects both the degree and continuity of the natural slopes across the site, as well as the associated predicted drainage nature.

The study area is located within the Central Bushveld Bioregion of the Savanna Biome (Mucina and Rutherford, 2006). The existing vegetation across the site was seen to comprise of abundant short grasses and bushes/small trees in conjunction with scattered large trees. Extensive sub-surface root systems are predicted to occur in areas hosting large trees. Furthermore, the removal of large trees will result in changes in both moisture conditions and degree of weathering of the surrounding soils.
The degree of organic material and biotic activity was seen to decrease with an increase in depth, with major root systems reaching to a depth of approximately 0.5 m below the existing ground level.

Termite mounds, subsoil nests and biological tunnelling was visible across the majority of the site.

4. METHOD OF INVESTIGATION

The fieldwork, entailing a site walkover, trial pitting and profile descriptions, was conducted on 8 June 2020 during which time ten (10) test pits were excavated and described. The test pits were excavated by means of a TLB-type light mechanical excavator (Volvo H940S). The exposed profiles are regarded as being representative of the site conditions.

Test pits were distributed across the designated development area, in locations deemed safe for excavations and free of subsurface infrastructure. The positions of the described pits are indicated in relation to the sites' boundary on a satellite image (Figure 3, Appendix A).

A registered Engineering Geologist recorded the soil profiles using the standard procedures as recommended by AEG/SAIEG/SAICE (2002). The soil profiles are included in Appendix B and photographs of test pit are attached in Appendix C.

A total of 7 disturbed soil samples and 1 bulk soil sample were retrieved from the transported and weathered soils and submitted to Letaba Lab for testing (SANAS accredited).

Foundation indicator tests were performed on the disturbed samples to determine the particle size distribution and plasticity of the soil. The material was tested for foundation purposes and therefore the grading was carried out to 0,002mm. A number of samples were also tested for pH and electrical conductivity.

Further compaction tests were conducted on the sampled materials to evaluate the suitability of the materials for the re-use in the proposed construction. Undisturbed sampling was not feasible due to the friable nature of the residual soils and the shallow occurrence of weathered bedrock.

5. GEOLOGY

5.1 GENERAL

According to the relevant 1:250 000-scale geological sheets, the site is underlain by talc-chlorite schist bedrock belonging to the Mothiba Formation of the Pietersburg Greenstone Belt and gneissic bedrock belonging to the Goudplaats-Houtriver Gneisses. These lithological units' form part of the oldest lithological units of the Swazian Period (Figure 4, Appendix A).

Following excavations and geological field mapping; the majority of the site was seen to be underlain by intercalated gneiss and schist bedrock- with the central portions of the site seen to host a small diabase dyke. Where intrusions are present, it is predicted that the gneissic bedrock has undergone various degrees of contact metamorphism. A highly undulating bedrock topography was exposed across the site; ranging from undisturbed competent rock to highly fractured and weathered incompetent rock/residual soil. This may impact the continuity of excavatability across the site as well as amplify differential settlement.

The central and south eastern elevated parts of the site are underlain by shallow or outcropping bedrock.

This site is not underlain by dolomitic bedrock and a stability investigation is therefore not required.

According to the geological maps and accompanied explanation no specific mineral deposits are present on the site.

As seen during the fieldwork phase of the investigation; a small diabase dyke was seen to traverse the northern portions of the site. This dyke forms part of a large swarm with a predicted NE/SW orientation. Due to the age of these structures the site is deemed to be geologically stable. The regional disturbance of the in-situ bedrock has led to the formation of zones of weakness which aid the movement of hydrothermal fluids (dykes and veins).

According to Brandt (2011) the regional seismic hazard in the project area can be defined as LOW, exhibiting a 10% probability of a seismic event with a peak ground acceleration of less than 0.1 cm/s^2 within a period of 50 years.

Climate determines the mode and rate of weathering. The effect of climate on the weathering process (i.e. soil formation) is determined by the climatic N value defined by Weinert (1980). The Climatic N-Value for the area falls between 3 and 4; therefore, chemical disintegration of the parent rocks in the regional setting is deemed the principal mode of weathering. This mode of weathering favours soil formation, rather than an abundance of rocky fragments occurring within the soil matrix. Physical/mechanical disintegration of parent rock will take place but on a lower scale.

5.2 SOIL PROFILE

A brief description of the various soil horizons encountered in the test pits, during this investigation, is given below with a summary in Table 1.

Two typical ground profiles, linked to the underlying bedrock geology, are present on this site:

Typical profile on intercalated gneiss and schist bedrock

The majority of the site was seen to be underlain by intercalated gneiss and schist bedrock and their weathered constituents.

Topsoil/Colluvium

The site was typically seen to be blanketed by a succession of fine grained organic rich topsoil. It's nature and extent were seen to vary as a result of the ever-changing geomorphology of the site; with thicker exposures present in the low-lying portions of the site.

The fine-grained colluvium/topsoil was described as: slightly moist dark reddish brown and dark brown speckled loose open root channels clayey SAND with trace amounts to abundant rounded quartz gravels and biological nests and abundant roots. The topsoil across the site was typically seen to extend from the surface to depths of between 0.09 and 0.40 m below the existing ground level (E.G.L.); with an average exposed thickness of approximately 0.23 m.

Pebble marker

The topsoil material was seen to be underlain by a concentrated gravel horizon marking the changeover from the transported to the residual soils. The pebble marker is typically a concentration of quartz gravels and cobbles in a fine-grained matrix. The pebble marker was described as a slightly moist dark reddish brown blotched orange and white loose and medium dense matrix supported sub-rounded coarse quartz gravels and traces of angular translucent quartz cobbles in a matrix of silty SAND with an overall undulating thickness, heterogenous composition and fine roots.

This horizon was seen to extend from below the topsoil or from the surface to a depth of between 0.13 and 1.05 m below E.G.L; with an average thickness of approximately 0.39 m. This horizon was seen to share an undulating contact with the underlying residuum.

Residual gneiss

The degree of bedrock decomposition was seen to fluctuate across the site, however, as a whole, the rock mass at depth was intact- displaying a favourable geotechnical nature. The uppermost weathered horizon was deemed to display a soil-like nature; as such was profiled as a residual soil.

Distinct exposures of residual gneiss were more prolific in the low lying, north western portions of the site underlain by gneissic bedrock. Intercalated successions of gneiss and schist were more prolific in the central to south eastern portions of the site.

The residual gneiss was generally profiled as; slightly moist dark reddish brown blotched cream and orange banded olive medium dense to dense at the base pinholed silty angular GRAVEL with minor cobble sized gneissic corestones, traces of ferricrete nodules, pockets of less weathered gneissic bedrock and traces of fine roots.

Where encountered the residual gneiss was seen to extend from below the above described pebble marker to depths of between 0.49 and 1.05 m below E.G.L; with an average thickness of approximately 0.38m. This horizon was seen to share a gradational contact with the underlying weathered bedrock.

Intercalated weathered gneiss and schist bedrock

As for the residual soils, the weathered bedrock material formed from the decomposition of the underlying rock mass; the degree of in-situ decomposition was however notably lower than that of their residual counterparts. The degree of weathering was seen to fluctuate across the site.

Gneissic bedrock was prolific across the lower lying north western portions of the site, followed by intercalated gneiss and schist bedrock in the central portions. These portions were seen to host extensive intercalated gneiss and schist outcrops. The high lying south eastern portions of the site were dominated by schist outcrops; with the schist outcrops seen to be softer than that of the gneiss.

Where thick exposures of weathered bedrock were encountered, they were profiled as; slightly moist light yellowish creamy brown stained red and banded light green dense with an increase in consistency with an increase in depth massive with relict joints sub-angular silty GRAVEL with trace amounts to abundant angular weathered gneiss and schist cobbles. Intercalated highly weathered gneiss and schist of the Mothiba Formation, Pietersburg Greenstone Belt.

Difficult excavation conditions through the use of a TLB- type light mechanical excavator occurred within/upon the weathered bedrock at depths of between 0.4 and 1.3 m below E.G.L. Excavations between exposed outcrops were shallow and undulating.

Typical profile on diabase bedrock

Test pit TP8, excavated in the northern portions of the site, exposed a diabase dyke and its weathered constituents. Intermittent surficial diabase boulders were encountered across the remaining portions of the site with no prominent outcrop. The exact orientation of the dyke is not known however it is predicted to follow the orientation of the regional dyke swarms, exhibiting a NE/SW strike.

Transported soils

This portion of the site was blanketed by a thin fine-grained topsoil followed by a pebble marker horizon as described in the preceding sections of this report. These transported materials were seen to extend from the surface to a depth of 0.5 m below E.G.L.

Weathered diabase bedrock

The transported soils were seen to be underlain by weathered diabase bedrock. The fractured nature of the rock mass enabled minor penetration; with the TLB managing to expose 0.09 m after which refusal occurred (final excavation depth of 0.59 m).

In profile the weathered bedrock was generally described as; slightly moist dark grey stained black and red dense with an abrupt increase in consistency with an increase in depth closely jointed moderately weathered medium hard rock DIABASE with minor fine roots along joints.

See table 1 overleaf which summarises the results of the trenching phase.

5.3 GROUNDWATER

The predominant runoff will occur as sheet wash following the topography. The uppermost soils will accommodate horizontal flow towards the low-lying western to north western portions. The predominant gentle sloping nature across the majority of the site will aid surface water infiltration into the underlying soils, rather than rapid surface water flow. Furthermore, the rock mass underlying the site is predicted to display an undulating topography, with the overall permeability on the in-situ material expected to decrease with depth. These attributes promote in the formation of fluctuating moisture conditions in the upper 1.0 m of the profile after prolonged precipitation events.

Significant changes in moisture content may contribute to the anticipated compressibility and collapse of the site soils. During construction and after development, shallow perched water systems may develop yet further due to stormwater management practices, localised infiltration and site modification practices.

Table 1: Test pit summary: Encountered depths of different materials (m)

Test pit	Geotechnical Zone	Fine Topsoil/ Colluvium			Pebble Marker			Residual Gneiss			Weathered Gneiss/ Schist Bedrock			Weathered Diabase Bedrock			Test pit depth
		From	To	Extent	From	To	Extent	From	To	Extent	From	To	Extent	From	To	Extent	
TP1	I	0.00	0.40	0.40	0.40	0.68	0.28	0.68	1.05	0.37	-	-	-	-	-	-	1.05
TP2	I	-	-	-	0.00	0.52	0.52	0.52	0.91	0.39	0.91	1.30	0.39	-	-	-	1.30
TP3	II	-	-	-	0.00	0.13	0.13	-	-	-	0.13	0.40	0.27	-	-	-	0.40
TP4	II	-	-	-	0.00	0.15	0.15	0.12	0.49	0.37	0.49	0.52	0.03	-	-	-	0.52
TP5	I	-	-	-	0.00	0.39	0.39	-	-	-	0.39	0.90	0.51	-	-	-	0.90
TP6	I	0.00	0.09	0.09	0.09	0.55	0.46	0.55	0.91	0.36	-	-	-	-	-	-	0.91
TP7	I	0.00	0.40	0.40	0.40	0.54	0.14	0.54	0.95	0.41	-	-	-	-	-	-	0.95
TP8	II	0.00	0.10	0.10	0.10	0.50	0.40	-	-	-	-	-	-	0.50	0.59	0.09	0.59
TP9	I	-	-	-	0.00	1.05	1.05	-	-	-	1.05	1.13	0.08	-	-	-	1.13
TP10	II	0.00	0.15	0.15	-	-	-	-	-	-	0.15	0.52	0.37	-	-	-	0.52

The following notes apply:

- Seepage was not encountered in any of the test pits excavated across the site, however traces of pedogenic material were observed in the upper 1 meter of the exposed soil profiles.
- Indications from the soil profiles are that perching of percolating groundwater may occur on the soil/bedrock interface; periodically inundating the foundations.
- The site is located within close proximity to the local watershed landform and associated catchment area; as such subordinate volumes of natural surface water discharge are expected.
- Channelized surface water flow and elevated rates of surface water run-off from compacted/sealed surfaces amplify the risk of erosion across the site.
- Design should incorporate the likelihood of enhanced shallow seepage due to localised infiltration, stormwater practices, etcetera.

The regional groundwater in this area occurs in intergranular and fractured aquifers with an average borehole yield in excess of 5 l/s. The groundwater quality is deemed to be between 0 and 70 mS/m (electrical conductivity range). According to the available information, large scale groundwater abstraction does not take place within the study area.

RECOMMENDED ACTIONS: Surface and subsurface drainage precautions are required to minimise large soil moisture changes. The potential for fluctuating moisture conditions in the upper 1 m is of concern and may need special damp proofing and other measures. If the site or a portion thereof is situated within the 1:100-year flood lines, or have been delineated as a wetland, it is the prerogative of the Civil Engineer or other suitably experienced specialist to overwrite the geotechnical recommendations for such portions.

6. GEOTECHNICAL EVALUATION

The geotechnical appraisal is based on the field observations and available laboratory test results from this site.

6.1 ENGINEERING AND MATERIAL CHARACTERISTICS

The foundation indicator test results conducted on the samples from this site are summarised in Table 2.

Table 2. Indicator test results.

Test Pit	DEPTH	MATERIAL	GRADING/ HYDROMETER				ATTERBERG LIMITS			GM	CLASSES			HEAVE
			%C	%M	%S	%G	LL	PI	LS		TRB	USC	COTO (2019)	
TP1	0.68-1.05	Residual Gneiss	10	7.8	33	40	25	9	4.6	2.2	A-2-4	SW/SC	N/A	LOW
TP2	0-0.52	Pebble Marker	13	9.1	47	18	27	11	5.7	2.2	A-2-6	GW/GC	G8	LOW
TP5	0.39-0.90	Schist Bedrock	6.3	9.5	57	17	27	7	3.7	2.4	A-2-4	GW/GM/GC	N/A	LOW
TP6	0.09-0.55	Pebble Marker	16	16	30	23	26	10	5.1	2.1	A-2-4	GC	N/A	LOW
TP7	0.54-0.95	Residual Gneiss	13	7.1	41	27	27	11	5.9	2	A-2-6	SC	N/A	LOW
TP8	0.10-0.50	Pebble Marker	20	11	44	6.2	27	10	5.2	2.3	A-2-4	GC	N/A	LOW
TP9	0.00-1.05	Pebble Marker	16	12	41	19	33	13	6.5	2.4	A-2-6	GP/GC	N/A	LOW
NOTES	-1	Grading: Percentage clay (%C), silt (%M), sand (%M) and gravel (%G) by weight.												
	-2	Atterberg Limits: Liquid Limit (LL), Plasticity Index weighted (PI), Linear Shrinkage (LS).												
	-3	Heave: Potential expansiveness (acc. Van Der Merwe, 1964).												

The results obtained from the soil samples indicate the following:

- The sampled materials grade as coarse sands/fine gravels with a grading modulus ranging between 2.0 and 2.4.

- The soils exhibit a low to medium plasticity (between 7 and 13), low to medium linear shrinkage values and an overall LOW potential for heave (acc. Van Der Merwe, 1964).
- Typical Unified Soil Classes are SW/SC and GP/GM/GW/GC.
- TRB class is A-2-4 and A-2-6.
- The sampled materials typically displayed moderate compactability; classifying as a G8- type material according to the COTO classification system (2019). The compactability of the on-site material is predicted to be favourable due to its course grained nature and low to medium plasticity.
- The sampled material displayed a measured CBR of 11 @93% MOD AASHTO.
- The organic rich topsoil was omitted from the sampling process.

Interpretation of results based on available literature

SW/SC Soils

- SW/SC Class materials are typically well graded clayey sands and are regarded as fair to good subgrade, fair subbase and not suitable as base course. (United States Army Corps of Engineers, 1953).
- Drainage will be poor, and a low compressibility can be expected once compacted (United States Army Corps of Engineers, 1953).
- The material may be suitable for the use as selected layers in the proposed construction (suitability based on the engineer's design).
- CBR values are typically between 10 and 20 and subgrade modulus 25 – 80 MN/m^3 (United States Army Corps of Engineers, 1953).
- The shear strength of the material is expected to be good when compacted and saturated.

GP/GM/GW/GC Soils

- GM/GW/GC Class materials are typically well/poorly graded clayey/silty gravel and are regarded as good subgrade, good to fair subbase and fair base course. (United States Army Corps of Engineers, 1953).
- The range of classifications highlight the heterogenous composition of the materials sampled across the site.
- Drainage will be fair, and a low compressibility can be expected once compacted (United States Army Corps of Engineers, 1953).
- The sampled material classified as a G8-type material (COTO)- as such the material may be suitable for the use as selected layers in the proposed construction (suitability based on the engineer's design).
- CBR values are typically between 20 and 50 and subgrade modulus 60 – 100 MN/m^3 (United States Army Corps of Engineers, 1953).
- The shear strength of the material is expected to be fair when compacted and saturated.

The residual gneiss and weathered bedrock were described in profile as medium dense which can be related to bearing pressures of 100 – 200 kPa (Look, 2014). Other sources list presumptive bearing capacity of silty sand soils (SC/SW) to 95 – 250 kPa (Alemdag et al, 2017; BS8004-1986; Builders Engineer 27 October 2012; USACE, 1953). The bearing capacity will increase with an increase in depth due to the increase in grain size and in-situ consistency as well as decrease in weathering grade.

The allowable bearing pressures imposed on the material is a function of both the soils shear strength (ultimate limit state) and its' settlement characteristics (serviceability limit state). The presumptive bearing capacity figures disregard the effect of soil moisture changes and in situ structure that may induce settlement or collapse. Taking the additional movements due to soil collapse into account will imply that foundation improvements will be necessary for light structures/residential development.

The voided structure in the underlying pebble marker and residual gneiss may in addition to the settlement also cause larger than normal settlements due to collapse under loading and saturation of these soils. Clay percentages are low to moderate, which may be sufficient to form clay bridges between grains- typical of a collapsible grain texture. The over excavation, sorting and re-compaction of these soils will result in the destruction of their non-favourable in-situ soil properties.

Some of the soil samples were tested for pH and electrical conductivity. These results and other indicators of aggressiveness to steel and concrete (corrosivity) are shown in Table 3. Based on the EC values- the material underlying the site is deemed to be potentially slightly corrosive. The use of steel pipes in the construction is not recommended.

Table 3. Corrosivity indicators.

Test Pit	DEPTH	MATERIAL	MOISTURE	%C	pH	EC (S/m)	Double hydrometer (%)
TP1	0.68-1.05	Residual Gneiss	Slightly Moist	10.1	6.6	0.03	1
TP2	0-0.52	Pebble Marker	Slightly Moist	13.4	6.3	0.028	2
TP7	0.54-0.95	Residual Gneiss	Slightly Moist	13.2	6.2	0.023	-
TP9	0.00-1.05	Pebble Marker	Slightly Moist	16.3	6.2	0.022	-
NOTES	-1	Material as per soil profile description.					
	-2	Moisture as per soil profile description or natural moisture content.					
	-3	%C (percentage clay), pH, EC and double hydrometer (%) as per laboratory test results.					

6.2 EXCAVATION CLASSIFICATION WITH RESPECT TO SERVICES

Excavations within the highly weathered rock masses were notably challenging; with rock material displaying a medium hard nature. The fractured nature of the various rock masses enabled minor penetration. The depth of excavation, as well as the stability of the various excavations, was dependant on the orientation of the trial pits in relation to the regional foliation and diabase dykes.

The excavatability across the site was seen to fluctuate over short distances; attributed to the intermittent occurrence of bedrock outcrops and varying degrees of decomposition of the underlying bedrock (gneiss, schist and diabase). The majority of the excavations conducted across the site were seen to display variable final excavation depths.

The average excavation depth across the site was approximately 0.83 m below the existing ground level. The excavation type to an average depth of 0.83 m below the existing ground level is deemed to be Soft Excavation (SANS 10400G); with Intermediate and Hard Rock excavation conditions predicted beyond this depth.

The excavatability of the onsite materials was seen to deteriorate in a south easterly direction across the site; with notably challenging excavation conditions and terrain mobility occurring in the central to south eastern portions. The central portions of the site were seen to host extensive intercalated gneiss and schist outcrops. Schist outcrops were noted to be softer than that of the gneiss.

It is predicted that the sites' subsoils may not be suitable for the use as fill and bedding for pipelines as a result of their medium plasticity and coarse fractions may need to be removed during the backfilling of tranches (SANS 10400-G).

Sidewalls generally remained stable for a period of at least 1 hour with little or no over break or collapse occurring. Localised instabilities were seen to occur in deep excavations in schist bedrock; with individual rock blocks failing due to the orientation of the excavation in relation to the regional schistocity (localised rock block failure).

All excavations on site must be inspected and comply with the health and safety regulations.

6.3 SLOPE STABILITY AND EROSION

The natural slopes which traverse the site generally display a westerly to south westerly declivity with average measured slopes of between 2 and 6 degrees; with the occurrence of localised steep slopes (between 6 and 12 degrees) in the high lying south eastern portions.

Natural slope instabilities are not expected but instabilities may be anticipated under changing loads and moisture conditions.

Due to the general site gradient levelling of building sites may involve cut to fill preparation. To prevent differential settlements if cut to fill platforms are constructed, controlled compaction should be implemented in especially the fills.

The soil erodibility is deemed low due to the low grade and soil type classes (SW/SC/GM/GW/GC) (Look, 2014).

The compaction of the topsoil's through vehicle and/or foot traffic will result in poor drainage characteristics and the possibility of channelized surface water flow. This concentrated flow elevates the risk of erosion in these areas.

Good water management practice must be employed to prevent surface ponding of runoff water due to the possible development of temporary perched groundwater levels in the profile due to the impervious shallow bedrock. Precautions need to be taken to prevent concentrated surface flow during construction.

6.4 IMPACT OF THE GEOTECHNICAL CHARACTER OF THE SITE ON DEVELOPMENT

The impact of the geotechnical constraints on development may be evaluated according to the general principles applied to light structures shown in TABLE 5 (Appendix E), which is a summary of the relevant general geotechnical constraints (Partridge, Wood and Brink, 1993).

The main expected geotechnical constraints for this site are:

- collapse settlement occurring in the granular pebble marker and underlying voided residual gneiss.
- temporary perched water tables less than 1.0 m below the existing ground level.
- consolidation and compressible behaviour of the topsoil, pebble marker and residuum.
- steep natural slopes of between 6 and 12 degrees in the high lying south eastern portions of the site with associated intermediate risk of erosion.
- central and south eastern portions: bedrock outcrops with associated difficultly in excavation to a depth of 1.5 m below the existing ground level, with in excess 40% of the total volume deemed to be rock.
- remaining portions- difficultly in excavation to a depth of 1.5 m below the existing ground level, with between 10 and 40% of the total volume deemed to be fractured rock.

7. SITE CLASSIFICATION AND FOUNDATION RECOMMENDATIONS

The site has been classified into three Site Class Designation zones (Figure 5), based on the above constraints and the criteria as set out in the National Home Building Manual (2015) guideline document of which the appropriate tables have been included in Appendix E.

The site class designation is specific as suggested in the Home Builders Manual (2015), Part 4, 4.2 and derived from an estimation of the expected range of soil volume change in single- and double-storey homes constructed of masonry walls with soil pressures not exceeding 50 kPa. The classification and foundation recommendations are based on results from this (test pits and lab results) and proximate investigations. The zoning can be summarised as follows:

- **I – C2/R(localised)/P(excavation) and 2ABD(3)F**; multiple sequences of compressible and potentially collapsible materials, shallow perched water tables, difficult excavation to a depth of 1.5 m and the highly localised occurrence of bedrock outcrops.

- **II – R/C/S/P(excavation) and 3F2B**; shallow bedrock with poor excavatability to a depth of 1.50m below the surface; shallow perched water tables; minor sequences of compressible and potentially collapsible materials.

- **III – R/C/S/P(excavation and steep slopes) and 3F2BEI**; shallow bedrock with poor excavatability to a depth of 1.50 m below the surface and predicted poor terrain mobility; steep slopes of between 6 and 12 degrees with the associated intermediate risk for

erosion; shallow perched water tables; minor sequences of compressible and potentially collapsible materials.

The foundation options for future single or double storey residential units (NHBRC, 2015) should be implemented in the zones listed above and summarized in Table 4. The specific foundation option will depend on the type of structure to be erected and the expected upper limit for bearing capacity of 100 kPa as well as expected collapse settlements.

Table 4. Summary of Geotechnical Zoning

ZONE & SITE CLASS		CONSTRAINTS	FOUNDATION RECOMMENDATIONS
I	**C2/R/ P(excavation)**	• Multiple sequences of collapsible and moderately compressible materials • Shallow perched water tables. • Difficultly in excavation to a depth of 1.5 m below the existing ground level, with between 10 and 40% of the total volume deemed to be rock. • Highly localised occurrence of bedrock outcrops.	• Removal of topsoil and localised surficial uncontrolled fill material within the footprint of the structure. • Stiffened strip, stiffened or cellular raft • Compaction of in-situ soils below individual footings • Deep strip foundations • Site drainage and plumbing/service precautions • Adequate damp proofing measures
II	**R/C/S/ P(excavation)**	• Shallow bedrock with poor excavatability to a depth of 1.50 m below the surface and predicted poor terrain mobility • Shallow perched water tables • Minor sequences of compressible and potentially collapsible materials.	• Removal of topsoil and localised surficial uncontrolled fill material within the footprint of the structure. • Foundations spanning across rock to soil or engineered fill need special measures. • Normal construction • Deep strip foundations • Good site drainage and plumbing/service precautions • Adequate damp proofing measures
II	**R/C/S/ P(excavation and steep slopes)**	• Shallow bedrock with poor excavatability to a depth of 1.50 m below the surface and predicted poor terrain mobility • Steep slopes of between 6 and 12 degrees with the associated intermediate risk for erosion • Shallow perched water tables • Minor sequences of compressible and potentially collapsible materials.	

It is recommended that the structural engineers calculate the best economical foundation option for the proposed development based on the type of structure and the different available construction methods to suit site specific geotechnical constraints.

Considering the mechanical properties of the in-situ soils, in conjunction with the nature of the development, it is recommended that the foundations/footings of the various structures be taken down to fresh/intact bedrock beyond the depth of the fractured soft materials OR the soft materials be over excavated and replaced in controlled layers below individual footings. Groundwater is anticipated to perch/flow along the soil-rock interface, periodically inundating the foundations.

The on-site materials were tested to be suitable for the use in controlled layer works across the site (final suitability based on engineer's design). It is recommended that additional tests be conducted to confirm the compaction characteristics of the various site soils.

8. SPECIAL PRECAUTIONARY MEASURES

The general site conditions with regards the geotechnical considerations are such that any light structure placed on the collapsible materials occurring on site will need special precautionary measures to prevent serious damage to the structure. Additional foundation modifications to prevent damage to single-storey structures due to differential settlements may be necessary.

Good site drainage will be necessary to manage surface water as well as groundwater flow across

the site. The possibility of saturation of the soil profile will also need special site drainage as this may lead to lowering in shear strength under load. Furthermore, specialised methods for the stabilisation of cuts into the slopes are deemed necessary. Where deep cuts are required; it is recommended that natural slopes be adequately sloped/stabilised to eliminate the risk of instabilities.

It is recommended that a detailed topographic survey be conducted across the township area in order to model small scale topographic anomalies.

Due to the general site gradient levelling of building sites may involve cut to fill preparation. To prevent differential settlements if cut to fill platforms are constructed, controlled compaction should be implemented in especially the fills.

Paving could be placed on well compacted subgrade and light structures such as security walls and guard houses could be placed on reinforced concrete footings.

The development will influence natural infiltration and run-off rates and appropriate precautions against ponding of surface water as well as concentrated flow must therefore be implemented.

Damp proofing of floors and foundation walls will be necessary to prevent rising damp due to possible surface water accumulation and life cycle changes. Foundations and installed services will cause soil density and texture changes which may lead to variations in soil moisture across the site with flow changes and build-up of moisture that may differ from the natural conditions.

The removal of trees will create loose highly compressible zones and will need special preventative measures to limit differential settlements.

The test pits were positioned to cover the accessible parts of the site. The pits were backfilled without proper compaction in layers. If structures are to be positioned over or across these pits, proper compaction will be necessary to prevent additional settlements from taking place. If development takes place across previous infrastructure such as foundations, septic tank and/or swimming pool excavations or previous waste dumps, additional foundation measures will be needed to prevent damage to structures due to differential settlements.

It is assumed that the development will be serviced by the usual municipal services or specific environmentally acceptable measures

9. CONCLUSIONS

The most important geological constraints that may influence the development on this site are the occurrence of multiple sequences of collapsible and moderately compressible materials, temporary perched water tables less than 1.0 m below the existing ground level, steep natural slopes of between 6 and 12 degrees in the high lying south eastern portions of the site - associated intermediate risk of erosion, central and south eastern portions - bedrock outcrops and associated difficultly in excavation to a depth of 1.5 m below the existing ground level, with in excess 40% of the total volume deemed to be rock, remaining portions - difficultly in excavation to a depth of 1.5 m below the existing ground level, with between 10 and 40% of the total volume deemed to be rock.

The laboratory test results, and soil classification show the on-site materials have the following properties: low potential expansiveness, grading modulus of between 2.0 and 2.4, displayed a moderate compactability; classifying as a G8 type material according to the COTO classification system (2019), measured CBR of 11 @93% MOD AASHTO and an assumptive bearing capacity between 100 and 200 kPa in residual and weathered rock horizons.

The in-situ site soils may be suitable for use in selected layers in pavement construction or selected backfill.

It is recommended that the fine grained surficial uncontrolled fill materials be removed and replaced with inert materials below surface beds and pavements.

10. REPORT PROVISIONS

While every effort is made during the fieldwork phase to identify the different soil horizons, areas subject to a perched water table, areas of poor drainage, areas underlain by hard rock and to estimate their distribution, it is impossible to guarantee that isolated zones of poorer foundation materials, or harder rock have not been missed.

For this reason, this investigation has sought to highlight areas of potential foundation, groundwater and excavation problems, to provide prior warning to the developer.

A competent person should inspect foundation excavations for future structures at the time of construction or the open service trenches, to determine the variance from the above assessment of the site. The present site zoning is based on the Home Building Manual with the guideline site class designation specifically for single or double storey masonry residential units. The findings are therefore specific to the development type, but this does not exclude alternative site uses.

The determination of flood lines and delineation of wetland areas were not part of this investigation scope and should be addressed by suitably competent professionals prior to the final site development plan is compiled, if deemed necessary.

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Pr.Sci.Nat. 400239/83

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APPENDIX A: FIGURES

Figure 1. Locality. KSL Student Lifestyle Precinct- Ptn 191- Tweefontein 915LS.

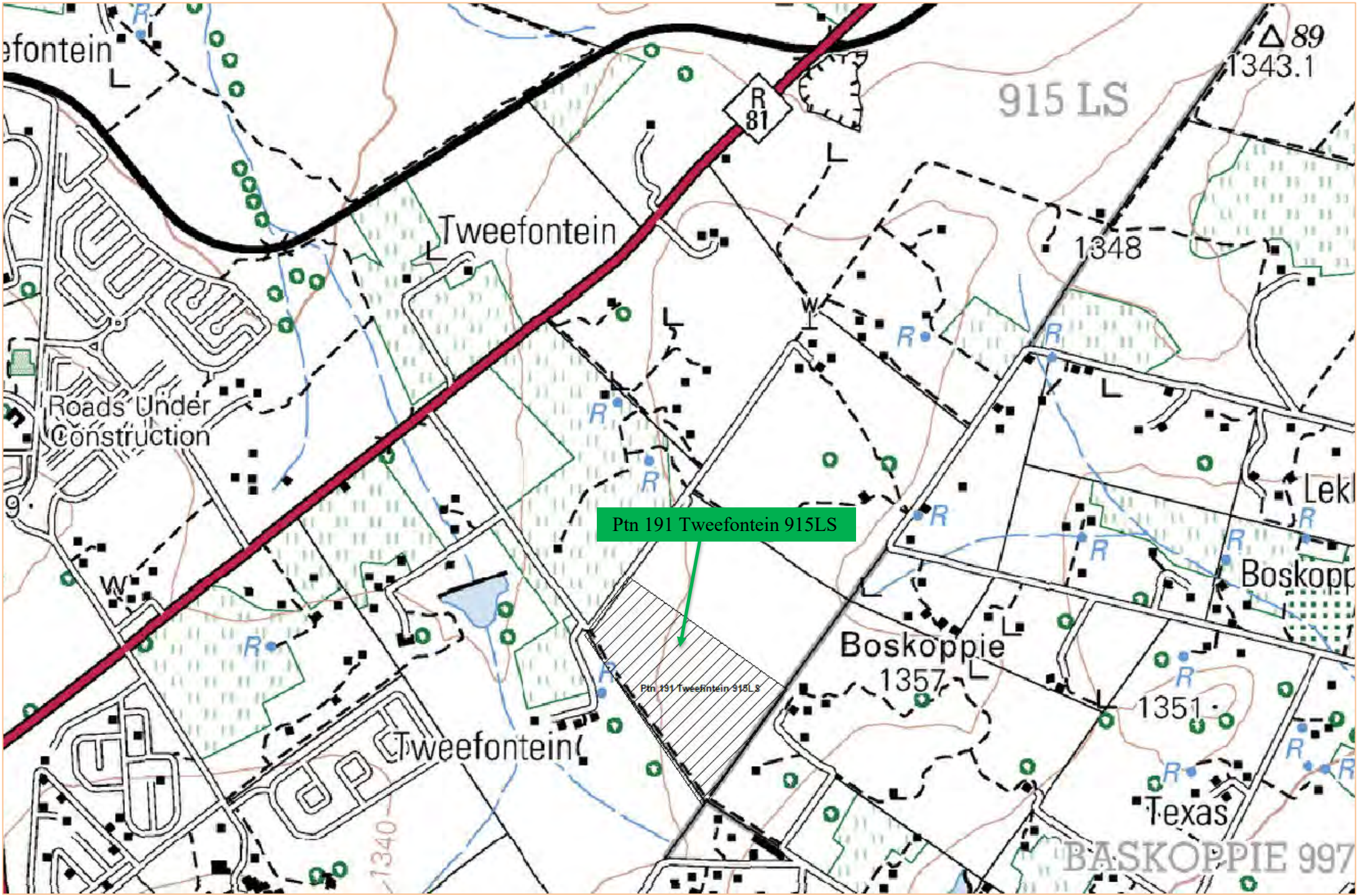

Figure 2. Locality. Topocadastral map 2329 DC Mankweng (1:50000)

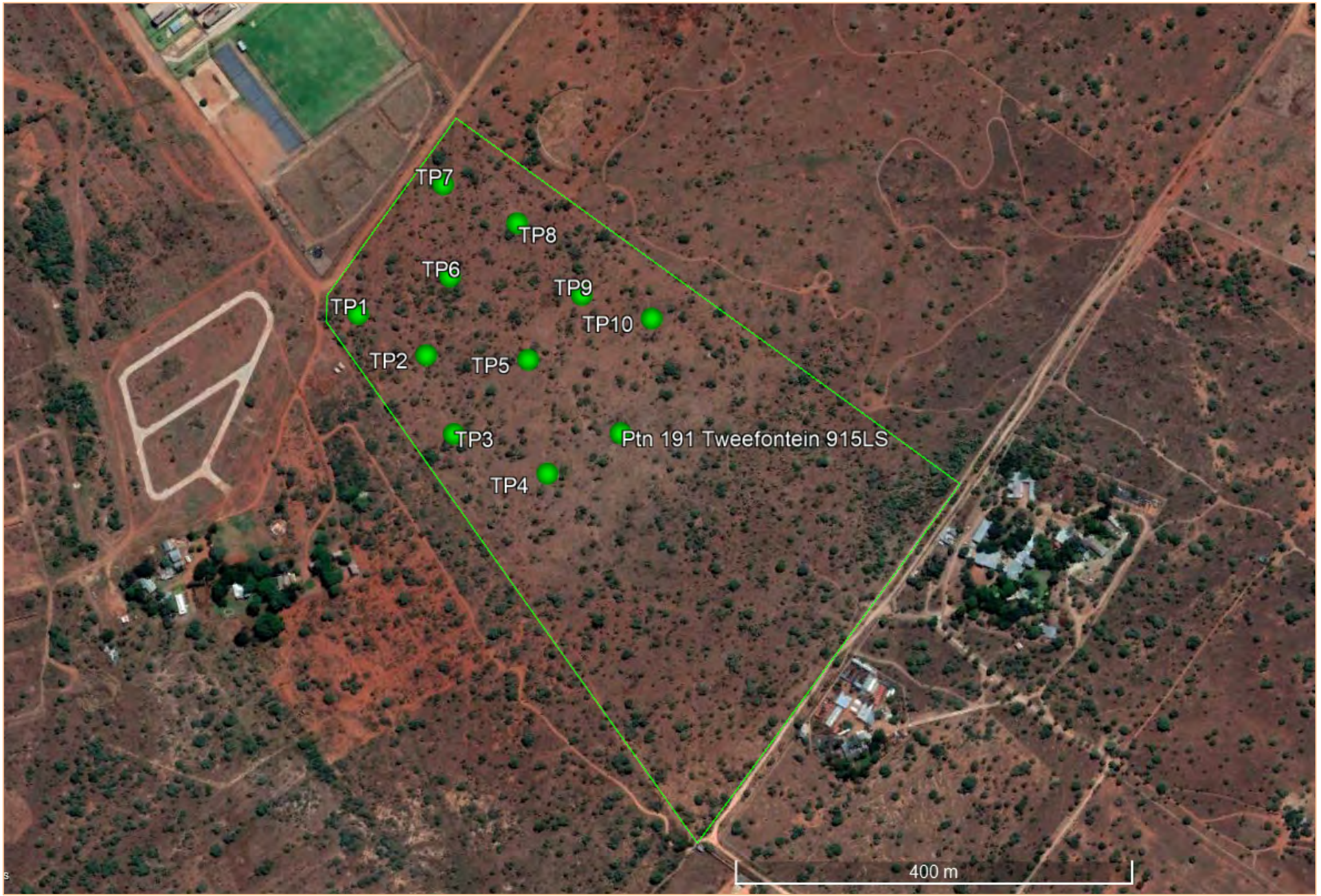

Figure 3. Site layout and test pit positions: KSL Student Lifestyle Precinct- Ptn 191- Tweefontein 915LS.

Figure 4. Regional Geological Map 1:250 000 (Geological Sheet 2328 Pietersburg)

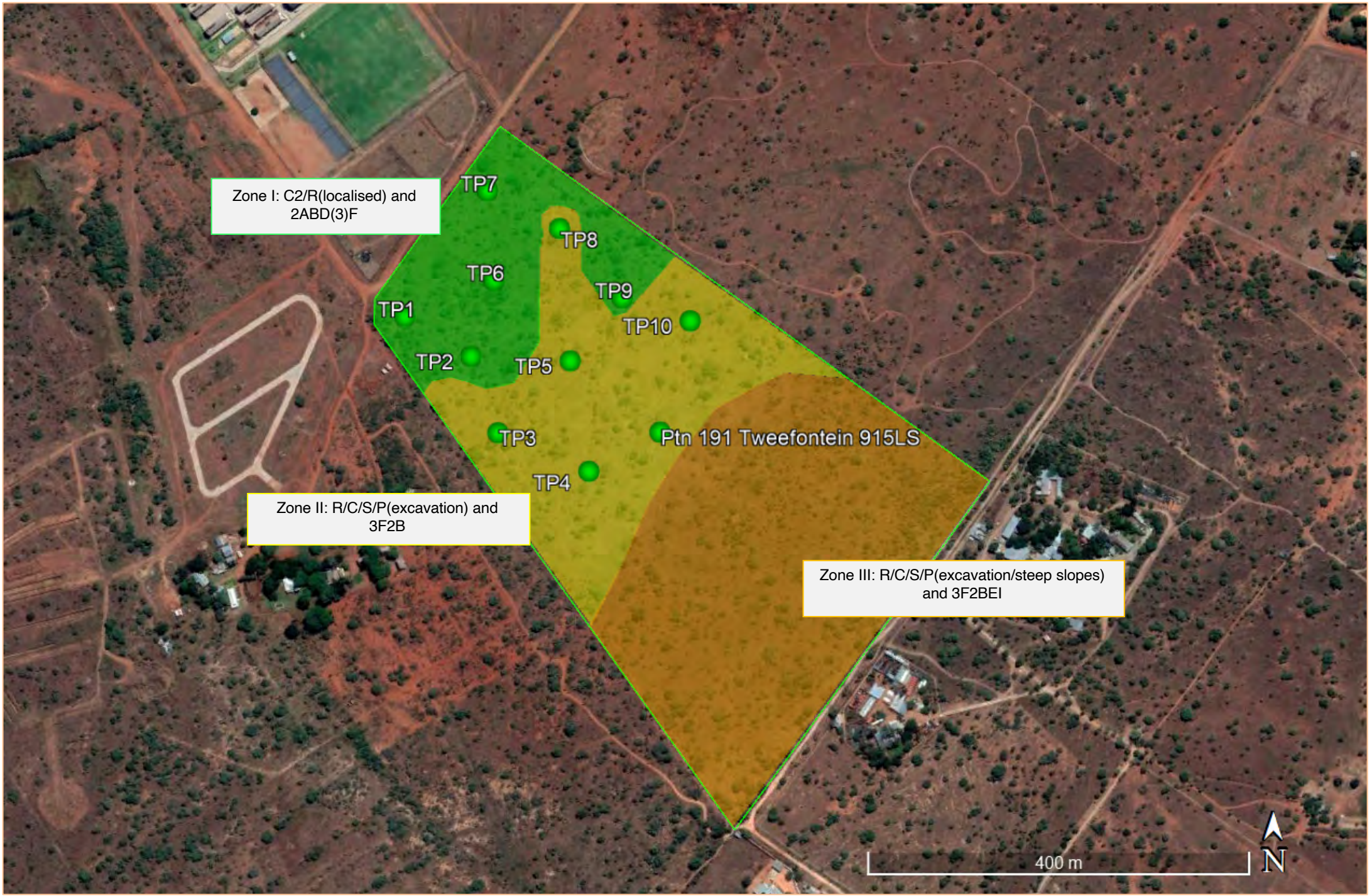

Figure 5. **Geotechnical zoning: KSL Student Lifestyle Precinct- Ptn 191- Tweefontein 915LS.**

APPENDIX B: SOIL PROFILES

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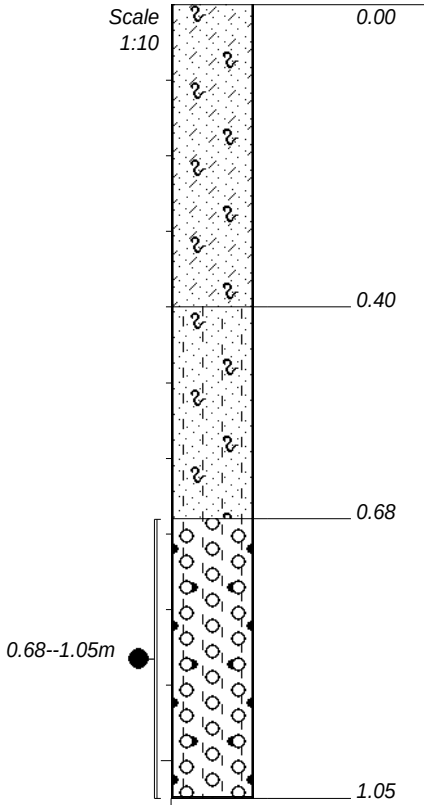
HOLE No: TP01
Sheet 1 of 1

JOB NUMBER: 202010



0.00 – 0.40: Slightly moist dark reddish brown speckled loose **open root channels** clayey SAND with traces of rounded quartz gravels. Topsoil. Biological nests and abundant roots.

0.40 – 0.68: Slightly moist dark reddish brown blotched orange and white medium dense **matrix supported** sub-rounded coarse quartz gravels and traces of angular translucent quartz cobbles in a matrix of silty SAND. Pebble Marker. Heterogenous composition and minor fine roots.

0.68 – 1.05: Slightly moist dark reddish brown blotched cream and orange banded olive medium dense to dense at the base **pinholed** silty angular GRAVEL with traces of Fe nodules. Residual gneiss. Pockets of less weathered gneissic bedrock.

0.68--1.05m

NOTES

1) Difficult excavation in weathered bedrock at 1.05m below E.G.L.
2) Gradual transition into less weathered bedrock at the base of the excavation.
3) Sidewalls stable.
4) No seepage.
5) Bulk sample 0.68--1.05m.

CONTRACTOR : Alpha Sand
MACHINE : Volvo H940S
DRILLED BY :
PROFILED BY : KS Coertzen
TYPE SET BY :
SETUP FILE : LOUIS1.SET

INCLINATION :
DIAM :
DATE :
DATE : 08/06/2020
DATE : 26/07/2020 11:18
TEXT : C\DOT7000\202010DP.TXT

ELEVATION : 1325m
X-COORD : -23.87407
Y-COORD : 29.52741

HOLE No: TP01

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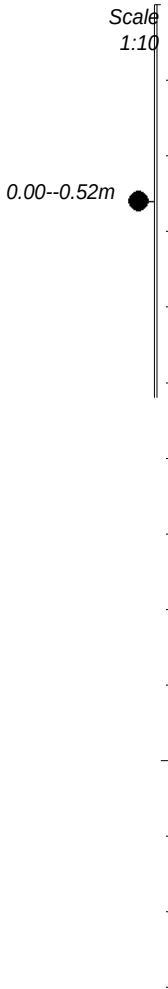
HOLE No: TP02
Sheet 1 of 1

JOB NUMBER: 202010



0.00

Slightly moist dark reddish brown blotched orange and white medium dense **matrix supported** sub-rounded coarse quartz gravels and traces of angular translucent quartz cobbles in a matrix of silty SAND. Pebble Marker. Heterogenous composition and abundant fine roots.

0.52

Slightly moist dark reddish brown blotched cream and orange banded olive medium dense to dense at the base **pinholed** silty angular GRAVEL. Residual gneiss. Traces of fine roots.

0.91

Slightly moist light yellowish creamy brown stained red and banded light green dense with an increase in consistency with an increase in depth **massive with relict joints** sub-angular silty GRAVEL with traces of angular weathered gneiss and schist cobbles. Intercalated highly weathered gneiss and schist of the Mothiba Formation- Pietersburg Greenstone Belt.

1.30

NOTES

1) Refusal on weathered bedrock at 1.30m below E.G.L.
2) Intercalated gneissic and schist bedrock at depth.
3) Sidewalls stable.
4) No seepage.
5) Disturbed sample 0.00--0.52m.

CONTRACTOR : Alpha Sand
MACHINE : Volvo H940S
DRILLED BY :
PROFILED BY : KS Coertzen
TYPE SET BY :
SETUP FILE : LOUIS1.SET

INCLINATION :
DIAM :
DATE :
DATE : 08/06/2020
DATE : 26/07/2020 11:18
TEXT : C\DOT7000\202010DP.TXT

ELEVATION : 1329m
X-COORD : -23.87448
Y-COORD : 29.52806 Elevation: 13

HOLE No: TP02

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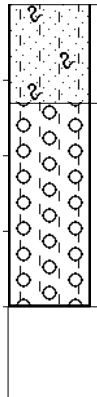
HOLE No: TP03
Sheet 1 of 1

JOB NUMBER: 202010

Scale 1:10



0.00

Slightly moist dark reddish brown blotched orange and white loose **matrix supported** sub-rounded coarse quartz gravels and traces of angular translucent quartz cobbles in a matrix of silty SAND. Pebble Marker. Heterogenous composition, undulating thickness and abundant fine roots.

0.13

Slightly moist light yellowish creamy brown stained red and banded light green dense with an increase in consistency with an increase in depth **massive with relict joints** sub-angular silty GRAVEL with abundant angular weathered gneiss and schist cobbles. Intercalated highly weathered gneiss and schist of the Mothiba Formation- Pietersburg Greenstone Belt.

0.40

NOTES

1) Refusal on weathered bedrock at 0.40m below E.G.L.
2) Test pit surrounded by extensive bedrock outcrop with variable topsoil thickness.
3) Intercalated gneissic and schist bedrock at depth.
4) Sidewalls stable.
5) No seepage.
6) No Sample.

CONTRACTOR : Alpha Sand
MACHINE : Volvo H940S
DRILLED BY :
PROFILED BY : KS Coertzen

TYPE SET BY :
SETUP FILE : LOUIS1.SET

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DATE : 08/06/2020

DATE : 26/07/2020 11:18
TEXT : C\DOT7000\202010DP.TXT

ELEVATION : 1330m
X-COORD : -23.87521
Y-COORD : 29.52835

HOLE No: TP03

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HOLE No: TP04
Sheet 1 of 1

JOB NUMBER: 202010

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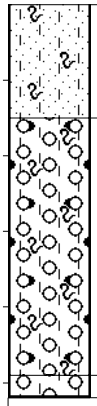

0.00

Slightly moist dark reddish brown blotched orange and white loose **matrix supported** sub-rounded coarse quartz gravels and traces of angular translucent quartz cobbles in a matrix of silty SAND. Pebble Marker. Heterogenous composition, undulating thickness and abundant fine roots.

0.15

Slightly moist dark reddish brown blotched cream, olive and orange medium dense to dense at the base **pinholed** silty angular GRAVEL with traces of Fe nodules. Residual gneiss. Traces of roots.

0.49

Slightly moist light yellowish creamy brown stained red and banded light green dense with an increase in consistency with an increase in depth **massive with relict joints** sub-angular silty GRAVEL with abundant angular weathered gneiss and schist cobbles. Intercalated highly weathered gneiss and schist of the Mothiba Formation- Pietersburg Greenstone Belt.

0.52

NOTES

1) Refusal on weathered bedrock at 0.52m below E.G.L.
2) Test pit surrounded by extensive bedrock outcrop with variable topsoil thickness.
3) Sidewalls stable.
4) No seepage.
5) No Sample.

CONTRACTOR : Alpha Sand
MACHINE : Volvo H940S
DRILLED BY :
PROFILED BY : KS Coertzen

TYPE SET BY :
SETUP FILE : LOUIS1.SET

INCLINATION :
DIAM :
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DATE : 08/06/2020

DATE : 26/07/2020 11:18
TEXT : C\DOT7000\202010DP.TXT

ELEVATION : 1335m
X-COORD : -23.87554
Y-COORD : 29.52928

HOLE No: TP04

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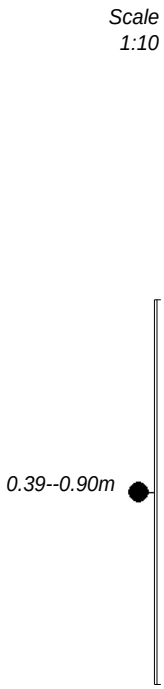
HOLE No: TP05
Sheet 1 of 1

JOB NUMBER: 202010



Slightly moist dark reddish brown blotched orange and white loose **matrix supported** sub-rounded coarse quartz gravels and traces of angular translucent quartz cobbles in a matrix of silty SAND. Pebble Marker. Heterogenous composition, undulating thickness and abundant fine roots.

Slightly moist dark brown stained red banded light green and blotched creamy brown dense with an increase in consistency with an increase in depth **relict joints** sub-angular silty GRAVEL with abundant angular weathered schict cobbles and traces of gneiss cobbles with pockets of residual soil. Intercalated highly weathered schist of the Mothiba Formation- Pietersburg Greenstone Belt.

NOTES

1) Refusal on weathered bedrock at 0.90m below E.G.L.
2) Test pit surrounded by extensive bedrock outcrop with variable topsoil thickness.
3) Rock mass displays a highly jointed nature.
4) Sidewalls stable.
5) No seepage.
6) Disturbed sample 0.39--0.90m.

CONTRACTOR : Alpha Sand
MACHINE : Volvo H940S
DRILLED BY :
PROFILED BY : KS Coertzen
TYPE SET BY :
SETUP FILE : LOUIS1.SET

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DATE : 26/07/2020 11:18
TEXT : C\DOT7000\202010DP.TXT

ELEVATION : 1333m
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Y-COORD : 29.52908

HOLE No: TP05

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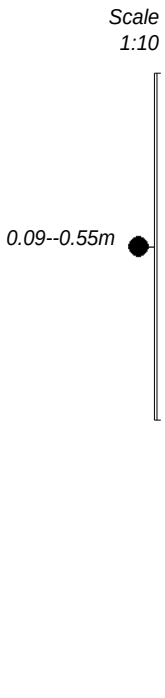
HOLE No: TP06
Sheet 1 of 1

JOB NUMBER: 202010



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Slightly moist dark reddish brown speckled loose **open root channels** clayey SAND with traces of rounded quartz gravels. Topsoil. Biological nests and abundant roots.

0.09

Slightly moist dark reddish brown blotched orange and white loose **matrix supported** sub-rounded coarse quartz gravels and traces of angular translucent quartz cobbles in a matrix of silty SAND. Pebble Marker. Heterogenous composition and minor fine roots.

0.55

Slightly moist dark reddish brown blotched cream and orange medium dense to dense at the base **pinholed** silty angular GRAVEL with minor cobble sized gneissic corestones and traces of Fe nodules. Residual gneiss. Pockets of less weathered gneissic bedrock.

0.91

NOTES

1) Difficult excavation in weathered bedrock at 0.91m below E.G.L.
2) Pebble marker displayed a heterogenous composition.
3) Gradual transition into less weathered bedrock at the base of the excavation.
4) Sidewalls stable.
5) No seepage.
6) Disturbed sample 0.09--0.55m.

CONTRACTOR : Alpha Sand
MACHINE : Volvo H940S
DRILLED BY :
PROFILED BY : KS Coertzen
TYPE SET BY :
SETUP FILE : LOUIS1.SET

INCLINATION :
DIAM :
DATE :
DATE : 08/06/2020
DATE : 26/07/2020 11:18
TEXT : C\DOT7000\202010DP.TXT

ELEVATION : 1329m
X-COORD : - 23.87388
Y-COORD : 29.52819

HOLE No: TP06

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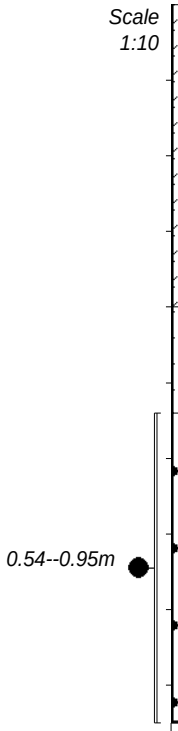
HOLE No: TP07
Sheet 1 of 1

JOB NUMBER: 202010



0.00 – 0.40: Slightly moist dark reddish brown speckled loose **open root channels** clayey SAND with traces of rounded quartz gravels. Topsoil. Biological nests and abundant roots.

0.40 – 0.54: Slightly moist dark reddish brown blotched orange and white loose **matrix supported** sub-rounded coarse quartz gravels and traces of angular translucent quartz cobbles in a matrix of silty SAND. Pebble Marker. Heterogenous composition and minor fine roots.

0.54 – 0.95: Slightly moist dark reddish brown blotched cream and orange medium dense to dense at the base **pinholed** silty angular GRAVEL with minor cobble sized gneissic corestones and traces of Fe nodules. Residual gneiss. Pockets of less weathered gneissic bedrock.

0.54--0.95m

NOTES

1) Difficult excavation in weathered bedrock at 0.95m below E.G.L.
2) Pebble marker displayed a heterogenous composition.
3) Gradual transition into less weathered bedrock at the base of the excavation.
4) Sidewalls stable.
5) No seepage.
6) Disturbed sample 0.54--0.95m.

CONTRACTOR : Alpha Sand
MACHINE : Volvo H940S
DRILLED BY :
PROFILED BY : KS Coertzen
TYPE SET BY :
SETUP FILE : LOUIS1.SET

INCLINATION :
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TEXT : C\DOT7000\202010DP.TXT

ELEVATION : 1328m
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Y-COORD : 29.52822

HOLE No: TP07

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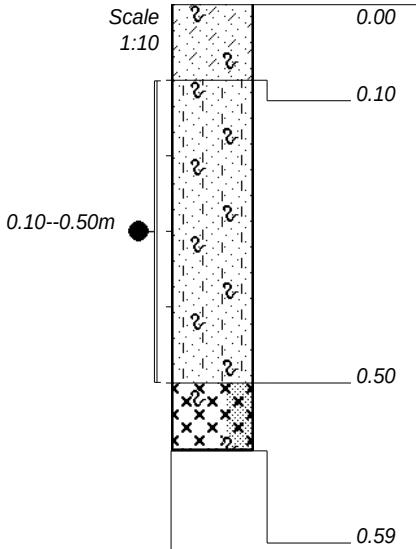
Portion 191 Farm Tweefontein 915-LS

HOLE No: TP08
Sheet 1 of 1

JOB NUMBER: 202010



Slightly moist dark brown speckled loose **open root channels** clayey SAND with traces of rounded quartz gravels. Topsoil. Abundant roots.

Slightly moist dark reddish brown blotched orange and white loose **matrix supported** sub-rounded coarse quartz gravels and traces of angular translucent quartz cobbles in a matrix of silty SAND. Pebble Marker. Heterogenous composition and minor fine roots.

Slightly moist dark grey stained black and red dense with an abrupt increase in consistency with an increase in depth **closely jointed** moderately weathered medium hard rock DIABASE. Minor fine roots along joints.

NOTES

1) Excavation refused on diabase bedrock at 0.59 m below E.G.L.
2) Bedrock displaying a slightly undulating topography.
3) Rapid transition onto bedrock at depth.
4) Sidewalls stable.
5) No seepage.
6) Disturbed sample 0.10--0.50m.

CONTRACTOR : Alpha Sand
MACHINE : Volvo H940S
DRILLED BY :
PROFILED BY : KS Coertzen
TYPE SET BY :
SETUP FILE : LOUIS1.SET

INCLINATION :
DIAM :
DATE :
DATE : 08/06/2020
DATE : 26/07/2020 11:18
TEXT : C\DOT7000\202010DP.TXT

ELEVATION : 1332m
X-COORD : -23.87328
Y-COORD : 29.52896

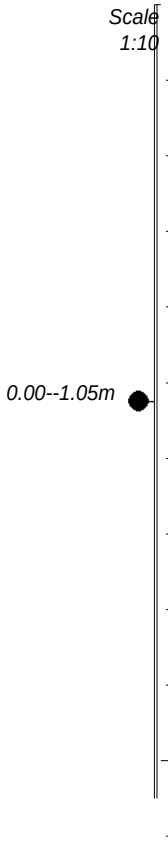
HOLE No: TP08

J LOUIS VAN ROOY
Pr.Sci.Nat. PhD(Pret) FSAIEG MGSSA
Engineering Geologist

KPD Property Development
Portion 191 Farm Tweefontein 915-LS

HOLE No: TP09
Sheet 1 of 1

JOB NUMBER: 202010



Slightly moist dark reddish brown blotched orange and white loose **matrix supported** sub-rounded coarse quartz gravels and traces of angular translucent quartz cobbles in a matrix of silty SAND. Pebble Marker. Heterogenous composition, undulating thickness and abundant fine roots.

Slightly moist light yellowish creamy brown stained red and banded light green dense with an increase in consistency with an increase in depth **massive with relict joints** sub-angular silty GRAVEL with abundant angular weathered gneiss and schist cobbles. Intercalated highly weathered gneiss and schist of the Mothiba Formation- Pietersburg Greenstone Belt.

NOTES

1) Refusal on weathered bedrock at 1.13m below E.G.L.
2) Test pit surrounded by extensive bedrock outcrop.
3) Variable topsoil thickness with a thick pebble marker succession.
4) Sidewalls stable.
5) No seepage.
6) Disturbed sample 0.00--1.05m.

CONTRACTOR : Alpha Sand
MACHINE : Volvo H940S
DRILLED BY :
PROFILED BY : KS Coertzen
TYPE SET BY :
SETUP FILE : LOUIS1.SET

INCLINATION :
DIAM :
DATE :
DATE : 08/06/2020
DATE : 26/07/2020 11:18
TEXT : C\DOT7000\202010DP.TXT

ELEVATION : 1335m
X-COORD : -23.87393
Y-COORD : 29.52963

HOLE No: TP09

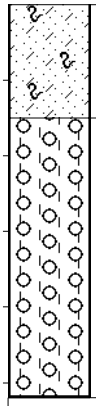
J LOUIS VAN ROOY
Pr.Sci.Nat. PhD(Pret) FSAIEG MGSSA
Engineering Geologist

KPD Property Development
Portion 191 Farm Tweefontein 915-LS

HOLE No: TP10
Sheet 1 of 1

JOB NUMBER: 202010

Scale 1:10



0.00 Slightly moist dark brown speckled loose **open root channels** clayey SAND with abundant rounded quartz gravels. Topsoil. Abundant roots.

0.15 Slightly moist light creamy brown stained red and banded light green dense with an increase in consistency with an increase in depth **massive with relict joints** sub-angular silty GRAVEL with abundant angular weathered gneiss and schist cobbles. Intercalated highly weathered gneiss and schist of the Mothiba Formation- Pietersburg Greenstone Belt.

0.52

NOTES

1) Refusal on weathered bedrock at 0.52m below E.G.L.
2) Test pit surrounded by extensive bedrock outcrop with variable topsoil thickness.
3) Intercalated gneissic and schist bedrock at depth.
4) Sidewalls stable.
5) No seepage.
6) No Sample.

CONTRACTOR : Alpha Sand
MACHINE : Volvo H940S
DRILLED BY :
PROFILED BY : KS Coertzen

TYPE SET BY :
SETUP FILE : LOUIS1.SET

INCLINATION :
DIAM :
DATE :
DATE : 08/06/2020

DATE : 26/07/2020 11:18
TEXT : C\DOT7000\202010DP.TXT

ELEVATION : 1339m
X-COORD : -23.874144
Y-COORD : 29.530301

HOLE No: TP10

APPENDIX C: SOIL PROFILE PHOTOGRAPHS

Soil Profile: Test Pit TP01

Soil Profile: Test Pit TP02

Soil Profile: Test Pit TP03

Soil Profile: Test Pit TP04

Soil Profile: Test Pit TP05

Soil Profile: Test Pit TP06

Soil Profile: Test Pit TP07

Soil Profile: Test Pit TP08

Soil Profile: Test Pit TP09

Soil Profile: Test Pit TP10

APPENDIX D: LABORATORY TEST RESULTS

LETABA LABORATORIES AND SURVEYORS (Pty)

CIVIL ENGINEERING MATERIALS LABORATORY

123 River Street
Polokwane, 0699
P.O Box 795
Fauna Park, 0787

T0863

Tel. No: 087 285 0816 **e-mail :** letaba@letabalab.co.za www.letabalab.co.za

GRAVEL, SOIL AND SAND ANALYSIS : FOUNDATION INDICATOR TEST REPORT

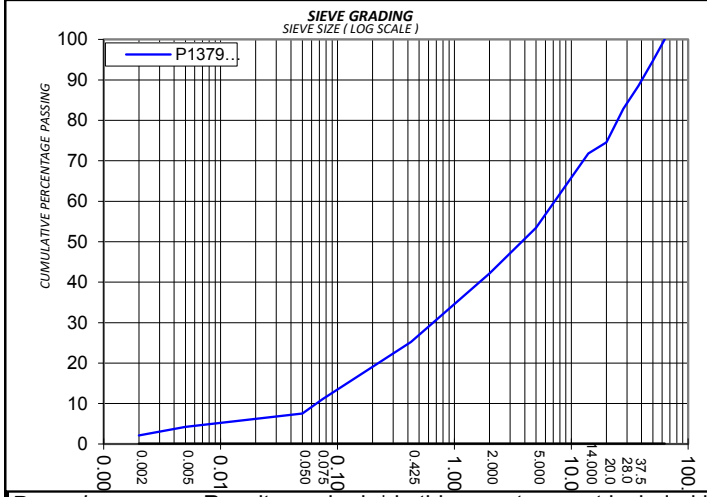
SANS 3001 Methods GR1, GR3, GR5, GR10, GR20, GR30 & GR40

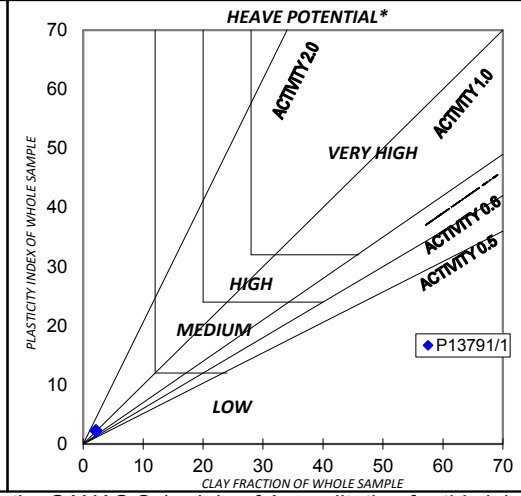
Client : **JL van Rooy** Address: P.O. Box 36786, Menlopark, 0102 **Date Sampled: 08-Jun-20**

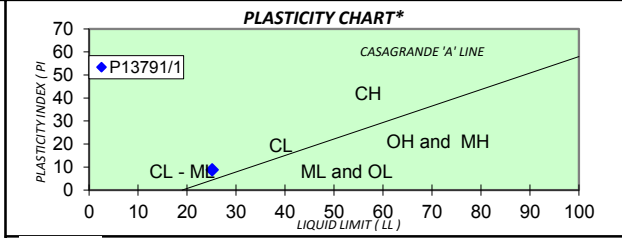
Contract : **Tweefontein** **Doc No:** P13791/1(i)

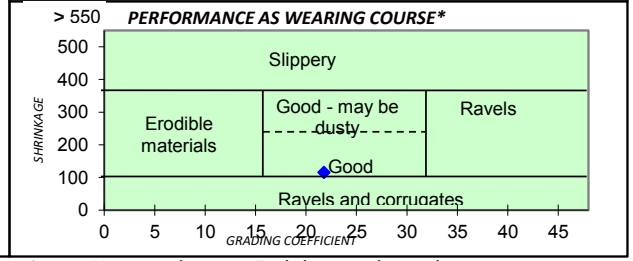
Description : **TP 1 - Sample No.TW1 from 0,68-1,05 m below existing ground level** **Date Tested: 17-Jun-20**

Depth (m)	Sample No.	Description (Unified Soil Classification - ASTM D2487*)	Sieve analysis Cumulative percentage passing: 50,0 mm	37,5 mm	28.0 mm	20,0 mm	14.0 mm	5.0 mm	2,00 mm	0,425 mm	0,075 mm	0,05 mm*	0.005 mm*	0.002 mm*	Soil Mortar Analysis % of mat. <2,00 mm*: Coarse sand <2,0 >0,425mm	Fine sand <0,425 >0,075mm	Silt <0,05 >0,005mm	Clay <0,005 mm	Effective size*	Uniformity - coef.*	Curvature coef.*	Grading modulus*	Atterberg Limits: Liquid Limit	Plasticity Index	Linear Shrinkage	Classifications*: Unified Soil	COLTO	US.Highway	Group Index
0,68-1,05	P13791/1	drk Red. Orange Well graded Clayey sand	95	89	83	75	72	53	42	25	11	7.6	4.3	2.1	40.2	33.4	7.8	10.1	0.066	110	0.9	2.2	25	9	4.6	sw/sc	N/A	A-2-4	0
					*Double Hydrometer Values:							1.6	0.1	0.0															









Remarks: Results marked * in this report are not included in the SANAS Schedule of Accreditation for this laboratory ** *tests done at Polokwane branch*

***DOUBLE HYDROMETER RESULT : 1 %** *If Double Hydrometer result is above 40%, the material is considered to be dispersive.*

***pH =6.6 , *Electrical Conductivity =0.03 S/m, tested on the -5mm fraction**

Date Issued: 29-Jun-20 *Technical signatory (Name) :* **H.C Nolte** *Signature:*

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Tel. No: 087 285 0816 **e-mail :** letaba@letabalab.co.za www.letabalab.co.za

GRAVEL, SOIL AND SAND ANALYSIS : FOUNDATION INDICATOR TEST REPORT

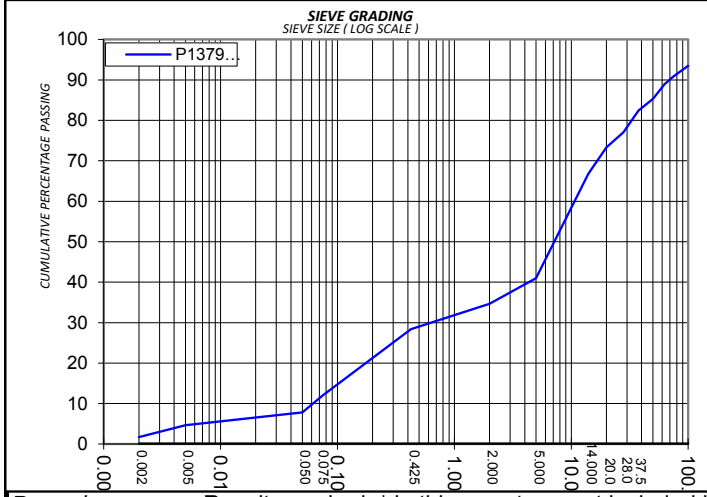
SANS 3001 Methods GR1, GR3, GR5, GR10, GR20, GR30 & GR40

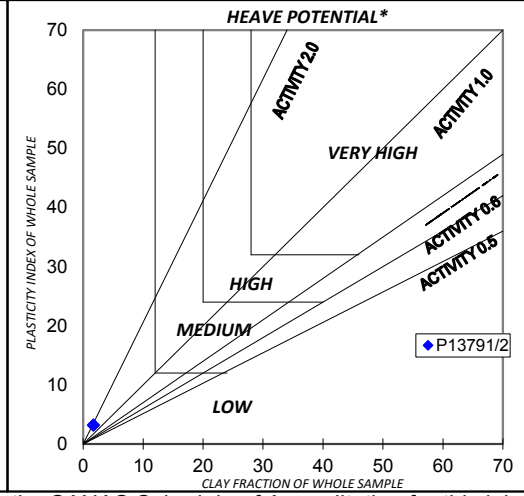
Client : **JL van Rooy** Address: P.O. Box 36786, Menlopark, 0102 **Date Sampled: 08-Jun-20**

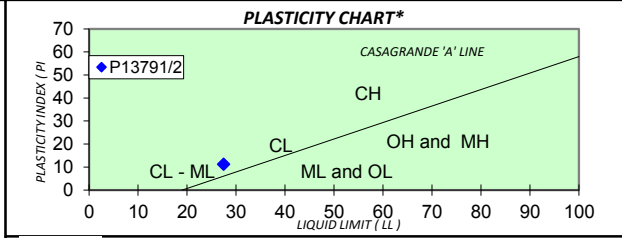
Contract : **Tweefontein** **Doc No:** P13791/2(i)

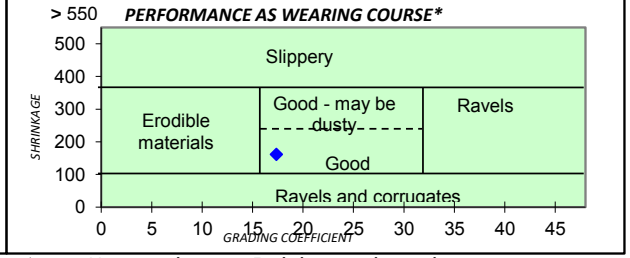
Description : **TP 2 - Sample No.TW2 from 0,0-0,52 m below existing ground level** **Date Tested: 18-Jun-20**

Depth (m)	Sample No.	Description (Unified Soil Classification - ASTM D2487*)	Sieve analysis Cumulative percentage passing: 50,0 mm	37,5 mm	28.0 mm	20,0 mm	14.0 mm	5.0 mm	2,00 mm	0,425 mm	0,075 mm	0,05 mm*	0.005 mm*	0.002 mm*	Soil Mortar Analysis % of mat. <2,00 mm*: Coarse sand <2,0 >0,425mm	Fine sand <0,425 ≥0,075mm	Silt <0,05 >0,005mm	Clay <0,005 mm	Effective size*	Uniformity - coef.*	Curvature coef.*	Grading modulus*	Atterberg Limits: Liquid Limit	Plasticity Index	Linear Shrinkage	Classifications*: Unified Soil	COLTO	US.Highway	Group Index
0,0-0,52	P13791/2	drk Reddish Brown Well graded gravel with clay and sand	85	82	77	73	67	41	35	28	12	7.8	4.7	1.7	18.0	47.3	9.1	13.4	0.062	173	0.6	2.2	27	11	5.7	GW/GC	G8	A-2-6	0
					*Double Hydrometer Values:							1.4	0.1	0.0															









Remarks: Results marked * in this report are not included in the SANAS Schedule of Accreditation for this laboratory ** *tests done at Polokwane branch*

***DOUBLE HYDROMETER RESULT : 2 %** *If Double Hydrometer result is above 40%, the material is considered to be dispersive.*

***pH =6.3 , *Electrical Conductivity =0.028 S/m, tested on the -5mm fraction**

Date Issued: 29-Jun-20 *Technical signatory (Name) :* **H.C Nolte** *Signature:*

LETABA LABORATORIES AND SURVEYORS (Pty) Ltd
CIVIL ENGINEERING MATERIALS LABORATORY

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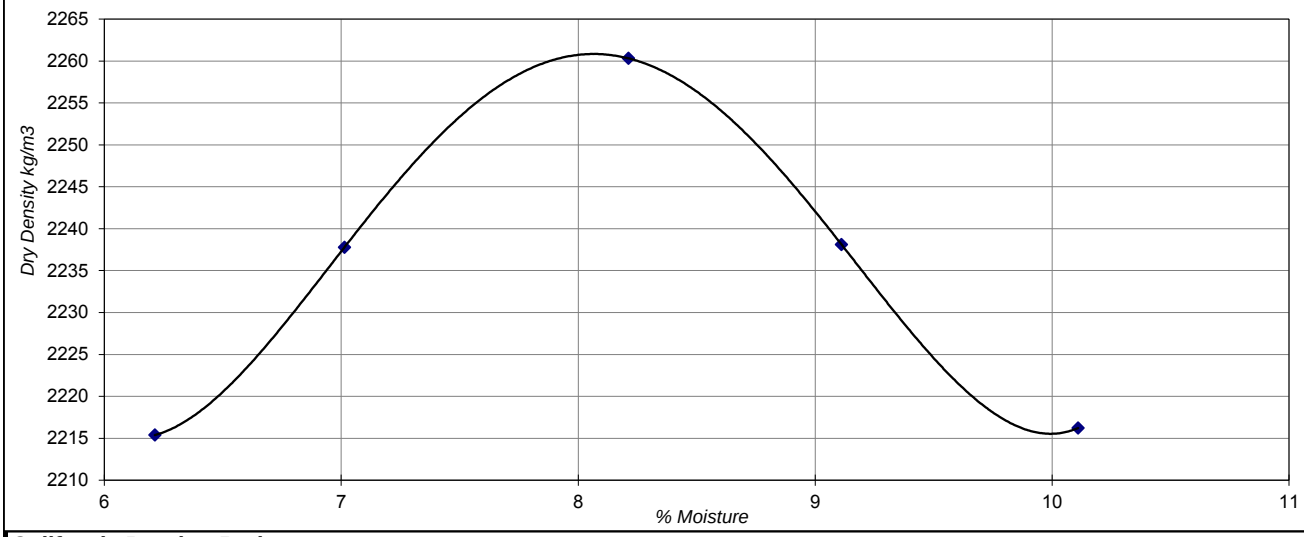
Tel. No: 087 285 0816 **e-mail :** letaba@letabalab.co.za www.letabalab.co.za

CBR and Maximum Dry Density Test Report

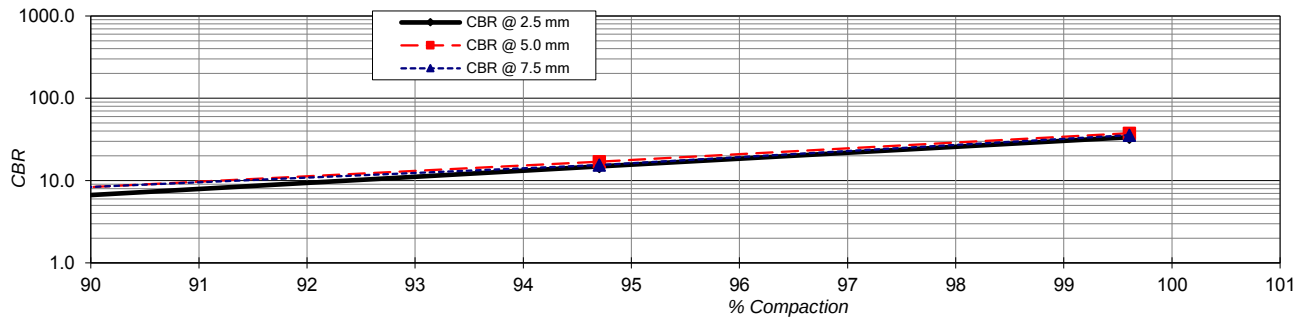
SANS 3001 Methods
GR20, GR30 & GR40

Client:	***JL van Rooy***	*Date tested:*	**18-Jun-20**
Contract :	***Tweefontein***	*Date Sampled:*	**08-Jun-20**
Description:	***TP 2 - Sample No.TW2 from 0,0-0,52 m below existing ground level***	*Sample No.*	**P13791/2**
		Doc no:	**P13791/2(II)**

Maximum Dry Density =	**2261**	**kg/m³**
Optimum moisture content =	**8.2**	**%**



California Bearing Ratio



% Compaction	**100**	**98**	**97**	**95**	**93**	**90**
CBR of 13.3 kN	**41**	**28**	**24**	**16**	**11**	**7**

*** tests done at Polokwane branch*

REMARKS

Briquette Information			
Compaction (%)	**99.6**	**94.7**	**89.7**
Dry Density (kg/m³)	**2252**	**2141**	**2028**
Compaction Moisture (%)	**8.3**	**8.3**	**8.3**
% Swell	**0.12**	**0.14**	**0.17**

Date Issued: 29-Jun-20 *Technical signatory (Name) :* **H.C Nolte** *Signature:*

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Tel. No: 087 285 0816 **e-mail :** letaba@letabalab.co.za www.letabalab.co.za

GRAVEL, SOIL AND SAND ANALYSIS : FOUNDATION INDICATOR TEST REPORT

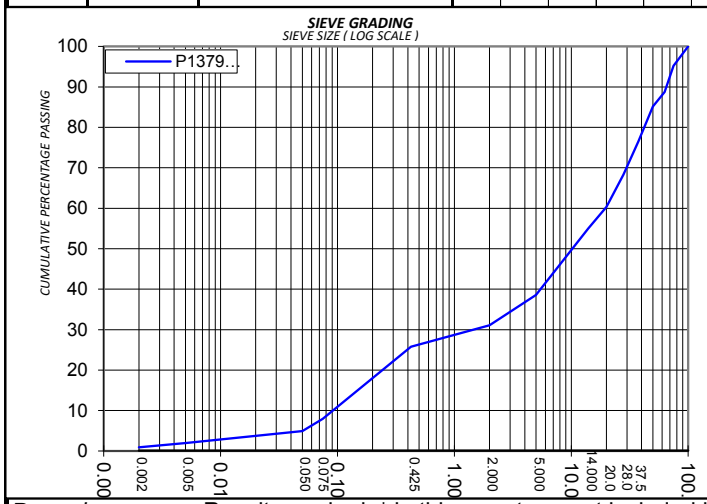
SANS 3001 Methods GR1, GR3, GR5, GR10, GR20, GR30 & GR40

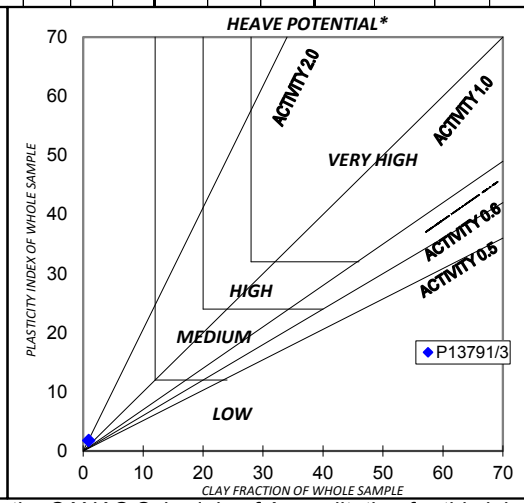
Client : **JL van Rooy** Address: P.O. Box 36786, Menlopark, 0102 **Date Sampled: 08-Jun-20**

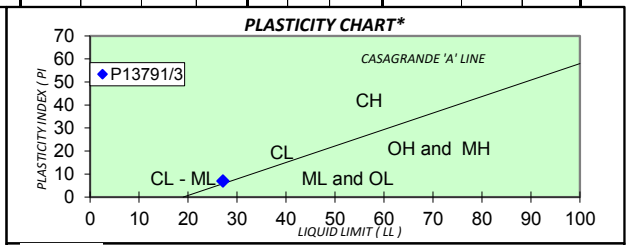
Contract : **Tweefontein** **Doc No:** P13791/3(i)

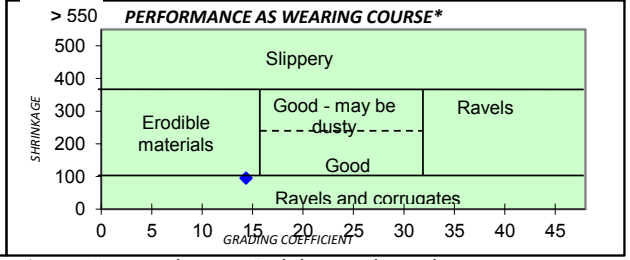
Description : **TP 5 - Sample No.TW3 from 0,39--0,90 m below existing ground level** **Date Tested: 17-Jun-20**

Depth (m)	Sample No.	Description (Unified Soil Classification - ASTM D2487*)	Sieve analysis Cumulative percentage passing											Soil Mortar Analysis % of mat. <2,00 mm*				Effective size*	Uniformity - coef.*	Curvature coef.*	Grading modulus*	Atterberg Limits			Classifications*			
			50,0 mm	37,5 mm	28.0 mm	20,0 mm	14.0 mm	5.0 mm	2,00 mm	0,425 mm	0,075 mm	0,05 mm*	0.005 mm*	0.002 mm*	Coarse sand <2,0 >0,425mm	Fine sand <0,425 ≥0,075mm	Silt <0,05 >0,005mm	Clay <0,005 mm					Liquid Limit	Plasticity Index	Linear Shrinkage	Unified Soil	COLTO	US.Highway	Group Index
0,39--0,90	P13791/3	drk Brown Well graded silty/clayey gravel with sand	85	77	68	60	55	39	31	26	8	4.9	1.9	0.9	17.1	57.4	9.5	6.3	0.092	214	1.2	2.4	27	7	3.7	GW/GM/G	N/A	A-2-4	0









Remarks: Results marked * in this report are not included in the SANAS Schedule of Accreditation for this laboratory ** *tests done at Polokwane branch*

Date Issued: 29-Jun-20 *Technical signatory (Name) :* **H.C Nolte** *Signature:*

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GRAVEL, SOIL AND SAND ANALYSIS : FOUNDATION INDICATOR TEST REPORT

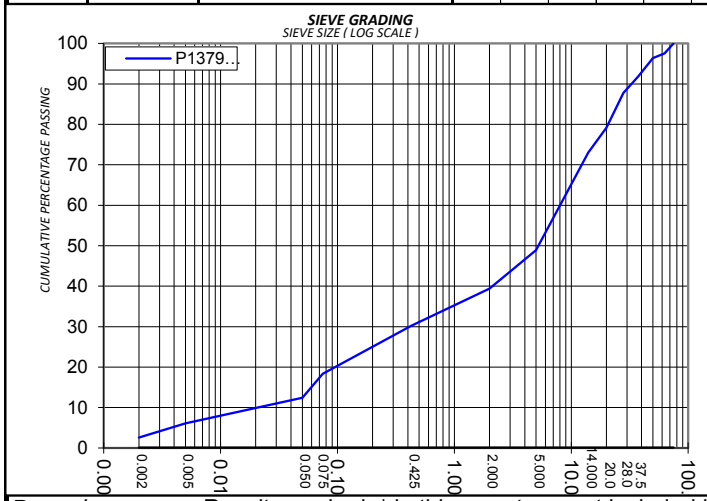
SANS 3001 Methods GR1, GR3, GR5, GR10, GR20, GR30 & GR40

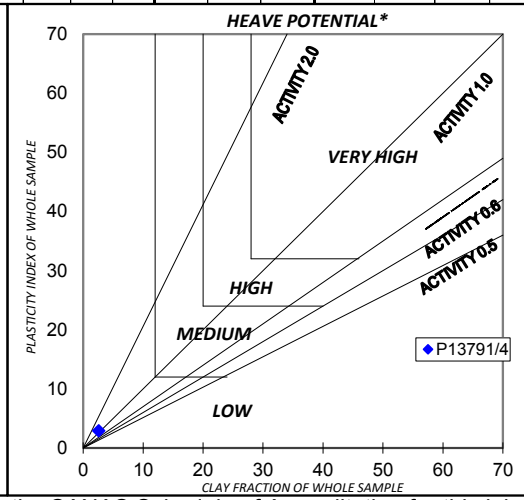
Client : **JL van Rooy** Address: P.O. Box 36786, Menlopark, 0102 **Date Sampled: 08-Jun-20**

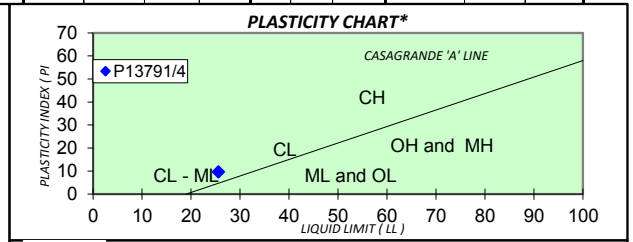
Contract : **Tweefontein** **Doc No:** P13791/4(i)

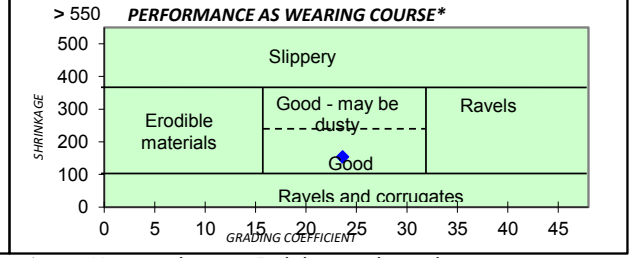
Description : **TP 6 - Sample No.TW4 from 0,09-0,55 m below existing ground level** **Date Tested: 17-Jun-20**

Depth (m)	Sample No.	Description (Unified Soil Classification - ASTM D2487*)	Sieve analysis Cumulative percentage passing											Soil Mortar Analysis % of mat. <2,00 mm*				Effective size*	Uniformity - coef.*	Curvature coef.*	Grading modulus*	Atterberg Limits			Classifications*			
			50,0 mm	37,5 mm	28.0 mm	20,0 mm	14.0 mm	5.0 mm	2,00 mm	0,425 mm	0,075 mm	0,05 mm*	0.005 mm*	0.002 mm*	Coarse sand <2,0 >0,425mm	Fine sand <0,425 ≥0,075mm	Silt <0,05 >0,005mm	Clay <0,005 mm					Liquid Limit	Plasticity Index	Linear Shrinkage	Unified Soil	COLTO	US.Highway	Group Index
0,09-0,55	P13791/4	drk Brown Clayey gravel with sand	96	92	88	79	73	49	39	30	18	12.4	6.1	2.6	23.3	30.2	16.0	15.5	0.021	388	1.0	2.1	26	10	5.1	GC	N/A	A-2-4	0









Remarks: Results marked * in this report are not included in the SANAS Schedule of Accreditation for this laboratory ** *tests done at Polokwane branch*

Date Issued: 29-Jun-20 *Technical signatory (Name) :* **H.C Nolte** *Signature:*

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GRAVEL, SOIL AND SAND ANALYSIS : FOUNDATION INDICATOR TEST REPORT

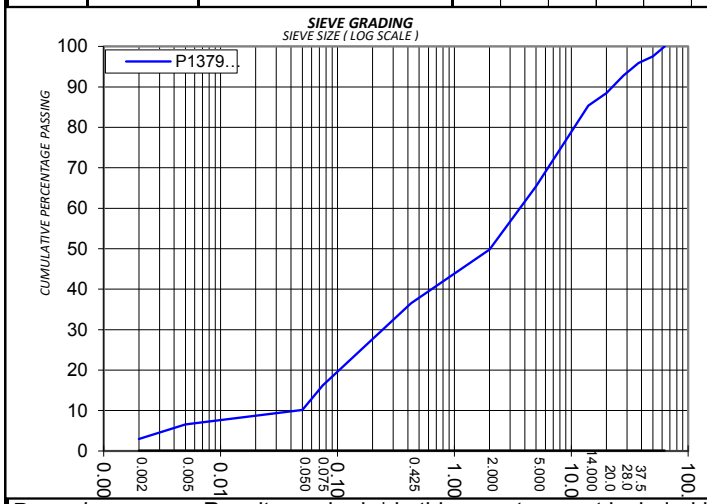
SANS 3001 Methods GR1, GR3, GR5, GR10, GR20, GR30 & GR40

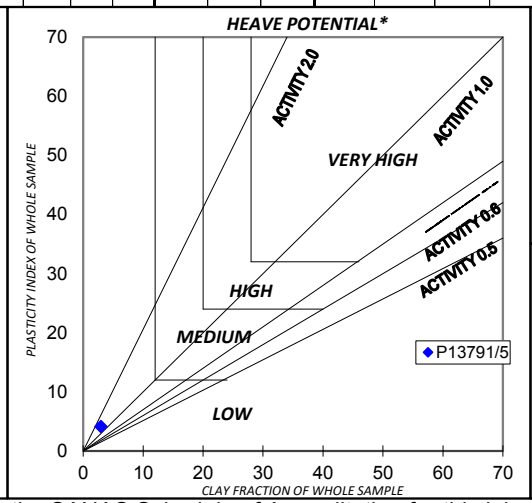
Client : **JL van Rooy** Address: P.O. Box 36786, Menlopark, 0102 **Date Sampled: 08-Jun-20**

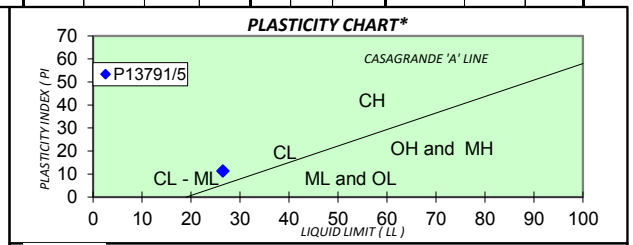
Contract : **Tweefontein** **Doc No:** P13791/5(i)

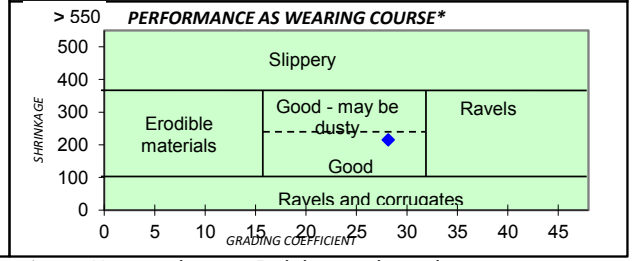
Description : **TP 7 - Sample No.TW5 from 0,54-0,95 m below existing ground level** **Date Tested: 17-Jun-20**

Depth (m)	Sample No.	Description (Unified Soil Classification - ASTM D2487*)	Sieve analysis Cumulative percentage passing											Soil Mortar Analysis % of mat. <2,00 mm*				Effective size*	Uniformity - coef.*	Curvature coef.*	Grading modulus*	Atterberg Limits			Classifications*			
			50,0 mm	37,5 mm	28.0 mm	20,0 mm	14.0 mm	5.0 mm	2,00 mm	0,425 mm	0,075 mm	0,05 mm*	0.005 mm*	0.002 mm*	Coarse sand <2,0 >0,425mm	Fine sand <0,425 ≥0,075mm	Silt <0,05 >0,005mm	Clay <0,005 mm					Liquid Limit	Plasticity Index	Linear Shrinkage	Unified Soil	COLTO	US.Highway	Group Index
0,54-0,95	P13791/5	drk Reddish Brown Clayey sand	98	96	93	88	85	65	50	37	16	10.1	6.6	3.0	26.6	40.9	7.1	13.2	0.045	80	0.4	2.0	27	11	5.9	SC	N/A	A-2-6	0









Remarks: Results marked * in this report are not included in the SANAS Schedule of Accreditation for this laboratory ** *tests done at Polokwane branch*

***pH =6.2 , *Electrical Conductivity =0.023 S/m, tested on the -5mm fraction**

Date Issued: 29-Jun-20 *Technical signatory (Name) :* **H.C Nolte** *Signature:*

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GRAVEL, SOIL AND SAND ANALYSIS : FOUNDATION INDICATOR TEST REPORT

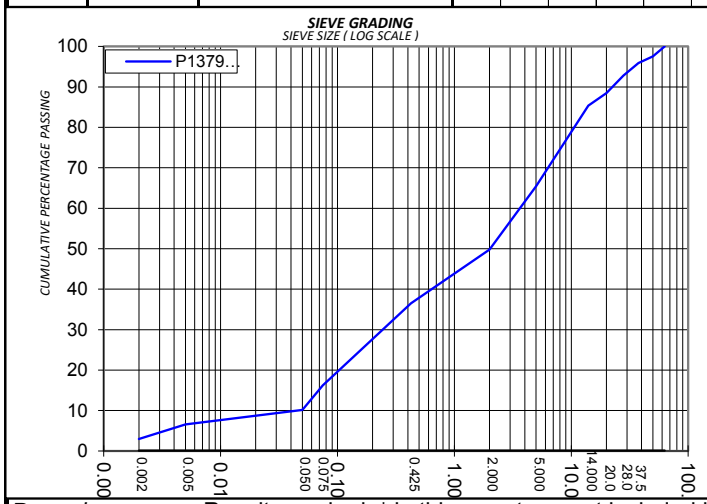
SANS 3001 Methods GR1, GR3, GR5, GR10, GR20, GR30 & GR40

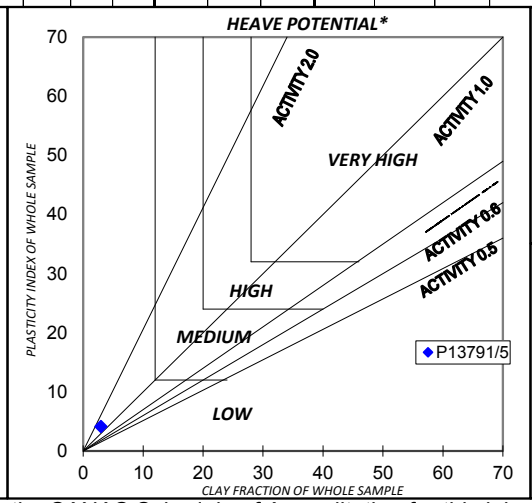
Client : **JL van Rooy** Address: P.O. Box 36786, Menlopark, 0102 **Date Sampled: 08-Jun-20**

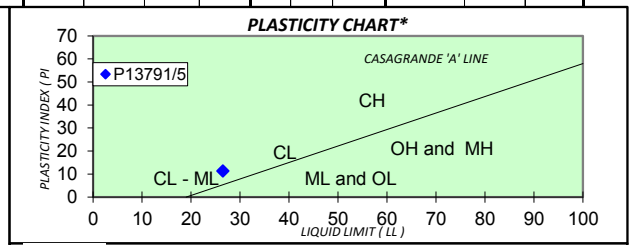
Contract : **Tweefontein** **Doc No:** P13791/5(i)

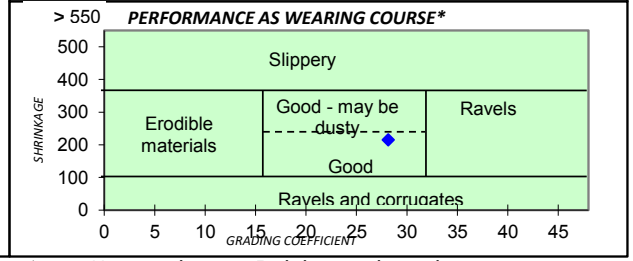
Description : **TP 7 - Sample No.TW5 from 0,54-0,95 m below existing ground level** **Date Tested: 17-Jun-20**

Depth (m)	Sample No.	Description (Unified Soil Classification - ASTM D2487*)	Sieve analysis Cumulative percentage passing											Soil Mortar Analysis % of mat. <2,00 mm*				Effective size*	Uniformity - coef.*	Curvature coef.*	Grading modulus*	Atterberg Limits			Classifications*			
			50,0 mm	37,5 mm	28.0 mm	20,0 mm	14.0 mm	5.0 mm	2,00 mm	0,425 mm	0,075 mm	0,05 mm*	0.005 mm*	0.002 mm*	Coarse sand <2,0 >0,425mm	Fine sand <0,425 ≥0,075mm	Silt <0,05 >0,005mm	Clay <0,005 mm					Liquid Limit	Plasticity Index	Linear Shrinkage	Unified Soil	COLTO	US.Highway	Group Index
0,54-0,95	P13791/5	drk Reddish Brown Clayey sand	98	96	93	88	85	65	50	37	16	10.1	6.6	3.0	26.6	40.9	7.1	13.2	0.045	80	0.4	2.0	27	11	5.9	SC	N/A	A-2-6	0









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***pH =6.2 , *Electrical Conductivity =0.023 S/m, tested on the -5mm fraction**

Date Issued: 29-Jun-20 *Technical signatory (Name) :* **H.C Nolte** *Signature:*

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GRAVEL, SOIL AND SAND ANALYSIS : FOUNDATION INDICATOR TEST REPORT

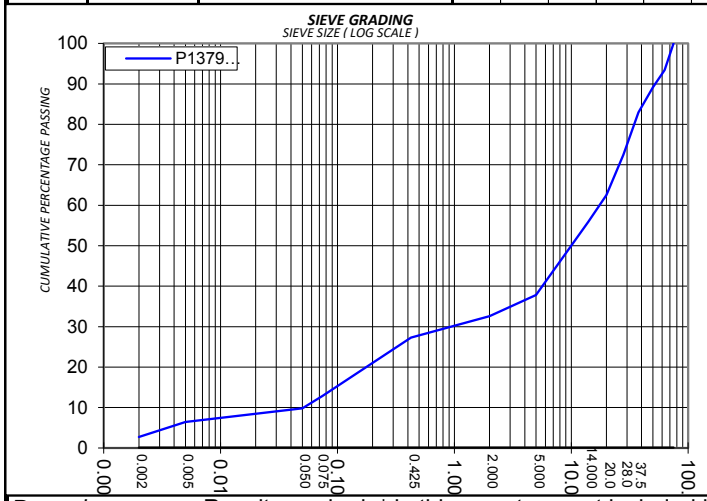
SANS 3001 Methods GR1, GR3, GR5, GR10, GR20, GR30 & GR40

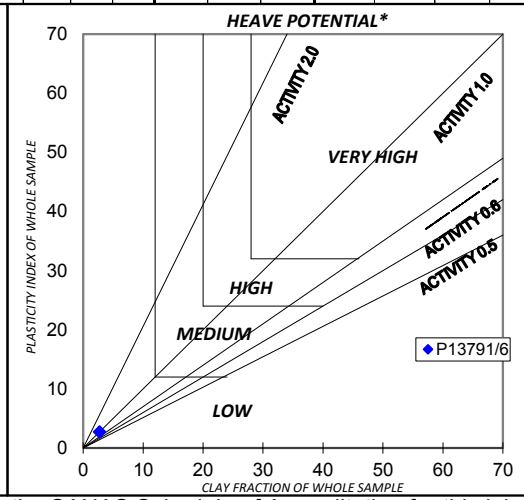
Client : **JL van Rooy** Address: P.O. Box 36786, Menlopark, 0102 **Date Sampled: 08-Jun-20**

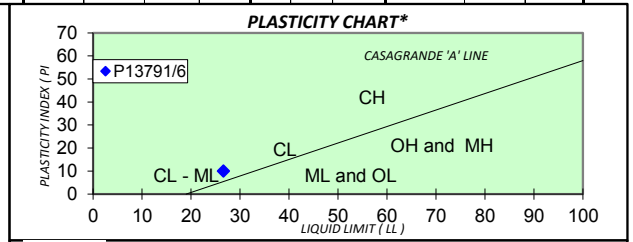
Contract : **Tweefontein** **Doc No:** P13791/6(i)

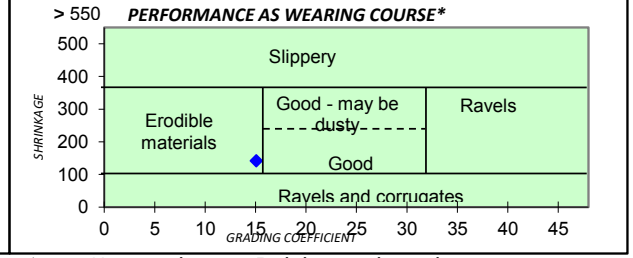
Description : **TP 8 - Sample No.TW6 from 0,10-0,50 m below existing ground level** **Date Tested: 17-Jun-20**

Depth (m)	Sample No.	Description (Unified Soil Classification - ASTM D2487*)	Sieve analysis Cumulative percentage passing											Soil Mortar Analysis % of mat. <2,00 mm*				Effective size*	Uniformity - coef.*	Curvature coef.*	Grading modulus*	Atterberg Limits			Classifications*			
			50,0 mm	37,5 mm	28.0 mm	20,0 mm	14.0 mm	5.0 mm	2,00 mm	0,425 mm	0,075 mm	0,05 mm*	0.005 mm*	0.002 mm*	Coarse sand <2,0 >0,425mm	Fine sand <0,425 ≥0,075mm	Silt <0,05 >0,005mm	Clay <0,005 mm					Liquid Limit	Plasticity Index	Linear Shrinkage	Unified Soil	COLTO	US.Highway	Group Index
0,10-0,50	P13791/6	drk Brown Clayey gravel with sand	89	83	72	63	56	38	33	27	13	9.8	6.4	2.7	16.2	44.2	10.5	19.6	0.051	341	1.0	2.3	27	10	5.2	GC	N/A	A-2-4	0









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GRAVEL, SOIL AND SAND ANALYSIS : FOUNDATION INDICATOR TEST REPORT

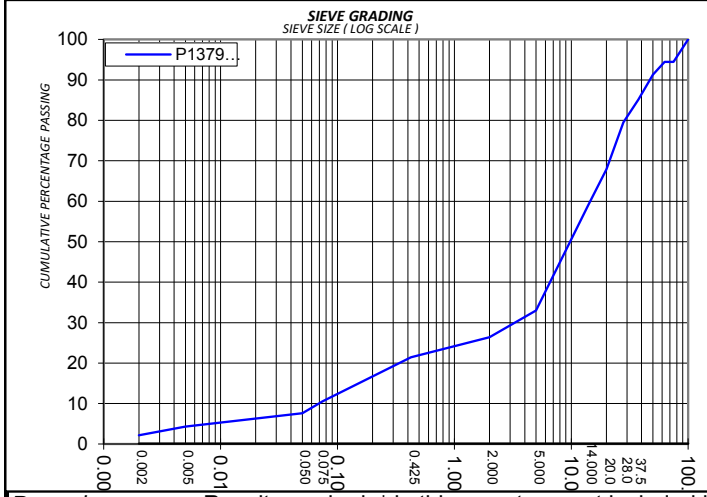
SANS 3001 Methods GR1, GR3, GR5, GR10, GR20, GR30 & GR40

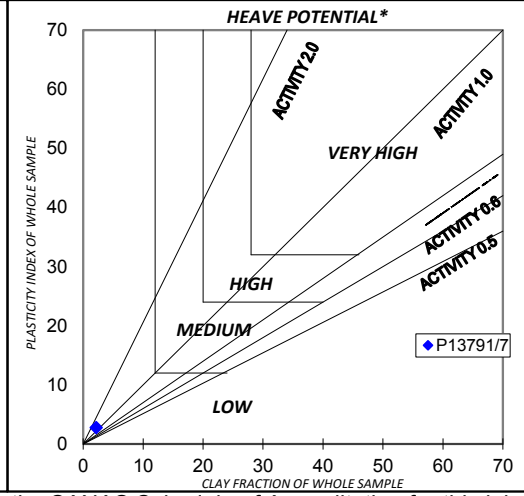
Client : **JL van Rooy** Address: P.O. Box 36786, Menlopark, 0102 **Date Sampled: 08-Jun-20**

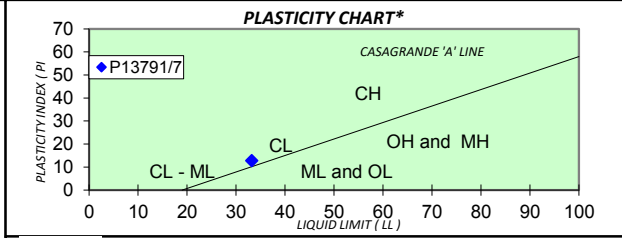
Contract : **Tweefontein** **Doc No:** P13791/7(i)

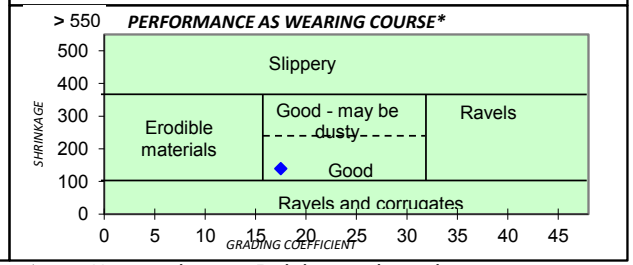
Description : **TP 9 - Sample No.TW7 from 0,0-1,05 m below existing ground level** **Date Tested: 17-Jun-20**

Depth (m)	Sample No.	Description (Unified Soil Classification - ASTM D2487*)	Sieve analysis Cumulative percentage passing											Soil Mortar Analysis % of mat. <2,00 mm*				Effective size*	Uniformity - coef.*	Curvature coef.*	Grading modulus*	Atterberg Limits			Classifications*			
			50,0 mm	37,5 mm	28.0 mm	20,0 mm	14.0 mm	5.0 mm	2,00 mm	0,425 mm	0,075 mm	0,05 mm*	0.005 mm*	0.002 mm*	Coarse sand <2,0 >0,425mm	Fine sand <0,425 ≥0,075mm	Silt <0,05 >0,005mm	Clay <0,005 mm					Liquid Limit	Plasticity Index	Linear Shrinkage	Unified Soil	COLTO	US.Highway	Group Index
0,0-1,05	P13791/7	drk Reddish Brown Poorly graded gravel with clay and sand	91	85	79	68	59	33	26	21	11	7.6	4.3	2.2	18.9	41.0	12.4	16.3	0.069	210	10.8	2.4	33	13	6.5	GP/GC	N/A	A-2-6	0









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***pH =6.2 , *Electrical Conductivity =0.022 S/m, tested on the -5mm fraction**

Date Issued: 29-Jun-20 *Technical signatory (Name) :* **H.C Nolte** *Signature:*

APPENDIX E: HOME BUILDING MANUAL
SITE CLASS TABLES

TABLE 5. GEOTECHNICAL CONSTRAINTS IN URBAN DEVELOPMENT (SANS 634:2012)				
CONSTRAINT		**DESCRIPTOR**		
	DESCRIPTION	**1 (most favourable)**	**2 (intermediate)**	**3 (least favourable)**
A	Collapsible soil	Any collapsible horizon or consecutive horizons totalling depth of less than 750 mm in thickness	Any collapsible horizon or consecutive horizons totalling depth of more than 750 mm in thickness	n/a
B	Seepage	Permanent or perched water table more than 1.5 m below ground surface	Permanent or perched water table less than 1.5 m below ground surface	Swamps and marshes
C	Active soil	Low soil-heave potential anticipated	Moderate soil-heave potential anticipated	High soil-heave potential anticipated
D	Highly compressible soil	Low soil compressibility anticipated	Moderate soil compressibility anticipated	High soil compressibility anticipated
E	Erodibility of soil	soil	Intermediate	High
F	Difficulty of excavation to 1.5 m depth	Scattered or occasional boulders less than 10% of total volume	Rock or hardpan pedocretes between 10% and 40% of total volume	Rock or hardpan pedocretes more than 40% of total volume
G	Undermined ground	Undermining at a depth greater than 200 m below surface	Old undermined areas to a depth of 200 m below surface	Mining within less than 200 m of surface with total extraction
H	Stability (dolomite land)	Possibly stable	Potentially instable	Known sinkholes and dolines
I	Steep slopes	2-6 degrees	< 2 degrees or 6-18 degrees	> 18 degrees
J	Unstable natural slopes	Low risk	Intermediate risk	High risk
K	Seismic activity	10% probability of an event less than 100 cm/s^2 in 50 years	Mining-induced seismicity > 100 cm/s^2	Natural seismicity > 100 cm/s^2
L	Flooding	n/a	Adjacent to known drainage or channel with slope < 1%	Areas within drainage channel or floodplain

(After Partridge, Wood & Brink, 1993)

Table 6. RESIDENTIAL SITE CLASS DESIGNATIONS (SAICE, 1995)

TYPICAL FOUNDATION MATERIAL	CHARACTER OF FOUNDING MATERIAL	EXPECTED RANGE OF TOTAL SOIL MOVEMENTS (mm)	ASSUMED DIFFERENTIAL MOVEMENT (% OF TOTAL)	SITE CLASS
Rock (excluding mud rocks which exhibit swelling to some depth)	STABLE	NEGLIGIBLE	-	R
Fine-grained soils with moderate to very high plasticity (clays, silty clays, clayey silts and sandy clays)	EXPANSIVE SOILS	< 7,5 7,5 – 15 15 – 30 > 30	50% 50% 50% 50%	H H1 H2 H3
Silty sands, sands, sandy and gravelly soils	COMPRESSIBLE AND POTENTIALLY COLLAPSIBLE SOILS	< 5,0 5,0 – 10 > 10	75% 75% 75%	C C1 C2
Fine-grained soils (clayey silts and clayey sands of low plasticity), sands, sandy and gravelly soils	COMPRESSIBLE SOIL	< 10 10 – 20 > 20	50% 50% 50%	S S1 S2
Contaminated soils Controlled fill Dolomitic areas Land fill Marshy areas Mine waste fill Mining subsidence Reclaimed areas Very soft silt/silty clays Uncontrolled fill	VARIABLE	VARIABLE		P

NOTES:

1. The classifications C, H, R and S are not intended for dolomitic area sites unless specific investigations are carried out to assess the stability (risk of sinkholes and doline formation) of the dolomites. Where this risk is found to be acceptable, the site shall be designated as Class P (dolomitic areas).
2. Site classes are based on the assumption that differential movements, experienced by single-storey residential buildings, expressed as a percentage of the total movements are equal to about 50% for soils that exhibit expansive or compressive characteristics and 75% for soils that exhibit both compressible and collapse characteristics. Where this assumption is incorrect or inappropriate, the total soil movements must be adjusted so that the resultant different movements implied by the table is equal to that which is expected in the field.
3. In some instances, it may be more appropriate to use a composite description to describe a site mote fully e.g. C1/H2 or S1 and/or H2. Composite Site Classes may lead to higher differential movements and result in design solutions appropriate to a higher range of differential movement e.g. a Class R/C1 site. Alternatively, a further site investigation may be necessary since the final design solution may depend on the location of the building on a particular site.
4. Where it is not possible to provide a single site designation and a composite description is inappropriate, sites may be given multiple descriptions to indicate the range of possible conditions e.g. H-H1-H2 or C1-C2.
5. Soft silts and clays usually exhibit high consolidation and low bearing characteristics. Structures founded on these horizons may experience high settlements and such sites should be designated as being Class S1 or S2 as relevant and appropriate.
6. Sites containing contaminated soils include those associated with reclaimed mine land, land down-slope of mine tailings and old land fills.
7. Where a site is designated as Class P, full particulars relating to the founding conditions on the site must be provided.
8. Where sites are designated as being Class P, the reason for such classification shall be placed in brackets immediately after the suffix – i.e. P(contaminated soils). Under certain circumstances, composite description may be more appropriate – e.g. P(dolomite areas)-C1.
9. Certain fills may contain contaminates which present a health risk. The nature of such fill should be evaluated and should be clearly demarcated as such.

Table 7. NHBRC SITE CLASSIFICATION DESIGNATIONS LINKED TO CONSTRUCTION TYPES (Home Builders Manual, 2015) (SAICE, 1995)

Site Class designation	Typical founding material	Character of founding material	Single storey masonry house construction type
R	Rock	Stable	Normal
H	Clays, silty clays, clayey silts and sandy clays.	Expansive soils	Normal
H1			Modified normal / soil raft
H2			Stiffened or cellular raft / piled or split construction / soil raft.
H3			Stiffened or cellular raft / piled or split construction / soil raft.
C	Silty sands, sands, sandy and gravelly soils.	Compressible and potentially collapsible soils	Normal
C1			Modified normal / compaction of in-situ soils below individual footings / deep strip foundations / soil rafts.
C2			Stiffened strip footings, stiffened or cellular raft / deep strip foundations / compaction of in-situ soil below individual footings / piled or pier foundations / soil raft.
P	Contaminated soils, controlled fill, dolomitic areas, landslip, landfill, marshy areas, mine waste fill, mining subsidence, reclaimed areas, uncontrolled fill, very soft silts / silty clays.	Variable.	Variable.
S	Clayey silts, clayey sands of low plasticity, sands, sandy and gravelly soils	Compressible soils	Normal
S1			Modified normal / compaction of in-situ soil below individual footings / deep strip foundations/ soil raft
S2			Stiffened strip footings, stiffened or cellular raft / deep strip foundations / compaction of in-situ soil below individual footings / piled or pier foundations / soil raft.