THE POPO MOLEFE DEVELOPMENT, BOITEKONG EXTENSION 39, PAARDEKRAAL, RUSTENBURG

ENGINEERING GEOLOGICAL INVESTIGATION

to DETERMINE the POTENTIAL for TOWNSHIP DEVELOPMENT

for THE POPO MOLEFE DEVELOPMENT, BOITEKONG EXTENSION 39, on

PORTIONS of the FARM PAARDEKRAAL 279JQ,

RUSTENBURG, NORTHWEST PROVINCE.

Georeference: 2527CB Rustenburg East

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REPORT ON THE ENGINEERING GEOLOGICAL INVESTIGATION CONDUCTED FOR THE POPO MOLEFE DEVELOPMENT, BOITEKONG EXTENSION 39, PAARDEKRAAL 279JQ, RUSTENBURG, NORTHWEST PROVINCE.

Executive Summary

An engineering geological investigation with reference to GFSH-2 specification was conducted for the Popo Molefe Development, Boitekong Extension 39, Paardekraal 279JQ, Rustenburg, Northwest Province, with the aim to assess aspects such as geology, relief and subsoil conditions which may influence the planned development in the area. The site is underlain by Mathlagama norite & anorthosite of the Rustenburg Layered Suite, Bushveld Complex. Surficial deposits include quaternary sand and colluvium covering the lithology. The mechanical properties of the soil layers were determined by means of laboratory tests performed on representative disturbed samples taken during the profiling of trial pits. The obtained site information is evaluated with regard to the development of masonry structures by the application of standard evaluation techniques. Development zonation for township development according to the NHBRC and SAIEG guidelines were done, characterizing the geotechnical conditions of the sites. The area is underlain by norite and anorthosite with high to very highly expansive properties, with an estimated total settlement or heave of more than 40mm up to 90mm measured at surface, and it classified as H3R. Foundations will therefore require special foundation techniques such as proper compaction techniques and lightly reinforced strip footings with articulation joints at all internal and external doors and openings with light reinforcement (brickforce) in masonry, or soil replacement by an engineered fill soil raft, stiffened or cellular rafts and even piled foundations. Excavatibility may hamper the placement of some services. Special care must be taken to ensure adequate surface drainage to prevent the accumulation of water next to structures. A concrete apron of at least 1,0m around structures are prescribed, and we recommend no gardening around structures to keep the moisture content as stable as possible. These proposed mitigation measures will be sufficient to successfully address the anticipated geotechnical problems and to ensure the sustainable development as planned.

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STL Summary of Results

STL Laboratory Results

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1. INTRODUCTION AND TERMS OF REFERENCE

On request of Me Rene Vermeijs of Akha Maduna in Klerksdorp, an engineering geological investigation was conducted for The Popo Molefe Development, Boitekong, Paardekraal, Rustenburg, Northwest Province, and communication between us and the abovementioned parties lead to the field work, commencing on 27 August 2019.

The aim of this investigation was to identify and evaluate any possible engineering geological problems before township proclamation.

This report is based on the in-situ evaluation of all the representative soil horizons within the ground profile, visual results of the site visit and other relative exposed geotechnical properties on site and derived from interpretation of laboratory results.

The proposed development site is for the Popo Molefe Development, Boitekong Extension 39 on portions 39, 106 & 109 and the remainder of portions 16 & 26 of the farm Paardekraal 279JQ, located southeast of Rustenburg. Figures 1-6 in Appendix A delineates the site.

2. INFORMATION USED IN THE STUDY

The following was consulted during the investigation:

2.3.1 The geological map 2527 Rustenburg. Scale 1:250 000. The Geological Survey of South Africa.

2.3.2 The topography map 2527CB Rustenburg East. Scale 1:50 000.The Chief Directorate: Surveys and Land Information, Mowbray.

3. SITE DESCRIPTION

3.1 PHYSIOGRAPHY

3.1.1 Topography

The site is located on a shallow slope towards the Hex River east of the site. A small drainage feature exist a distance south of the site and it drains eastwards into the Hex River.

3.1.2 Climate

The region is characterized by summer rainfall with thunderstorms, with annual low rainfall figures of 685 mm (Agriculture) and 703 mm (Buffelspoort), recorded at the closest weather station to the site. Winters are dry with frost common. The warmest months are normally December and January and the coldest months are June and July.

An analysis of the data confirms a Weinert's N-Value in the order of 2,4 for Rustenburg. The chemical decomposition of rocks will therefore be dominant over mechanical disintegration, and deep soil horizons will be expected in areas of poor drainage, underlain by igneous rocks.

Storm water drainage and road pavement design must incorporate the climatic extremes above.

3.1.3 Vegetation

The area is typically characterized by sourish mixed bushveld *veld type* (Acocks, 1988).

The site itself is covered by sparse grasslands of which some was used as agriculture land, and few indigenous thorn trees are present on site within the stands.

4. NATURE OF INVESTIGATION

4.1 SITE INVESTIGATION

All available information was studied before and during the site visit.

The investigation commenced with a desk study, where all relevant information is collected and compiled on a base map. The site was divided into land forms, after which the accuracy of the information was checked by means of a field visit.

Test pits were dug and representative disturbed samples were collected and tested. The position of the test pits are represented in FIGURE 2 (Appendix A). The soil profiles were described according to the methods described by Jennings *et al* (Jennings 1973). This method describes each horizon in terms of moisture content, colour, consistency, structure, type of soil and origin of the soil.

Disturbed samples of the soil materials were taken for laboratory analysis. The gradings of the soils were determined by sieve and hydrometer analysis, resulting in cumulative grading curves.

The mechanical properties of the soil material are described in terms of the liquid limit and plasticity index (determined by means of the Atterberg Limit tests) and the linear shrinkage. These values can be used to calculate the potential expansiveness of the soils, and to evaluate the materials for use as construction material. The consistency of a soil is described by means of its Atterberg limits, where the effect of a change in the moisture content on the consistency of a cohesive soil is measured. According to Cernica (1982) these tests are useful "mostly for soil identification and classification". It can also be used to determine the mechanical properties of cohesive soil material. Note that cohesionless soils (i.e. sandy material) cannot be tested for plasticity or collapse potential as this material does not contain enough fines to exhibit consistency. The taking of undisturbed samples was not possible due to disintegration.

The linear shrinkage test to determine the percentage shrinkage that can be expected, is performed by wetting a soil to approximately its liquid limit and drying the resultant paste in a linear shrinkage mould.

The potential expansiveness of a soil depends upon its clay content, the type of clay mineral, its chemical composition and mechanical character. A material is potentially expansive if it exhibits the following properties (Kantey and Brink, 1952):

- clay content greater than 12 percent,
- plasticity index of more than 12,
- liquid limit of more than 30 percent, and
- linear shrinkage of more than 8 percent.

The potential expansiveness (low, medium, high, very high) is calculated by means of Van der Merwe's method (Van der Merwe, 1964), where the equivalent plasticity index versus the clay content of the material is plotted on a graph divided into heave categories. If any sample in the study area classifies as potentially expansive, the amount of heave or mobilization in mm measured on the surface will be calculated.

4.2 LABORATORY TESTS

Sampling was reduced according to the limited variability of the geotechnical character and simplicity of the entire sites as well as accessibility to the almost totally built up area comprising double and single story upmarket houses with associated infrastructure.

No consolidometer or potential collapse tests were done as it was impossible to secure any undisturbed soil sample required for these tests.

No soil chemistry samples were tested as all new developments use synthetic pipes not reactive to soil aggressiveness.

The disturbed samples taken during the investigation were tested by the accredited laboratory of Spesialised Testing Laboratory in Pretoria to determine their physical properties.

Indicator tests include a grading analyses, the determination of Atterberg limits and linear shrinkage. A free swell tests was also done.

The results are represented in Appendix C.

5. SITE GEOLOGY AND GROUNDWATER CONDITIONS

5.1 Geology

The area is underlain by Mathlagama norite & anorthosite of the Rustenburg Layered Suite, Bushveld Complex, consisting of gabbro, norite, locally with anorthosite bands. Surficial deposits on site include quaternary calcrete or ferricrete and colluvium, sometimes covering the lithology.

No dolomite occurs in the area and no stability investigation is required.

5.2 Groundwater Conditions

Plate flow is the dominant drainage pattern on site, and the site is drained in a southerly direction towards a perennial stream, a tributary to the Hex River not too far east of this site.

The permanent or perched water table on site is deeper than 1,5m below ground surface. Slow percolation of water within the clay is expected.

6. GEOTECHNICAL EVALUATION

6.1 ENGINEERING AND MATERIAL CHARACTERISTICS

6.1.1 SOIL PROFILES

All terrain land forms or mapping units were extensively sampled and more than adequate representative characterization of each unit took place.

The soil profiles with accompanied plates are represented in Appendix B.

Typical profile

Slightly moist to moist, reddish brown or black to dark brown, soft, micro shattered & slicken sided, sandy clay. Colluvium or reworked norite.

Slightly moist, kaki orange to white speckled black, soft to stiff, intact, silty clayey sand. Residual slightly weathered norite.

Refusal of TLB on clayey silty sandy gravel of residual slightly weathered norite, core stones or shallow rock norite.

Some problems regarding excavatability can be expected on the site, and the competent TLB refused in many test pits, generally ranging from 1,5m up to 2,5m in refusal depth. Shallow rock and rock outcrop were noted and norite core stones are expected that can cause differential settlement, and it will also increase development cost as pneumatic tools and even blasting may be required to reach installation depths.

To ensure the stability of excavations, it will need standard sidewall protection in all excavations exceeding 1,5m.

6.1.2 LABORATORY RESULTS

Sampling took place according to the limited variability of the geotechnical character according to the land forms and simplicity of the entire site. All terrain land forms or mapping units were extensively sampled with more than adequate representative characterization of each identified zone or unit.

No consolidometer or potential collapse tests were done as it was impossible to secure any undisturbed soil sample required for these tests.

The highly clay percentages tested between 22 to 66% for the colluvium comprising the turf or black clay with highly to very highly plasticity indexes of between 15 and 52, with liquid limits from 29 to as high as 90% and linear shrinkage percentages between 8 and 38,5%, indicating the expansive character of the clayey material.

The PRA classification ranged from A-7-5 (9 samples) and usually A-7-6 (10 samples) as highly compressible silty clay to high volume change clay, and classified according to the Unified System as mainly CH (15 samples): Inorganic clay of high plasticity, fat clay to CL (7 samples): inorganic clay of low to medium plasticity, gravelly, sandy or silty clay, lean clay.

The material tested very highly in expansive potential (15 samples) according to the method of heave estimation of Van der Merwe with expected heave in excess of 30mm measured at surface in many of the test pits. The moderately weathered norite is expected to have a lower heave potential with an increase of gravel of the residual

norite as expected.

Special foundation techniques and construction methods will be required for any development on the site.

Due to the level of development within the area, the likelihood for the development of borrow pits on the sites are low.

All road building and construction materials will be sourced from established commercial activities in and around Rustenburg.

6.2 SLOPE STABILITY AND EROSION

The potential for lateral soil movement or erosion is medium, and the colluvium may be washed away during thunderstorms, although the relative flat topography prevents this from reaching problematic status.

Except for local slope instability within opened trenches and the collapse of pit side walls, no other slope instability is expected within these areas.

6.3 EXCAVATION CLASSIFICATION WITH RESPECT TO SERVICES

The excavation characteristics of the different soil horizons encountered have been evaluated according to the South African Bureau of Standards standardized excavation classification for earthworks (SABS – 1200D) and earthworks (small works – SABS 1200DA). In terms of this classification and the in-situ soil/rock consistencies as profiled, the relationships given below are generally applicable:

1. “soft excavation” - very loose/very soft through to dense or stiff.
2. “intermediate excavation” - very dense/very stiff through to very soft rock.
3. “hard excavation” - soft rock or better

Problems regarding excavatability can be expected on portions of the site, with some sub outcrop or shallow norite rock and norite rock outcrop areas that classified as hard rock excavation.

The upper hillwash comprising of clay or turf is relatively easily excavated by a TLB, and it was classified as soft in restricted and non-restricted excavation (SANS 1200 D). Restricted access during wet summer months due to slippery conditions with limited movement of larger equipment will also restrict development.

The excavation in ferricrete, calcrete or residual norite with possible core stones or boulders and shallow rock norite will increase the development cost and is classified as intermediate to hard, and the excavation depth with a competent TLB is usually limited to less than 1,5m deep in medium hard rock norite and a competent TLB or excavator and even blasting will be needed to reach installation depths for services in some areas. It was classified as intermediate becoming hard rock in restricted and non-restricted excavation (SANS 1200 D).

To ensure the stability of excavations, it will need standard sidewall protection in excavations exceeding 1,5m.

6.4 IMPACT OF THE GEOTECHNICAL CHARACTER OF THE SITE ON HOUSING DEVELOPMENTS

During the engineering geological investigation it is essential to determine and quantify the extent of potential problems associated with the area (addressed in **bold** below), before proper township proclamation. The ideal conditions for urban development may be listed as follows:

* A smooth surface gradient with slopes less than 12°. Accessibility should not be restricted by topography (plateau areas).
* No potential for slope instability features - landslides, mud flows.
* **Easy excavation** for foundations and installation of services (normal depth of 1,5 m required).
* Foundations above the ground water level or perched water table, with not too low permeability.
* Development above the 1:50 year flood line.
* Adequate surface and subsurface drainage conditions, with minimal erosion potential.
* No presence of problematic soils, for example **heaving clays, compressible clays**, sand with a collapse potential, or dispersive soils, that will require expensive remedial measures.
* No potential for surface subsidence due to the presence of dolomite (sinkholes) or undermining.
* No damaging differential subsidence or movement (less than 5mm total movement at the surface allowed).
* The site should be placed away from potential pollutants such as waste disposal sites.

6.4.1 EVALUATION FOR URBAN DEVELOPMENT

The presence of ferricrete or calcrete indicates that perennial fluctuations of ground water will be encountered on site, proving that a seasonal perched water table may exist.

Special care must be taken to ensure adequate surface drainage to prevent the accumulation of water next to structures. A concrete apron of at least 1,0m around structures are prescribed, and we recommend no gardening around structures to keep the moisture content as stable as possible.

The sites contain highly to very highly expansive and compressible soil, and foundations will need special treatment to withstand movement associated with the variation in moisture content of the soil.

Some problems regarding excavatability can be expected on the site reflected in the R classification of the zones due to the presence of calcrete and some core stones of norite.

Retaining walls as well as slope stabilization measures are recommended on all constructed embankments exceeding 1,5m.

Mining activities in the areas and a history of mining and possibly contaminated land were not identified on the site. The site itself is located a distance from any active mining operations and in an inactive area regarding seismic activity.

Storm water diversion measures such as ponding pools are recommended to control peak flows during thunderstorms. Drainage provision along the already provided gutters from the existing roads from town should be well maintained.

All embankments must be adequately compacted and planted with grass to stop any excessive erosion and scouring of the landscape.

7. SITE CLASSIFICATION

By grouping together all the land facets with the same geotechnical characteristics, the site can be divided into development zones, this being the main objective or result

of a phase 1 engineering geological investigation. Each zone can therefore be defined as a grouping of areas with specific geotechnical properties placing similar constraints upon development. With the above-mentioned criteria in mind, the study area can be divided into typical development zones for residential development (SAICE, SAIEG & NHBRC, 1995):

Land suitable for development: Standard foundation techniques and normal construction with normal site drainage and standard building practice will be adequate for development.

Land suitable for development with precaution or risk: A few precautionary measures for problematic soils in this zone are necessary before urban development can be initiated, with a higher than normal cost implication to overcome geotechnical constraints. The risk of restricted excavatability for the placing of services induces a higher cost for development.

Land not suitable for development typically comprises of the drainage features that are susceptible to annual flooding below the 1:50 year flood line, and is also associated with perched water tables. Land in close proximity of unstable ground such as a potential slope failure or mud flow induced by rainfall is also not suitable for development.

On account of the field observations, laboratory results, previous experience and engineering properties of the soil, it is zoned as follows (SAIEG,1997- See tabular explanation of classification in Appendix D):

7.1 ENGINEERING GEOLOGICAL ZONATION

Modified Normal to Special Development:

Site Class C2H1/2A1C:

Hillwash comprising dark reddish brown silty clayey sand with fine gravel represents a slightly expansive and medium compressible to highly collapsible soil, with a thickness in excess of 0,75m, and an expected range of up to 15mm of total soil movement measured at surface, form this zone on site. Foundations will therefore require modified normal foundation techniques such as lightly reinforced strip footings or reinforced boxed steel in slightly widened strip foundations, the use of split construction techniques or articulation joints at all internal and external doors and openings with light reinforcement (brickforce) in masonry, or soil replacement by an engineered fill soil raft by removing all or part of the expansive horizon to 1,0m beyond the perimeter of the structure and replacing with inert backfill, compacted to 93%MOD ASSHTO density at or near optimum moisture content, where after normal strip footing foundations can be used. Site drainage, a concrete apron of 1,0m around all structures and plumbing and service precautions are advised. It is classified as C2H1 in terms of the NHBRC

guidelines (1995) or the SAICE Code of practice (1995) and 2A1C after the classification for urban development (Partridge, Wood & Brink).

Special Development with Risk:

Site Class H3R/3C2F:

This zone usually comprises of slicken slided and micro shattered dark red or black clay (turf) in excess of 0,75m in thickness consisting of highly to very highly expansive soil, with an estimated total settlement or heave in excess of 30mm measured at surface and will require special foundation techniques to enable proper development. It is underlain by norite and some norite core stones or shallow rock norite can be expected which will restrict excavations for the placement of services or foundations with possible differential settlement and it could require pneumatic tools, a competent TLB and even blasting to reach the required depth for the placement of services and foundations with additional R designation. Special construction techniques include the use of soil rafts, deep strip foundations, stiffened strip footings, stiffened or cellular rafts or even piled foundations. Site drainage, a concrete apron of 1,0m around all structures with no gardening allowed next to structures and plumbing and service precautions are advised. It was classified as H3R in terms of the NHBRC guidelines (1995) or the SAICE Code of practice (1995) and 3C2F according to the classification for urban development (Partridge, Wood & Brink).

Suitable for development with precaution

Site Class PR:

Norite rock outcrop and sub-outcrop will restrict excavatability required during service installation as well as foundation excavations. Blasting or difficult excavation operations will dramatically increase the development cost in this zone.

Site Class PQ:

Areas where small quarries or filling or dumping of spoil were identified must be rehabilitated before any construction can be allowed, and backfilling with an engineer's material may improve the developability of these zones, but these operations will dramatically increase the development cost in this zone.

Undevelopable:

Site Class PD:

Perennial drainage features where the 1:100 year flood line will determine or specify the allowable distance of development from rivers, usually at least 32m from the center of the river.

8. FOUNDATION RECOMMENDATIONS AND SOLUTIONS

8.1 *Expansive soil*

Site Class H (Estimated total heave of less than 7.5mm):

Soil tested as medium expansive with a clay layer thickness of up to 0,3m from surface

Normal construction:
Minor heave requires normal construction (strip footing and slab on the ground) with site drainage and service/plumbing precautions recommended.

Site Class H1 (Estimated total heave of between 7.5 and 15mm):

Tested as <u>medium</u> expansive with a clay layer thickness of between 0,3 to 0,85m from surface, or a <u>highly</u> expansive clay layer of between 0,3 and 0,4m in thickness from surface or a clay layer with a <u>very high</u> expansive potential of up to 0.3m.

Modified normal:
Lightly reinforced strip footings.
Articulation joints at all internal/external doors and openings
Light reinforcement in masonry.
Site drainage and plumbing/service precautions.

Or soil raft:
Remove all or part of expansive horizon to 1,0m beyond the perimeter of the construction and replace with inert backfill compacted to 93% MOD AASHTO density at -1% to 2% of optimum moisture content.
Normal construction with lightly reinforced strip footings and masonry.
Site drainage and plumbing/service precautions.

<u>Site Class H2 (Estimated total heave of between 15 and 30mm):</u>

Tested as <u>medium</u> expansive with a clay layer thickness of between 0,85 to 2,0m, or <u>highly</u> expansive of between 0,4 and 0,85m in thickness measured from surface, or a clay layer with a <u>very high</u> expansive potential of between 0.3 and 0.4m.

Soil raft:
See H1.

Stiffened or cellular raft:
Articulation joints or solid lightly reinforced masonry.
Site drainage and plumbing/service precautions.

Piled construction:
Piled foundation with suspended floor slabs with or without ground beams.
Site drainage and plumbing/service precautions.

Split construction:
Combination of reinforced brickwork/blockwork and full movement joints.
Suspended floors or fabric reinforced ground slabs.
Site drainage and plumbing/service precautions.

<u>Site Class H3 (Estimated total heave of more than 30mm):</u>

Soil tested as <u>medium</u> expansive with a clay layer thickness of more than 2,0m (>2,0m thick), or <u>highly</u> expansive of more than 0,85m (0,85m or more in thickness), or a clay layer with a <u>very high</u> expansive potential of more than 0.4m in thickness. Foundations require special design by structural engineer of the following:

Soil raft:

As for H1.

Stiffened or cellular raft:
As for H2.

Piled construction:
As for H2.

8.2 ***Consolidation or collapse settlement***

Site Class C (Estimated total Settlement of less than 5mm):

Normal Construction:
Minor collapse settlement requires normal construction (strip footing and slab on the ground) with compaction in foundation trenches and good site drainage.

Site Class C1 (Estimated total Settlement of between 5 and 10mm):

Modified normal construction:
Reinforced strip footing and slab on the ground.
Articulation joints at some internal and all external doors and openings.
Light reinforcement in masonry.
Site drainage and service/plumbing precautions recommended.
Foundation pressure not to exceed 50 kPa (single storey buildings).

Compaction of in situ soils below individual footings:
Remove in situ material below foundations to a depth and width of 1,5 times the foundation width or to a competent horizon and replace with material compacted to 93% MOD AASHTO density at -1% to +2% of optimum moisture content.
Normal construction with light reinforcement in strip foundation and masonry.

Deep strip foundations
Normal construction with drainage precaution.
Founding on a competent horizon below problem horizon.

Soil Raft
Remove in situ material to 1,0m beyond perimeter of building to a depth and width of 1,5 times the widest foundation or to a competent horizon and replace with material compacted to 93% MOD AASHTO density at -1% to +2% of optimum moisture content.
Normal construction with lightly reinforced strip footings and masonry.

Site Class C2 (Estimated total Settlement of more than 10mm):

Stiffened strip footings, stiffened or cellular raft
Stiffened strip footings or stiffened or cellular raft with articulation joints or solid lightly reinforced masonry
Bearing pressure not to exceed 50 kPa.
Fabric pressure not to exceed 50 kPa.
Site drainage and service/plumbing precautions.

Deep strip foundations
See C1

Compaction of in situ soils below individual footings
See C1

Piled or pier foundations
Reinforced concrete ground beams or solid slabs on piled or pier foundations.

Ground slabs with fabric reinforcement.
Good site drainage.

Soil Raft
See C1

9. DRAINAGE

The site is located on a moderate to shallow to moderate slope towards the Hex River.

Plate flow is the dominant drainage pattern on the sites, and some prominent drainage features or channel intersects the sites. Drainage occurs in a northwestern direction towards the Hex River.

The drainage systems from culverts for the roads should be incorporated within the roads.

Seepage and the presence of perennial fluctuations of ground water were encountered on site, proving that a seasonal perched water table may exist. A ferruginised profile or calcrete indicates that some perennial water level fluctuations may occur.

Ground water in the form of seepage was not intersected in any test pit during the investigation, but normal water tightening techniques such as damp course on foundation levels are required.

The expected low permeability of the silty sandy clay will limit leachate from sanitation systems to reach the ground water along the shallow norite bedrock, but a closed water borne sewage system is recommended as the percolation rate through this clayey material prevents movement resulting in that pits may fill up and overflow.

The depth of excavation also restricts the use of open pit latrines on the site.

Special care must be taken to ensure adequate surface drainage to prevent the accumulation of water next to structures. A concrete apron of at least 1,0m around structures are prescribed, and we recommend no gardening around structures to keep the moisture content as stable as possible.

Storm water diversion measures such as ponding pools are recommended to control peak flows during thunderstorms.

All embankments must be adequately compacted and planted with grass to stop any excessive erosion and scouring of the landscape.

10. CONCLUSIONS

1. The proposed Popo Molefe Development, Boitekong Extension 39, Paardekraal 279JQ in Rustenburg was investigated to determine the engineering geological properties that will influence the planned township development.

2. The area is underlain by Mathlagama norite & anorthosite of the Rustenburg Layered Suite, Bushveld Complex. Surficial deposits include quaternary calcrete and colluvium, covering the lithology on site.

3. Some problems are foreseen regarding the excavatability to 1,5m depth on portions of the site.

4. Special care must be taken to ensure adequate surface drainage to prevent the accumulation of water next to structures. A concrete apron of at least 1,0m around structures are prescribed, and we recommend no gardening around structures to keep the moisture content as stable as possible.

5. Zoning of the site revealed zones with constraints regarding the **compressibility, as well as the expansive properties** of the soil, and **shallow rock and core stones** may hamper the placement of services.

6. The following Zones were identified:

Modified Normal to Special Development:

Site Class C2H1/2A1C:

Hillwash comprising dark reddish brown silty clayey sand with fine gravel represents a slightly expansive and medium compressible to highly collapsible soil, with a thickness in excess of 0,75m, and an expected range of up to 15mm of total soil movement measured at surface, form this zone on site. Foundations will therefore require modified normal foundation techniques such as lightly reinforced strip footings or reinforced boxed steel in slightly widened strip foundations, the use of split construction techniques or articulation joints at all internal and external doors and openings with light reinforcement (brickforce) in masonry, or soil replacement by an engineered fill soil raft by removing all or part of the expansive horizon to 1,0m beyond the perimeter of the structure and replacing with inert backfill, compacted to 93%MOD ASSHTO density at or near optimum moisture content, where after normal strip footing foundations can be used. Site drainage, a concrete apron of 1,0m around all structures and plumbing and service precautions are advised. It is classified as C2H1 in terms of the NHBRC guidelines (1995) or the SAICE Code of practice (1995) and 2A1C after the classification for urban development (Partridge, Wood & Brink).

Special Development with Risk:

Site Class H3R/3C2F:

This zone usually comprises of slicken slided and micro shattered dark red or black clay (turf) in excess of 0,75m in thickness consisting of highly to very highly expansive soil, with an estimated total settlement

or heave in excess of 30mm measured at surface and will require special foundation techniques to enable proper development. It is underlain by norite and some norite core stones or shallow rock norite can be expected which will restrict excavations for the placement of services or foundations with possible differential settlement and it could require pneumatic tools, a competent TLB and even blasting to reach the required depth for the placement of services and foundations with additional R designation. Special construction techniques include the use of soil rafts, deep strip foundations, stiffened strip footings, stiffened or cellular rafts or even piled foundations. Site drainage, a concrete apron of 1,0m around all structures with no gardening allowed next to structures and plumbing and service precautions are advised. It was classified as H3R in terms of the NHBRC guidelines (1995) or the SAICE Code of practice (1995) and 3C2F according to the classification for urban development (Partridge, Wood & Brink).

Suitable for development with precaution

Site Class PR:

Norite rock outcrop and sub-outcrop will restrict excavatability required during service installation as well as foundation excavations. Blasting or difficult excavation operations will dramatically increase the development cost in this zone.

Site Class PQ:

Areas where small quarries or filling or dumping of spoil were identified must be rehabilitated before any construction can be allowed, and backfilling with an engineer's material may improve the developability of these zones, but these operations will dramatically increase the development cost in this zone.

Undevelopable:

Site Class PD:

Perennial drainage features where the 1:100 year flood line will determine or specify the allowable distance of development from rivers, usually at least 32m from the center of the river.

7. **Special construction** techniques must be used to enable proper development including the use of **compaction techniques with steel reinforcement** or **soil rafts** and even **piled foundations** or **stiffened or cellular rafts** as described.

8. **This investigation was done to reveal the geotechnical properties on site with the techniques as described to form our opinion. Although every possible factor during the investigation was dealt with, it is possible to encounter variable local conditions. This will require the inspection of foundations by a competent person to verify expected problems.**

11. BIBLIOGRAPHY

ACOCKS, J.P.H., 1988. “Veld types of South Africa.” Memoir no. 57 The Botanic Survey South Africa.

BRINK, A.B.A., 1979. "Engineering geology of Southern Africa Vol. 1". Building Publications, Pretoria.

BRINK, PARTRIDGE & WILLIAMS, 1982. "Soil Survey for Engineering." Clarendon Press, Oxford.

BRINK, PARTRIDGE & WILLIAMS. Priorities for the Application of Engineering Geology in Developing Countries. Department of Geology, University of the Witwatersrand.

FISHER, G.J., 1994. “The selection of cemetery sites in South Africa .” Proceedings of the Fourth Symposium on Terrain Evaluation and Data Storage, Midrand, August 1994.

HUNT, R.E., 1984. “Geotechnical Engineering Investigation Manual.” McGrawHill.

JENNINGS, J.E., BRINK, A.B.A & WILLIAMS, A.A.B., 1973. "Revised guide to soil profiling for civil engineering purposes in South Africa". The Civil Engineer in South Africa, Vol. 15, No.1, January 1973.

PARTRIDGE, T.C., WOOD, C.K., and BRINK, A.B.A., 1993. Priorities for Urban Expansion within the PWV Metropolitan Region: The Primacy of Geotechnical Constraints. South African Geographical Journal, Vol 75, pp 9 - 13.

SOUTH AFRICAN INSTITUTE OF CIVIL ENGINEERS/INSTITUTION OF STRUCTURAL ENGINEERS, 1995. Code of Practice: Foundations and Superstructures for Single Storey Residential Buildings of Masonry Construction. Joint Structural Division, Johannesburg.

SWARTZ, K., 1985. “Problem Soils in South Africa - State of the art: Collapsible Soils”, The Civil Engineer in South Africa, July 1985.

THE NATIONAL HOME BUILDERS REGISTRATION COUNCIL (NHBRC), 1995. Standards and guidelines, first issue, May 1995.

THE SOUTH AFRICAN INSTITUTE OF ENGINEERING GEOLOGISTS (SAIEG), 1997. Guidelines for Urban Engineering Geological Investigations.

VAN DER MERWE, D.H., 1964. “The prediction of heave from the plasticity index and percentage clay fraction of soils”. The Civil Engineer in South Africa., June 1964.

WEATHER BUREAUX, 1988. “Climate of South Africa. Climate statistics up to 1984.

WEINERT, H.H., 1980. "The natural road construction materials of Southern Africa", Academica, Cape Town.

APPENDICES

APPENDIX A: FIGURES

Figure 1: The Popo Molefe Development, Boitekong, Paardekraal: Regional Locality Map.
Figure 2: The Popo Molefe Development, Boitekong, Paardekraal: Topography Map.
Figure 3: The Popo Molefe Development, Boitekong, Paardekraal: Drainage and Infrastructure Map.
Figure 4: The Popo Molefe Development, Boitekong, Paardekraal: Cadastral Map.
Figure 5: The Popo Molefe Development, Boitekong, Paardekraal: Geology Map.
Figure 6: The Popo Molefe Development, Boitekong, Paardekraal: Engineering Geological Zone Map with Test Positions on Google Image.

APPENDIX B: SOIL PROFILES

Soil Profiles Tabled Summary
Soil Profile Descriptions
Soil Profile Photographs

APPENDIX C: LABORATORY RESULTS

Table A: Summary of Laboratory Results
STL Summary of Results
STL Laboratory Results

APPENDIX D: TABULAR EXPLANATION OF ZONING

Extract from: THE SOUTH AFRICAN INSTITUTE OF ENGINEERING GEOLOGISTS (SAIEG), 1997. Guidelines for Urban Engineering Geological Investigations.

Table 1. Categories of Urban Engineering Geological Investigation

Table 2. Geotechnical Classification for Urban Development: Partridge, Wood & Brink (1993)

Table 3. Residential Site Class Designations: SAICE, SAIEG & NHBRC (1995)

APPENDIX E: DATA INPUT SHEETS

Site Specific Data Input Sheets

APPENDIX A: FIGURES

Figure 1: The Popo Molefe Development, Boitekong, Paardekraal: Regional Locality Map.

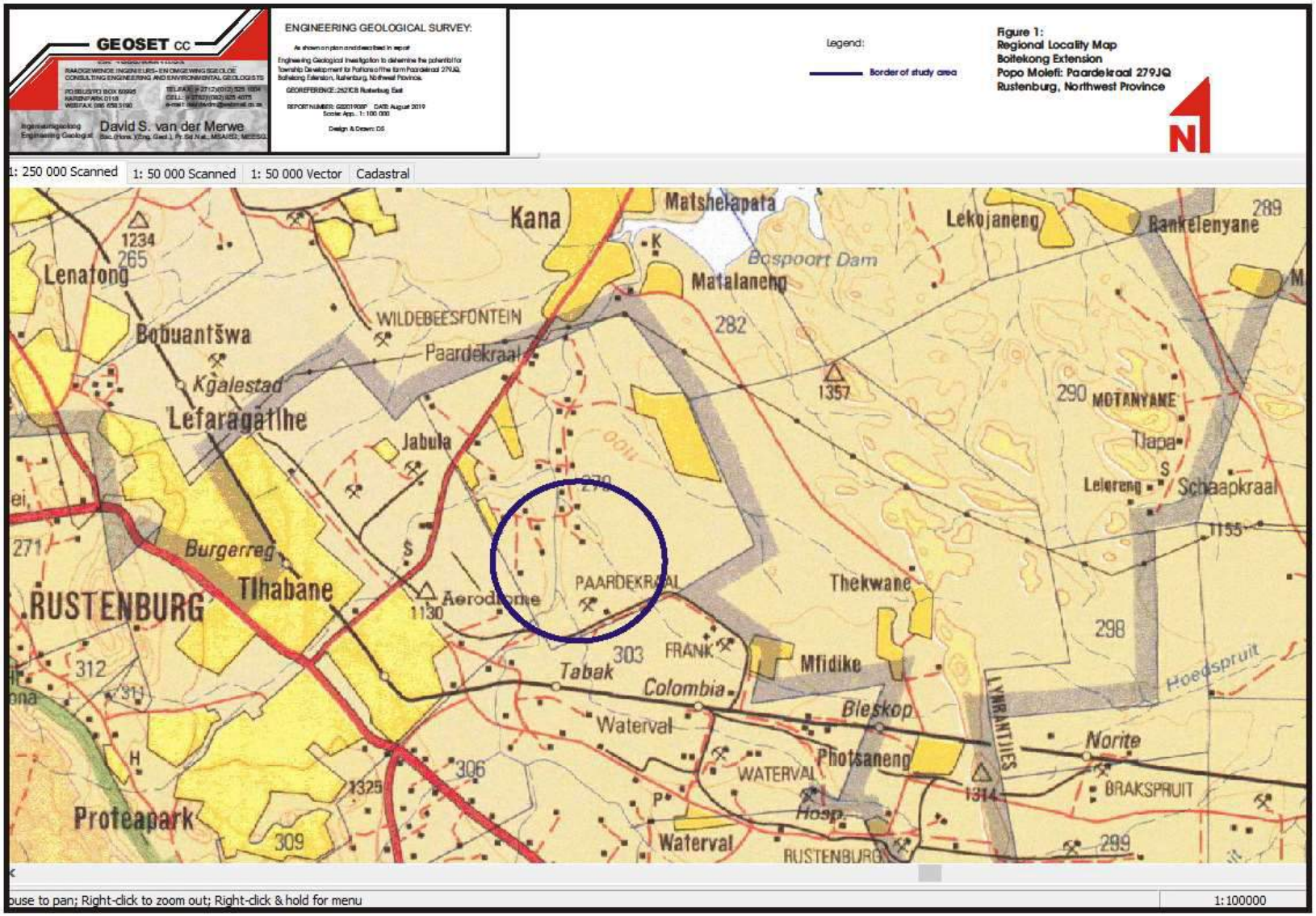
Figure 2: The Popo Molefe Development, Boitekong, Paardekraal: Topography Map.

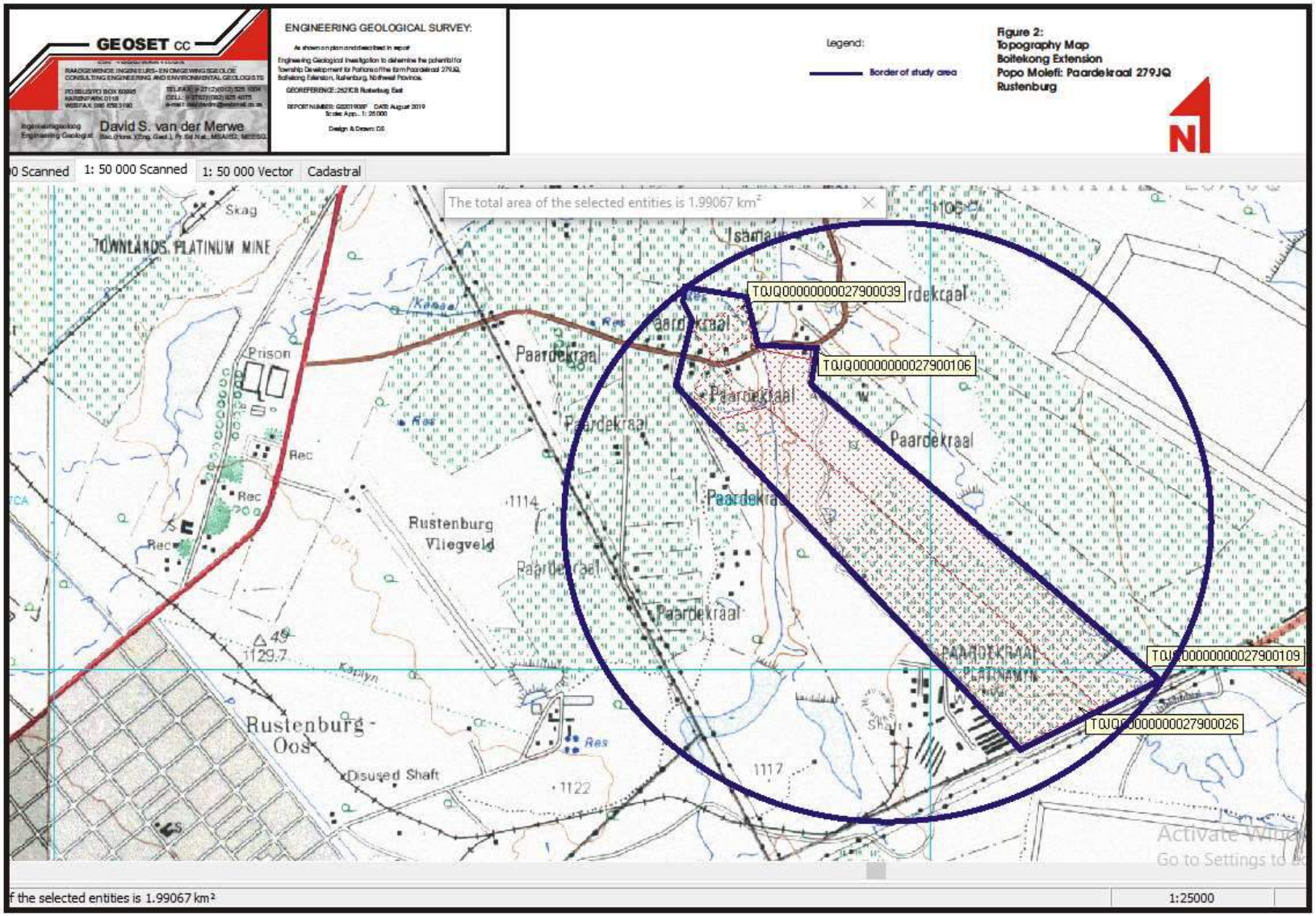
Figure 3: The Popo Molefe Development, Boitekong, Paardekraal: Drainage and Infrastructure Map.

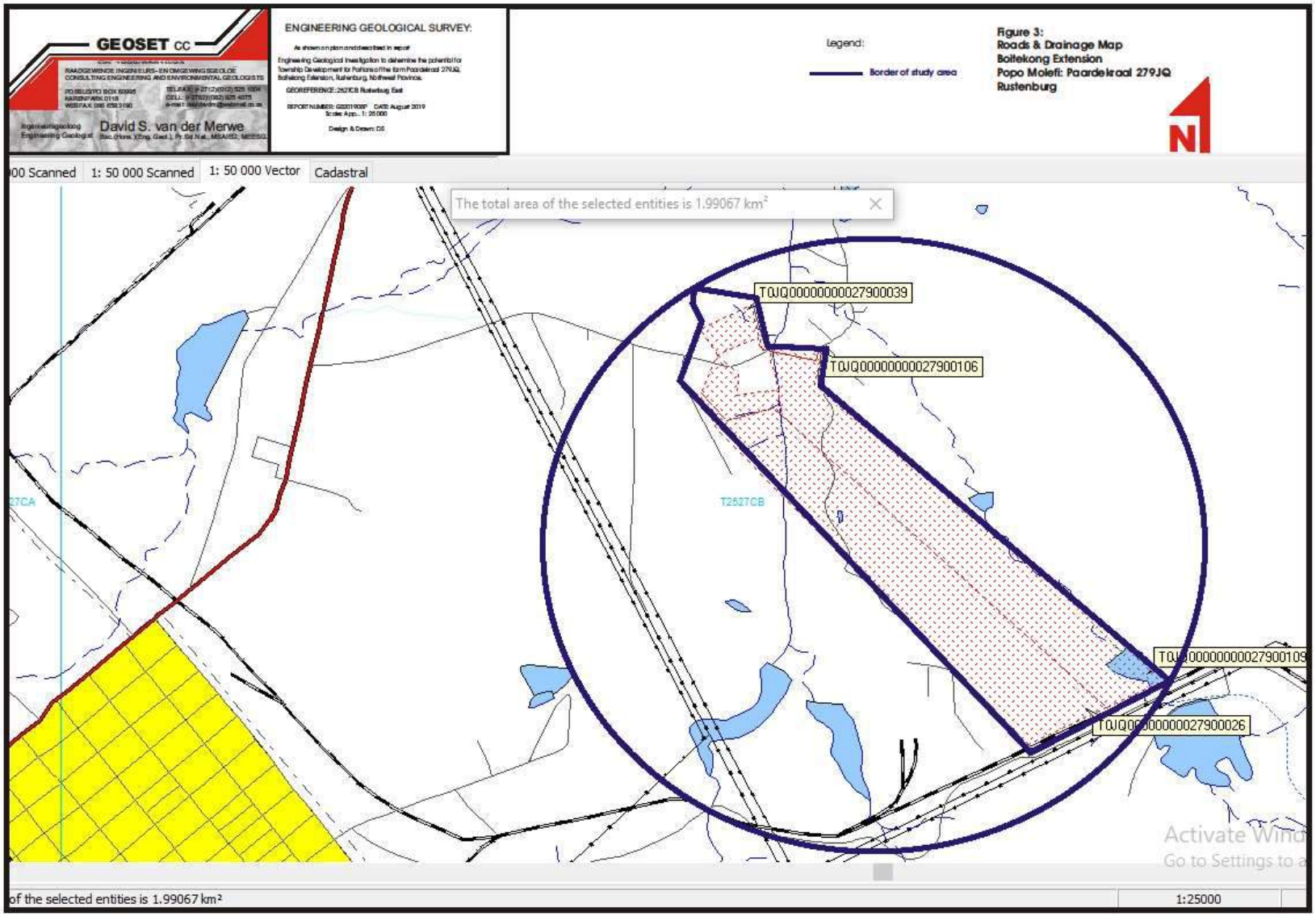
Figure 4: The Popo Molefe Development, Boitekong, Paardekraal: Cadastral Map.

Figure 5: The Popo Molefe Development, Boitekong, Paardekraal: Geology Map.

Figure 6: The Popo Molefe Development, Boitekong, Paardekraal: Engineering Geological Zone Map with Test Positions on Google Image.


GEOSET CC
ENGINEERING GEOLOGICAL SURVEY:
David S. van der Merwe
Legend:
Border of study area
Figure 1:
Regional Locality Map
Boitekong Extension
Popo Molefi: Paardekraal 279JQ
Rustenburg, Northwest Province
1: 250 000 Scanned
1: 50 000 Scanned
1: 50 000 Vector
Cadastral
Kana
Matshelapata
Lekojaneng
Rankelenyane
Bospoort Dam
Matalaneng
Lenatong
WILDEBEESFONTEIN
Paardekraal
Bobuantšwa
Kgalestad
Lefaragatlhe
Jabula
MOTANYANE
Tlapa
Lelereng
Schaapkraal
Burgerreg
Tlhabane
RUSTENBURG
PAARDEKRAAL
Thekwane
Aerodrome
FRANK
Tabak
Colombia
Mfidike
Bleskop
Waterval
Norite
Photsaneng
WATERVAL
BRAKSPRUIT
Hoedspruit
LYMBRANTJIES
Proteapark
Hosp.
Waterval
RUSTENBURG
1:100000


GEOSET CC
ENGINEERING GEOLOGICAL SURVEY:
David S. van der Merwe
Legend:
Border of study area
Figure 2:
Topography Map
Boitekong Extension
Popo Molefi: Paardekraal 279JQ
Rustenburg
1: 50 000 Scanned
1: 50 000 Vector
Cadastral
The total area of the selected entities is 1.99067 km²
TOWNLANDS PLATINUM MINE
Prison
Paardekraal
Rustenburg
Vliegveld
Rustenburg -
Oos
Disused Shaft
TOWNLANDS PLATINUM
TOWNLANDS
TOWNLANDS
1:25000


GEOSET CC
ENGINEERING GEOLOGICAL SURVEY:
David S. van der Merwe
Legend:
Border of study area
Figure 3:
Roads & Drainage Map
Boltekong Extension
Popo Molefi: Paardekraal 279JQ
Rustenburg
1: 50 000 Scanned
1: 50 000 Vector
Cadastral
The total area of the selected entities is 1.99067 km²
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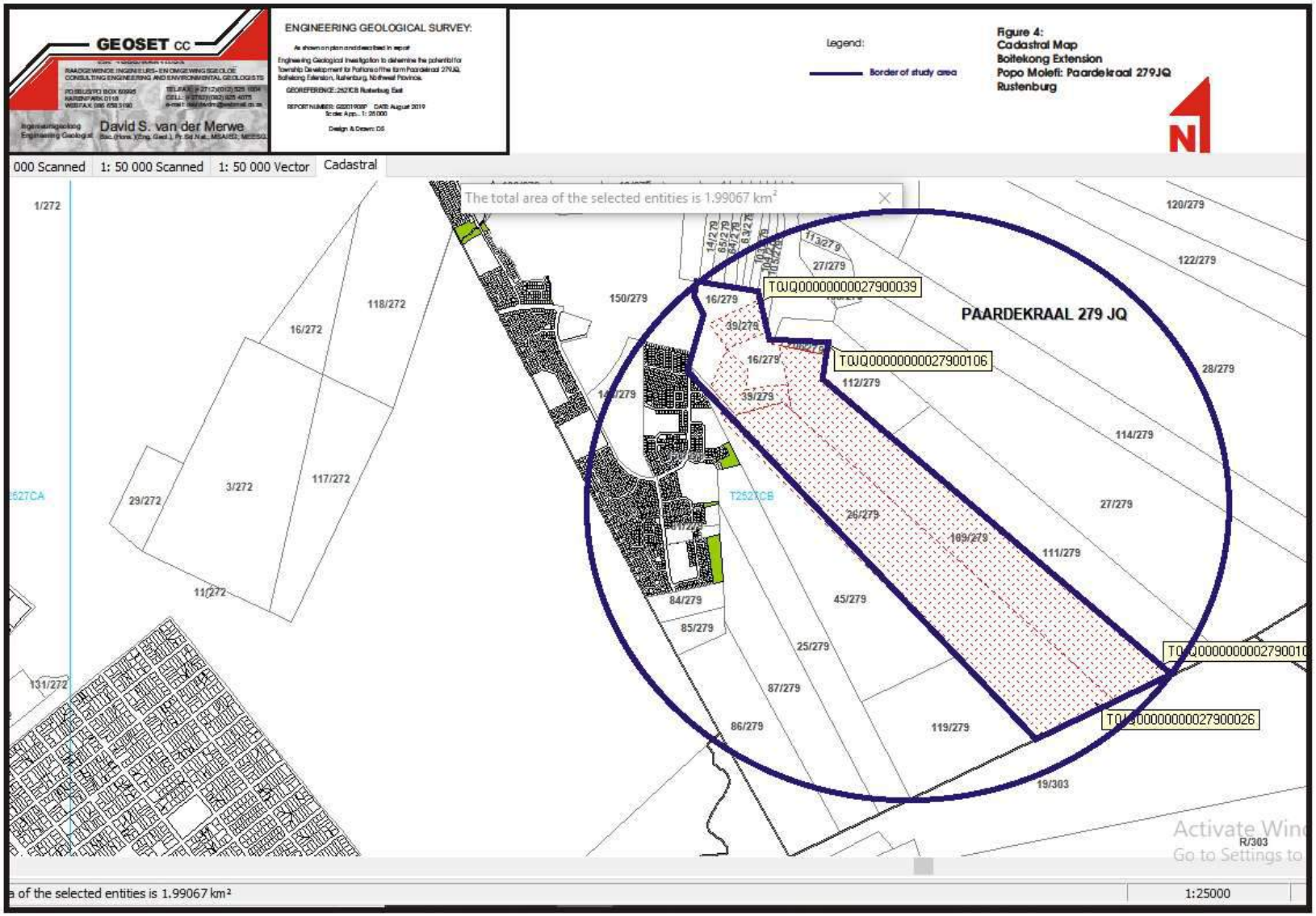
GEOSET CC
ENGINEERING GEOLOGICAL SURVEY:
David S. van der Merwe
Legend:
Border of study area
Figure 4:
Cadastral Map
Boitekong Extension
Popo Molefi: Paardekraal 279JQ
Rustenburg
000 Scanned
1: 50 000 Scanned
1: 50 000 Vector
Cadastral
The total area of the selected entities is 1.99067 km²
PAARDEKRAAL 279 JQ
TQJQ00000000027900039
TQJQ00000000027900106
1/272
118/272
16/272
3/272
117/272
29/272
11/272
131/272
150/279
16/279
39/279
112/279
113/279
27/279
120/279
122/279
28/279
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R/303
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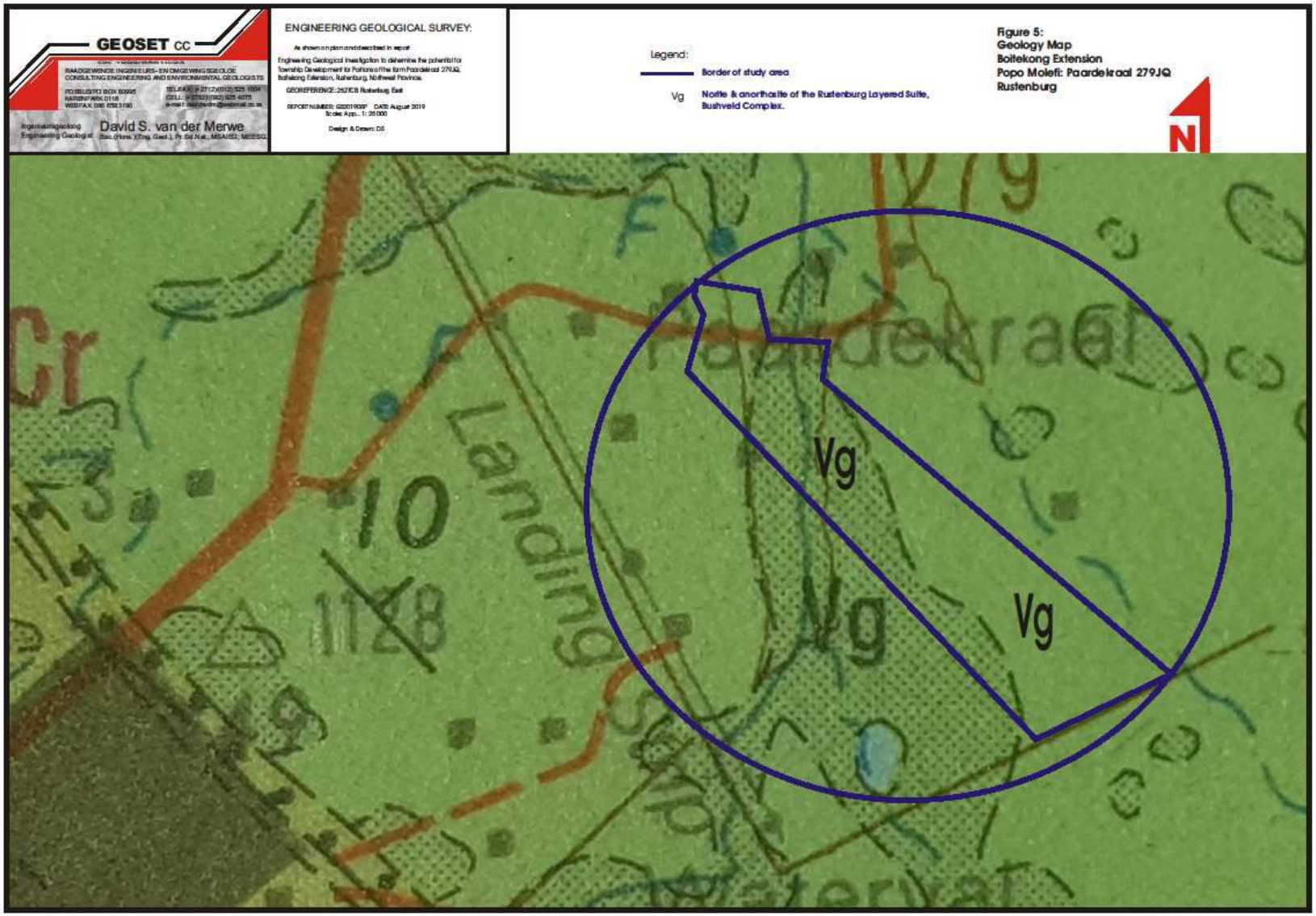
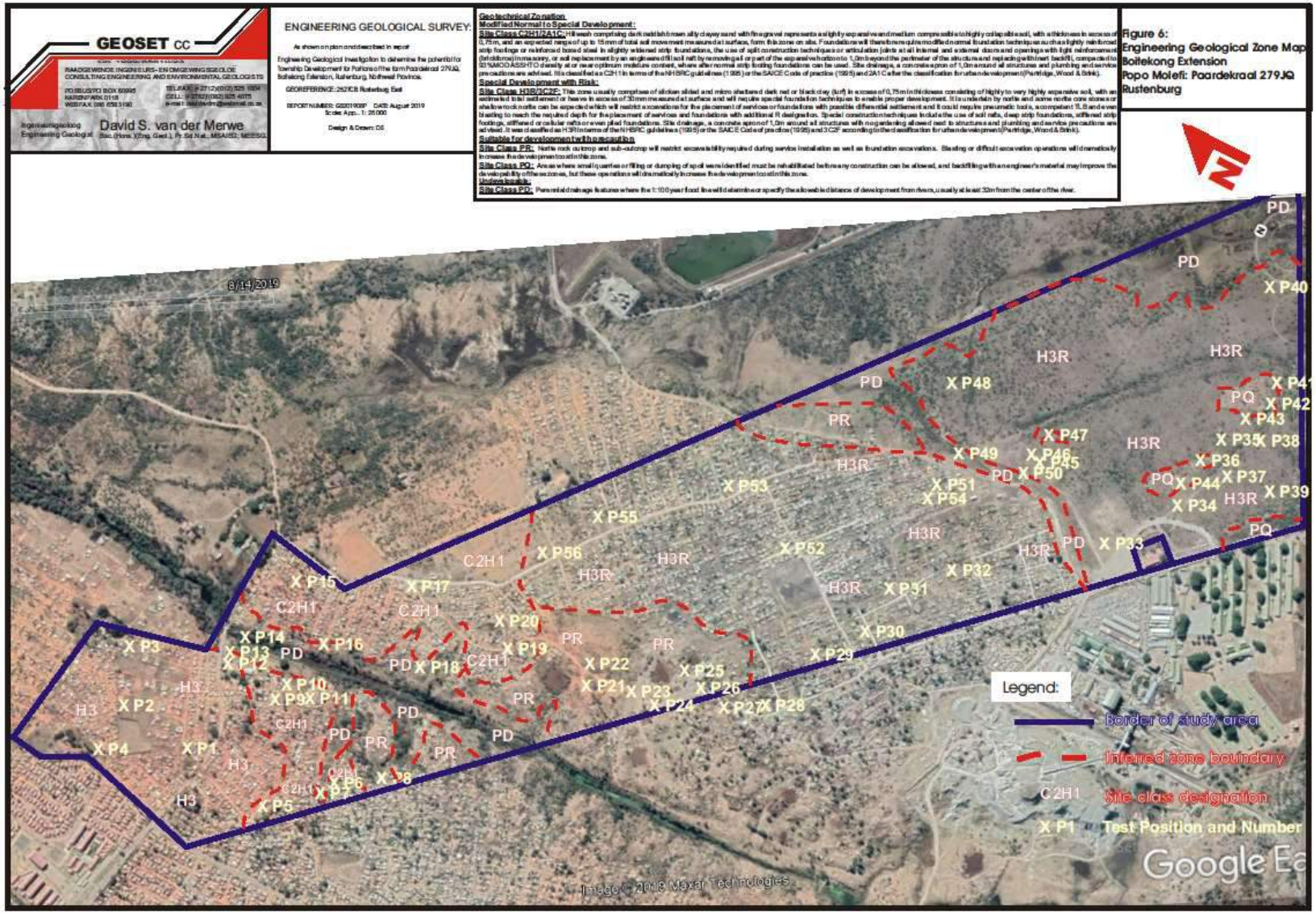

GEOSET CC
RAADGEWENDE INGENIEURS- EN OMGEWINGSGEOLOGE
CONSULTING ENGINEERING AND ENVIRONMENTAL GEOLOGISTS
David S. van der Merwe
ENGINEERING GEOLOGICAL SURVEY:
As shown on plan and described in report
Engineering Geological Investigation to determine the potential for Township Development for Portions of the farm Paardekraal 279JQ, Boitekong Extension, Rustenburg, Northwest Province.
GEOREFERENCE: 2527CB Rustenburg East
REPORT NUMBER: GS001908F DATE: August 2019
Scale: App.- 1: 25 000
Design & Drawn: DS
Legend:
Border of study area
Vg
Norite & anorthosite of the Rustenburg Layered Suite, Bushveld Complex.
Figure 5:
Geology Map
Boitekong Extension
Popo Molefi: Paardekraal 279JQ
Rustenburg
N
Vg
Vg
Vg
10
1128
Landing Strip


GEOSET CC
ENGINEERING GEOLOGICAL SURVEY:
Engineering Geological Investigation to determine the potential for Township Development for Portions of the farm Paardekraal 279JQ, Boitekong Extension, Rustenburg, Northwest Province.
GEOREFERENCE: 2527CB Rustenburg East
REPORT NUMBER: GS0019087 DATE: August 2019
Scale: App.- 1: 25000
Design & Drawn: DS
David S. van der Merwe
Geo-technical Zonation
Modified Normal to Special Development :
Site Class C2H1/2A1C: Hillwash comprising dark reddish brown silty clayey sand with fine gravel represents a slightly expansive and medium compressible to highly collapsible soil, with a thickness in excess of 0,75m, and an expected range of up to 15mm of total soil movement measured at surface, form this zones on site. Foundations will therefore require modified normal foundation techniques such as highly reinforced strip footings or reinforced based steel in slightly widened strip foundations, the use of split construction techniques or articulation joints at all internal and external doors and openings with light reinforcement (brickforce) in masonry, or soil replacement by an engineered fill soil mat by removing all or part of the expansive horizon to 1,0m beyond the perimeter of the structure and replacing with inert backfill, compacted to 93%MOD.AASHTO density at or near optimum moisture content, where after normal strip footing foundations can be used. Site drainage, a concrete apron of 1,0m around all structures and plumbing and service precautions are advised. It is classified as a C2H 1 in terms of the NHBRC guidelines (1985) or the SAICE Code of practice (1995) and 2A1 C after the classification for urban development (Partridge, Wood & Brink).
Special Development with Risk:
Site Class H3R/3C2E: This zone usually comprises of stickon silted and micro sheared dark red or black clay (turf) in excess of 0,75m in thickness consisting of highly to very highly expansive soil, with an estimated total settlement or heave in excess of 30mm measured at surface and will require special foundation techniques to enable proper development. It is underlain by norite and some norite core stones or shallow rock norite can be expected which will restrict excavations for the placement of services or foundations with possible differential settlement and it could require pneumatic tools, accompanied by blasting to reach the required depth for the placement of services and foundations with additional R designation. Special construction techniques include the use of soil nails, deep strip foundations, stiffened strip footings, stiffened or cellular rafts or even piled foundations. Site drainage, a concrete apron of 1,0m around all structures with no gardening allowed next to structures and plumbing and service precautions are advised. It was classified as H3R in terms of the NHBRC guidelines (1985) or the SAICE Code of practice (1995) and 3C2F according to the classification for urban development (Partridge, Wood & Brink).
Suitable for development with precaution
Site Class PR: Norite rock outcrop and sub-outcrop will restrict excavatability required during service installation as well as foundation excavations. Blasting or difficult excavation operations will dramatically increase the development cost in this zone.
Site Class PQ: Areas where small quarries or filling or dumping of spoil were identified must be rehabilitated before any construction can be allowed, and backfilling with an engineer's material may improve the developability of the sezones, but these operations will dramatically increase the development cost in this zone.
Undevelopable :
Site Class PD: Perennial drainage features where the 1:100 year flood line will determine or specify the allowable distance of development from rivers, usually at least 32m from the center of the river.
Figure 6:
Engineering Geological Zone Map
Boitekong Extension
Popo Molefi: Paardekraal 279JQ
Rustenburg
8/14/2019
Legend:
border of study area
Inferred zone boundary
C2H1 Site class designation
X P1 Test Position and Number
Image © 2018 Maxar Technologies
Google Ea

APPENDIX B: SOIL PROFILES

Soil Profiles Tabled Summary
Soil Profile Descriptions
Soil Profile Photographs

Test Pit Nr		Samples Depth m	Hillwash Depth 0m to m	Pebble m Depth 0m to m	Residual norite Depth to m	Site Class	Remarks	GPS Coordinates X Coord	Y Coord		Test Pit Nr
P	1	0,2&0,6&2,0	1,6		2,6+	C2H1	Near refusal on norite	25°38'00,42" S	27°17'17,18" E	P	1
P	2	0,5&1,7	1,6		3,2+	C2H1	Near refusal on norite	25°37'54,98" S	27°17'15,80" E	P	2
P	3	0,5&2,0	1,6		2,6+	C2H1	Near refusal on norite	25°37'54,39" S	27°17'22,52" E	P	3
P	4	0,4	2,1+			C2H1	Near refusal on hillwash	25°38'02,99" S	27°17'13,91" E	P	4
P	5	0,4&1,6	2,1+			C2H1	Near refusal on hillwash	25°38'08,79" S	27°17'13,27" E	P	5
P	6					PR	Norite outcrop	25°38'13,53" S	27°17'13,57" E	P	6
P	7					PR	Norite outcrop & drainag	25°38'12,07" S	27°17'19,28" E	P	7
P	8					PR	Norite outcrop	25°38'16,79" S	27°17'20,59" E	P	8
P	9					PR	Norite outcrop	25°38'06,80" S	27°17'22,57" E	P	9
P	10					PR	Norite outcrop	25°38'05,88" S	27°17'24,29" E	P	10
P	11	0,7	0,7		1,3+	C2H1	Refusal on norite	25°38'07,94" S	27°17'25,10" E	P	11
P	12		0,4		0,7+	C2H1	Refusal on norite	25°38'00,73" S	27°17'23,43" E	P	12
P	13					PR	Norite outcrop	25°38'00,87" S	27°17'25,11" E	P	13
P	14					PD	River	25°38'00,13" S	27°17'26,29" E	P	14
P	15				2,3+	C2H1	Refusal on norite	25°38'02,98" S	27°17'23,88" E	P	15
P	16		1,2		2,4+	C2H1	0,5m of filling	25°38'07,35" S	27°17'29,18" E	P	16
P	17		1,2	1,8	2,4+	C2H1	0,5m of filling	25°38'11,88" S	27°17'36,97" E	P	17
P	18					PR	Norite outcrop	25°38'15,12" S	27°17'31,72" E	P	18
P	19	0,3	0,5		1,5+	C2H1	Refusal on norite	25°38'21,15" S	27°17'36,40" E	P	19
P	20					PR	Norite outcrop	25°38'19,30" S	27°17'37,90" E	P	20
P	21					PR	Norite outcrop	25°38'27,70" S	27°17'36,36" E	P	21
P	22					PR	Norite outcrop	25°38'26,79" S	27°17'38,14" E	P	22
P	23					PR	Norite outcrop	25°38'32,27" S	27°17'38,06" E	P	23
P	24					PR	Norite outcrop	25°38'35,39" S	27°17'39,48" E	P	24
P	25					PR	Norite outcrop	25°38'33,74" S	27°17'41,51" E	P	25
P	26					PR	Norite outcrop	25°38'36,75" S	27°17'40,53" E	P	26
P	27					PR	Norite outcrop	25°38'41,45" S	27°17'40,69" E	P	27
P	28	0,3	1,3		1,5+	H3R	Refusal on norite	25°38'42,47" S	27°17'42,31" E	P	28
P	29					PR	Norite outcrop	25°38'42,94" S	27°17'48,47" E	P	29
P	30	0,3	1,0		1,2+	H3R	Refusal on norite	25°38'46,17" S	27°17'52,09" E	P	30
P	31					PR	Norite outcrop	25°38'47,07" S	27°17'55,96" E	P	31
P	32	0,3	1,0		1,2+	H3R	Refusal on norite	25°38'50,92" S	27°18'00,71" E	P	32
P	33	0,6	1,0		1,2+	H3R	Refusal on norite	25°39'00,53" S	27°18'08,47" E	P	33
P	34		0,4		0,6+	H3R	Refusal on norite	25°39'04,00" S	27°18'13,97" E	P	34
P	35		1,0		1,2+	H3R	Refusal on norite	25°39'00,53" S	27°18'08,47" E	P	35
P	36					PR	Norite outcrop	25°39'04,33" S	27°18'18,03" E	P	36
P	37					PR	Norite outcrop	25°39'06,25" S	27°18'19,07" E	P	37
P	38	0,6	1,0		1,2+	H3R	Refusal on norite	25°39'07,80" S	27°18'23,25" E	P	38
P	39					H3R	Norite outcrop	25°39'11,04" S	27°18'20,23" E	P	39
P	40	0,5&1,2	1,7		3,0&3,2+	H3R	Refusal on norite	25°39'05,16" S	27°18'39,03" E	P	40
P	41					PR	Norite outcrop	25°39'08,45" S	27°18'30,32" E	P	41
P	42					PR	Norite outcrop	25°39'08,42" S	27°18'08,47" E	P	42
P	43					PR	Norite outcrop	25°39'06,68" S	27°18'15,38" E	P	43
P	44					PR	Norite outcrop	25°39'04,58" S	27°18'18,55" E	P	44
P	45					H3	Surface cracks	25°39'53,71" S	27°18'12,39" E	P	45
P	46	0,6	0,9		1,1+	H3R	Refusal on norite	25°38'52,62" S	27°18'11,50" E	P	46
P	47					H3R	Norite outcrop / quarry	25°38'50,67" S	27°18'13,15" E	P	47
P	48		1,8&2,9		3,1+	H3R	Refusal on norite	25°38'43,78" S	27°18'15,09" E	P	48
P	49					PD	Drainage/sewerage	25°38'46,19" S	27°18'09,76" E	P	49
P	50					PD	Drainage/sewerage	25°38'52,12" S	27°18'10,37" E	P	50
P	51	0,6	1,1		1,3+	H3R	Refusal on norite	25°38'44,38" S	27°18'05,57" E	P	51
P	52	0,6	1,5		1,7+	H3R	Refusal on norite	25°38'37,31" S	27°17'55,37" E	P	52
P	53					PR	Norite outcrop	25°38'31,04" S	27°17'57,54" E	P	53
P	54	0,6	1,4		1,6+	H3R	Refusal on norite	25°38'43,68" S	27°18'04,64" E	P	54
P	55	1,2	1,4		2,3	H3R	Refusal on norite	25°38'23,28" S	27°17'50,64" E	P	55
P	56					H3R	Cemetery	25°38'20,13" S	27°17'45,27" E	P	56
		16 Samples			1,56m						

No water was encountered in any test pit

A competent Bell 315SL 4X4 TLB was supplied by Selby.

All the test pits were dug to the refusal depth of the TLB, usually in norite.

The moisture content of the soil profiles were usually described as dry and sometimes as slightly moist.

The hillwash usually consisted of turf or sandy clay & gravel.

The consistency of the soil increased with increasing depth and was described as loose to dense.

Transported material comprized sandy clay to gravelly soil sometimes with calcrete nodules and quartz and hematite pebbles.

Refusal on the norite was noted in all test pits, with an average refusal depth of 1.56m.

Soil Profile Nr: P1

DATE: 27 August 2019
JOB NR: GS201908P
PROJECT NAME: Popo Molefe
TOWN: Rustenburg LM
CLIENT: King & Associates
TLB Contractor: Lucky
TLB Machine: Bell 315SL 4X4
TLB Operator: Aaron

GEOSET CC
Consulting Engineering & Environmental Geologists
Raadgewende Ingenieurs- en Omgewingsgeoloë
P.O. Box / Posbus 60995 **Tel:** 012 525 1004
KARENPARK 0118 **Webfax:** 086 658 3190
e-mail: davidsvdm@webmail.co.za **Cell:** 082 925 4075
Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2			
0.3			
0.4			
0.5		P1-0,6	
0.6		●	
0.7			Dry to slightly moist, reddish brown, loose, open textured sandy clay and norite gravel
0.8			Hillwash.
0.9			
1.0			
1.1			
1.2			
1.3			
1.4			
1.5			
1.6			
1.7			
1.8			
1.9		P1-2,0	
2.0		●	
2.1			Dry to slightly moist, kaki speckled white & black, stiff, micro shattered & slicken sided
2.2			sandy clay and norite gravel. Moderately weathered norite.
2.3			
2.4			
2.5			
2.6			

Notes:
1. Near refusal on norite.
2. No groundwater was intersected.
3. ● Disturbed samples P1-0,6&2,0m.

Lat/long	X Coord:	25˚38'00,42" S
WGS84 datum	Y Coord:	27˚17'17,18" E

Soil Profile Nr: P2

DATE: 27 August 2019
JOB NR: GS201908P
PROJECT NAME: Popo Molefe
TOWN: Rustenburg LM
CLIENT: King & Associates
TLB Contractor: Lucky
TLB Machine: Bell 315SL 4X4
TLB Operator: Aaron

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Consulting Engineering & Environmental Geologists
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Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:I		
0.2	I:I:I:I:I:I:I:I		
0.3	I:I:I:I:I:I:I:I		
0.4	I:I:I:I:I:I:I:I	P2-0,5	
0.5	I:I:I:I:I:I:I:I	●	
0.6	I:I:I:I:I:I:I:I		
0.7	I:I:I:I:I:I:I:I		Dry to slightly moist, reddish brown, loose, open textured sandy clay and norite gravel
0.8	I:I:I:I:I:I:I:I		Hillwash.
0.9	I:I:I:I:I:I:I:I		
1.0	I:I:I:I:I:I:I:I		
1.1	I:I:I:I:I:I:I:I		
1.2	I:I:I:I:I:I:I:I		
1.3	I:I:I:I:I:I:I:I		
1.4	I:I:I:I:I:I:I:I		
1.5	I:I:I:I:I:I:I:I		
1.6	I:I:I:I:I:I:I:I		
1.7	I:I	●	
1.8	I:I	P2-1,7	
1.9	I:I		
2.0	I:I		
2.1	I:I		Dry to slightly moist, kaki grey speckled black, stiff, micro shattered & slicken sided
2.2	I:I		sandy clay and norite gravel. Moderately weathered norite.
2.3	I:I		
2.4	I:I		
2.5	I:I		
2.6	I:I		
2.7	I:I		
2.8	I:I		
2.9	I:I		
3.0	I:I		
3.1	I:I		
3.2	I:I		

Notes:
1. Near refusal on norite.
2. No groundwater was intersected.
3. ● Disturbed samples P2-0,5&1,7m.

Lat/long	X Coord:	25°38'02,99" S
WGS84 datum	Y Coord:	27°17'13,91" E

Soil Profile Nr: P2

Soil Profile Nr: P3

DATE: 27 August 2019

JOB NR: GS201908P

PROJECT NAME: Popo Molefe

TOWN: Rustenburg LM

CLIENT: King & Associates

TLB Contractor: Lucky

TLB Machine: Bell 315SL 4X4

TLB Operator: Aaron

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Consulting Engineering & Environmental Geologists

Raadgewende Ingenieurs- en Omgewingsgeoloë

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e-mail: davidsvdm@webmail.co.za **Cell:** 082 925 4075

Engineering Geologist: David S. van der Merwe.

Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:I		
0.2	I:I:I:I:I:I:I:I		
0.3	I:I:I:I:I:I:I:I		
0.4	I:I:I:I:I:I:I:I	P3-0,5	
0.5	I:I:I:I:I:I:I:I	●	
0.6	I:I:I:I:I:I:I:I		
0.7	I:I:I:I:I:I:I:I		Dry to slightly moist, reddish brown, loose, open textured sandy clay and norite gravel
0.8	I:I:I:I:I:I:I:I		Hillwash.
0.9	I:I:I:I:I:I:I:I		
1.0	I:I:I:I:I:I:I:I		
1.1	I:I:I:I:I:I:I:I		
1.2	I:I:I:I:I:I:I:I		
1.3	I:I:I:I:I:I:I:I		
1.4	I:I:I:I:I:I:I:I		
1.5	I:I:I:I:I:I:I:I		
1.6	I:I:I:I:I:I:I:I		
1.7	I:I		
1.8	I:I		
1.9	I:I	P3-2,0	
2.0	I:I	●	
2.1	I:I		Dry to slightly moist, kaki grey speckled black, stiff, micro shattered & slicken sided
2.2	I:I		sandy clay and norite gravel. Moderately weathered norite.
2.3	I:I		
2.4	I:I		
2.5	I:I		
2.6	I:I		

Notes:

1. Near refusal on norite.
2. No groundwater was intersected.
3. ● Disturbed samples P2-0,5&2,0m.

Lat/long	X Coord:	25˚38'02,99" S
WGS84 datum	Y Coord:	27˚17'13,91" E

Soil Profile Nr: P3

Soil Profile Nr: P4

DATE: 27 August 2019

JOB NR: GS201908P

PROJECT NAME: Popo Molefe

TOWN: Rustenburg LM

CLIENT: King & Associates

TLB Contractor: Lucky

TLB Machine: Bell 315SL 4X4

TLB Operator: Aaron

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Engineering Geologist: David S. van der Merwe.

Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:I		
0.2	I:I:I:I:I:I:I:I		
0.3	I:I:I:I:I:I:I:I		
0.4	I:I:I:I:I:I:I:I	●	
0.5	I:I:I:I:I:I:I:I	P4-0,4	
0.6	I:I:I:I:I:I:I:I		
0.7	I:I:I:I:I:I:I:I		Dry to slightly moist, reddish brown, loose, open textured sandy clay and norite gravel
0.8	I:I:I:I:I:I:I:I		Hillwash.
0.9	I:I:I:I:I:I:I:I		
1.0	I:I:I:I:I:I:I:I		
1.1	I:I:I:I:I:I:I:I		
1.2	I:I:I:I:I:I:I:I		
1.3	I:I:I:I:I:I:I:I		
1.4	I:I:I:I:I:I:I:I		
1.5	I:I:I:I:I:I:I:I		
1.6	I:I:I:I:I:I:I:I		
1.7	I:I:I:I:I:I:I:I		
1.8	I:I:I:I:I:I:I:I		
1.9	I:I:I:I:I:I:I:I		
2.0	I:I:I:I:I:I:I:I		
2.1	I:I:I:I:I:I:I:I		

Notes:

1. End of hole.
2. No groundwater was intersected.
3. ● Disturbed sample P4-0,4.

Lat/long	X Coord:	25˚38'02,99" S
WGS84 datum	Y Coord:	27˚17'13,91" E

Soil Profile Nr: P4

Soil Profile Nr: P5

DATE: 27 August 2019
JOB NR: GS201908P
PROJECT NAME: Popo Molefe
TOWN: Rustenburg LM
CLIENT: King & Associates
TLB Contractor: Lucky
TLB Machine: Bell 315SL 4X4
TLB Operator: Aaron

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Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:I		
0.2	I:I:I:I:I:I:I:I		
0.3	I:I:I:I:I:I:I:I		
0.4	I:I:I:I:I:I:I:I	●	
0.5	I:I:I:I:I:I:I:I	P5-0,4	
0.6	I:I:I:I:I:I:I:I		
0.7	I:I:I:I:I:I:I:I		Dry to slightly moist, reddish brown, loose, open textured sandy clay and norite gravel
0.8	I:I:I:I:I:I:I:I		Hillwash.
0.9	I:I:I:I:I:I:I:I		
1.0	I:I:I:I:I:I:I:I		
1.1	I:I:I:I:I:I:I:I		
1.2	I:I:I:I:I:I:I:I		
1.3	I:I:I:I:I:I:I:I		
1.4	I:I:I:I:I:I:I:I		
1.5	I:I:I:I:I:I:I:I		
1.6	I:I:I:I:I:I:I:I	●	
1.7	I:I:I:I:I:I:I:I	P5-1,6	
1.8	I:I:I:I:I:I:I:I		
1.9	I:I:I:I:I:I:I:I		
2.0	I:I:I:I:I:I:I:I		
2.1	I:I:I:I:I:I:I:I		

Notes:
1. End of hole.
2. No groundwater was intersected.
3. ● Disturbed sample P5-0,4&1,6.

Lat/long	X Coord:	25˚38'08,79" S
WGS84 datum	Y Coord:	27˚17'13,27" E

Soil Profile Nr: P5

Soil Profile Nr: P11

DATE: 27 August 2019
JOB NR: GS201908P
PROJECT NAME: Popo Molefe
TOWN: Rustenburg LM
CLIENT: King & Associates
TLB Contractor: Lucky
TLB Machine: Bell 315SL 4X4
TLB Operator: Aaron

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Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2			
0.3			Dry to slightly moist, reddish brown, loose, open textured sandy clay and norite gravel
0.4		●	Hillwash.
0.5		P11-0,4	
0.6			
0.7			
0.8			
0.9			
1.0			Dry to slightly moist, grey white speckled black, dense, intact norite gravel.
1.1			Slightly weathered norite.
1.2			
1.3			

Notes:
1. Refusal on norite.
2. No groundwater was intersected.
3. ● Disturbed sample P11-0,4.
4. Large core stones in vicinity.

Lat/long		X Coord:	25°38'07,94" S
WGS84 datum		Y Coord:	27°17'25,10" E

Soil Profile Nr: P11

Soil Profile Nr: P12

DATE: 27 August 2019
JOB NR: GS201908P
PROJECT NAME: Popo Molefe
TOWN: Rustenburg LM
CLIENT: King & Associates
TLB Contractor: Lucky
TLB Machine: Bell 315SL 4X4
TLB Operator: Aaron

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Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I		
0.2	I		Dry to slightly moist, reddish brown, loose, open textured sandy clay and norite gravel
0.3	I		Hillwash.
0.4	I		
0.5	I		
0.6	I		Dry to slightly moist, grey white speckled black, dense, intact norite gravel.
0.7	I		Slightly weathered norite.

Notes:
1. Refusal on norite.
2. No groundwater was intersected.
3. No samples were taken.
4. Electrical cable?.

Lat/long	X Coord:	25˚38'00,73" S
WGS84 datum	Y Coord:	27˚17'23,43" E

Soil Profile Nr: P12

Soil Profile Nr: P15

DATE: 27 August 2019
JOB NR: GS201908P
PROJECT NAME: Popo Molefe
TOWN: Rustenburg LM
CLIENT: King & Associates
TLB Contractor: Lucky
TLB Machine: Bell 315SL 4X4
TLB Operator: Aaron

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Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:I		
0.2	I:I:I:I:I:I:I:I		
0.3	I:I:I:I:I:I:I:I		
0.4	I:I:I:I:I:I:I:I	●	
0.5	I:I:I:I:I:I:I:I	P15-0,4	
0.6	I:I:I:I:I:I:I:I		
0.7	I:I:I:I:I:I:I:I		
0.8	I:I:I:I:I:I:I:I		
0.9	I:I:I:I:I:I:I:I		
1.0	I:I:I:I:I:I:I:I		Dry to slightly moist, reddish brown, loose, open textured sandy clay and norite gravel
1.1	I:I:I:I:I:I:I:I		Hillwash.
1.2	I:I:I:I:I:I:I:I		
1.3	I:I:I:I:I:I:I:I		
1.4	I:I:I:I:I:I:I:I		
1.5	I:I:I:I:I:I:I:I		
1.6	I:I:I:I:I:I:I:I		
1.7	I:I:I:I:I:I:I:I		
1.8	I:I:I:I:I:I:I:I		
1.9	I:I:I:I:I:I:I:I		
2.0	I:I:I:I:I:I:I:I		
2.1	I:I:I:I:I:I:I:I		
2.2	I:I:I:I:I:I:I:I		
2.3	I:I:I:I:I:I:I:I		

Notes:
1. End of hole.
2. No groundwater was intersected.
3. ● Disturbed sample P15-0,4.

Lat/long	X Coord:	25˚38'02,98" S
WGS84 datum	Y Coord:	27˚17'23,88" E

Soil Profile Nr: P15

Soil Profile Nr: P16

DATE: 27 August 2019
JOB NR: GS201908P
PROJECT NAME: Popo Molefe
TOWN: Rustenburg LM
CLIENT: King & Associates
TLB Contractor: Lucky
TLB Machine: Bell 315SL 4X4
TLB Operator: Aaron

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Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2			
0.3			Filling; waste plastic ash etc.
0.4			
0.5			
0.6			
0.7			
0.8			Dry to slightly moist, reddish brown, loose, open textured sandy clay and norite gravel
0.9			Hillwash.
1.0			
1.1			
1.2			
1.3			
1.4			
1.5			
1.6			
1.7			
1.8			Abundant small & medium well rounded pebbles & cobbles of norite & quatzite, matrix
1.9			supported In a matrix of slightly moist, reddish brown, loose, intact, sandy clayey grav
2.0			Pebble marker.
2.1			
2.2			
2.3			
2.4			

Notes:
1. End of hole.
2. No groundwater was intersected.
3. No sample.

Lat/long	X Coord:	25°38'07,35" S
WGS84 datum	Y Coord:	27°17'29,18" E

Soil Profile Nr: P16

Soil Profile Nr: P17

DATE: 27 August 2019
JOB NR: GS201908P
PROJECT NAME: Popo Molefe
TOWN: Rustenburg LM
CLIENT: King & Associates
TLB Contractor: Lucky
TLB Machine: Bell 315SL 4X4
TLB Operator: Aaron

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Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2			
0.3			Filling; waste plastic ash etc.
0.4			
0.5			
0.6			
0.7			
0.8			Dry to slightly moist, reddish brown, loose, open textured sandy clay and norite gravel
0.9			Hillwash.
1.0			
1.1			
1.2			
1.3			
1.4			Abundant small & medium well rounded pebbles & cobbles of norite & quatzite, matrix
1.5			supported In a matrix of slightly moist, reddish brown, loose, intact, sandy clayey grav
1.6			Pebble marker.
1.7			
1.8			
1.9			
2.0			
2.1			
2.2			Dry to slightly moist, kaki grey speckled black, dense, intact norite gravel.
2.3			Slightly weathered norite.
2.4			

Notes:
1. End of hole.
2. No groundwater was intersected.
3. No sample.

Lat/long	X Coord:	25°38'11,88" S
WGS84 datum	Y Coord:	27°17'36,97" E

Soil Profile Nr: P17

Soil Profile Nr: P19

DATE: 27 August 2019
JOB NR: GS201908P
PROJECT NAME: Popo Molefe
TOWN: Rustenburg LM
CLIENT: King & Associates
TLB Contractor: Lucky
TLB Machine: Bell 315SL 4X4
TLB Operator: Aaron

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Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2			
0.3		●	Dry to slightly moist, reddish brown, loose, open textured sandy clay and norite gravel
0.4		P19-0,3	Hillwash.
0.5			
0.6			
0.7			
0.8			
0.9			
1.0			Dry to slightly moist, grey white speckled black, dense, intact norite gravel.
1.1			Slightly weathered norite.
1.2			
1.3			
1.4			
1.5			

Notes:
1. Refusal on norite.
2. No groundwater was intersected.
3. ● Disturbed sample P19-0,3.

Lat/long	X Coord:	25°38'21,15" S
WGS84 datum	Y Coord:	27°17'36,40" E

Soil Profile Nr: P19

Soil Profile Nr: P28

DATE: 27 August 2019
JOB NR: GS201908P
PROJECT NAME: Popo Molefe
TOWN: Rustenburg LM
CLIENT: King & Associates
TLB Contractor: Lucky
TLB Machine: Bell 315SL 4X4
TLB Operator: Aaron

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e-mail: davidsvdm@webmail.co.za **Cell:** 082 925 4075
Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2			
0.3		●	
0.4		P28-0,3	
0.5			
0.6			Dry to slightly moist, dark brown to black, stiff, slicken slided & micro shattered sandy c
0.7			Reworked norite or hillwash.
0.8			
0.9			
1.0			
1.1			
1.2			
1.3			
1.4			Dry to slightly moist, grey white speckled black, dense, intact norite gravel.
1.5			Slightly weathered norite.

Notes:
1. Refusal on norite.
2. No groundwater was intersected.
3. ● Disturbed sample P28-0,3.

Lat/long	X Coord:	25°38'42,47" S
WGS84 datum	Y Coord:	27°17'42,31" E

Soil Profile Nr: P28

Soil Profile Nr: P30

DATE: 27 August 2019
JOB NR: GS201908P
PROJECT NAME: Popo Molefe
TOWN: Rustenburg LM
CLIENT: King & Associates
TLB Contractor: Lucky
TLB Machine: Bell 315SL 4X4
TLB Operator: Aaron

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Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:I		
0.2	I:I:I:I:I:I:I:I		
0.3	I:I:I:I:I:I:I:I	●	
0.4	I:I:I:I:I:I:I:I	P30-0,3	
0.5	I:I:I:I:I:I:I:I		Dry to slightly moist, dark brown to black, stiff, slicken slided & micro shattered sandy c
0.6	I:I:I:I:I:I:I:I		Reworked norite or hillwash.
0.7	I:I:I:I:I:I:I:I		
0.8	I:I:I:I:I:I:I:I		
0.9	I:I:I:I:I:I:I:I		
1.0	I:I:I:I:I:I:I:I		
1.1	I		Dry to slightly moist, grey white speckled black, dense, intact norite gravel.
1.2	I		Slightly weathered norite.

Notes:
1. Refusal on norite.
2. No groundwater was intersected.
3. ● Disturbed sample P30-0,3.

Lat/long	X Coord:	25°38'46,17" S
WGS84 datum	Y Coord:	27°17'52,09" E

Soil Profile Nr: P30

Soil Profile Nr: P32

DATE: 27 August 2019
JOB NR: GS201908P
PROJECT NAME: Popo Molefe
TOWN: Rustenburg LM
CLIENT: King & Associates
TLB Contractor: Lucky
TLB Machine: Bell 315SL 4X4
TLB Operator: Aaron

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Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2			
0.3		●	
0.4		P32-0,3	
0.5			Dry to slightly moist, black, stiff, slicken slided & micro shattered sandy clay.
0.6			Reworked norite or hillwash.
0.7			
0.8			
0.9			
1.0			
1.1			Dry to slightly moist, grey white speckled black, dense, intact norite gravel.
1.2			Slightly weathered norite.

Notes:
1. Refusal on norite.
2. No groundwater was intersected.
3. ● Disturbed sample P32-0,3.

Lat/long	X Coord:	25°38'50,92" S
WGS84 datum	Y Coord:	27°18'00,71" E

Soil Profile Nr: P32

Soil Profile Nr: P33

DATE: 27 August 2019
JOB NR: GS201908P
PROJECT NAME: Popo Molefe
TOWN: Rustenburg LM
CLIENT: King & Associates
TLB Contractor: Lucky
TLB Machine: Bell 315SL 4X4
TLB Operator: Aaron

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Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2			
0.3			
0.4			
0.5		P33-0,6	Dry to slightly moist, black, stiff, slicken slided & micro shattered sandy clay.
0.6		●	Reworked norite or hillwash.
0.7			
0.8			
0.9			
1.0			
1.1			Dry to slightly moist, grey white speckled black, dense, intact norite gravel.
1.2			Slightly weathered norite.

Notes:
1. Refusal on norite.
2. No groundwater was intersected.
3. ● Disturbed sample P33-0,6.

Lat/long	X Coord:	25°39'00,53" S
WGS84 datum	Y Coord:	27°18'08,47" E

Soil Profile Nr: P33

Soil Profile Nr: P34

DATE: 27 August 2019
JOB NR: GS201908P
PROJECT NAME: Popo Molefe
TOWN: Rustenburg LM
CLIENT: King & Associates
TLB Contractor: Lucky
TLB Machine: Bell 315SL 4X4
TLB Operator: Aaron

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Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:I		
0.2	I:I:I:I:I:I:I:I		Dry to slightly moist, black, stiff, slicken slided & micro shattered sandy clay.
0.3	I:I:I:I:I:I:I:I		Reworked norite or hillwash.
0.4	I:I:I:I:I:I:I:I		
0.5	I		Dry to slightly moist, grey white speckled black, dense, intact norite gravel.
0.6	I		Slightly weathered norite.

Notes:
1. Refusal on norite.
2. No groundwater was intersected.
3. No sample.

Lat/long	X Coord:	25˚39'04,00" S
WGS84 datum	Y Coord:	27˚18'13,97" E

Soil Profile Nr: P34

Soil Profile Nr: P35

DATE: 27 August 2019
JOB NR: GS201908P
PROJECT NAME: Popo Molefe
TOWN: Rustenburg LM
CLIENT: King & Associates
TLB Contractor: Lucky
TLB Machine: Bell 315SL 4X4
TLB Operator: Aaron

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Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2			
0.3			
0.4			
0.5		P35-0,6	Dry to slightly moist, black, stiff, slicken slided & micro shattered sandy clay.
0.6		●	Reworked norite or hillwash.
0.7			
0.8			
0.9			
1.0			
1.1			Dry to slightly moist, grey white speckled black, dense, intact norite gravel.
1.2			Slightly weathered norite.

Notes:
1. Refusal on norite.
2. No groundwater was intersected.
3. ● Disturbed sample P35-0,6.

Lat/long	X Coord:	25°39'00,53" S
WGS84 datum	Y Coord:	27°18'08,47" E

Soil Profile Nr: P35

Soil Profile Nr: P38

DATE: 27 August 2019
JOB NR: GS201908P
PROJECT NAME: Popo Molefe
TOWN: Rustenburg LM
CLIENT: King & Associates
TLB Contractor: Lucky
TLB Machine: Bell 315SL 4X4
TLB Operator: Aaron

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Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I		
0.2	I		
0.3	I		
0.4	I		
0.5	I	P38-0,6	Dry to slightly moist, black, stiff, slicken slided & micro shattered sandy clay.
0.6	I	●	Reworked norite or hillwash.
0.7	I		
0.8	I		
0.9	I		
1.0	I		
1.1	I		Dry to slightly moist, grey white speckled black, dense, intact norite gravel.
1.2	I		Slightly weathered norite.

Notes:
1. Refusal on norite.
2. No groundwater was intersected.
3. ● Disturbed sample P38-0,6.

Lat/long	X Coord:	25°39'07,80" S
WGS84 datum	Y Coord:	27°18'23,25" E

Soil Profile Nr: P38

Soil Profile Nr: P40

DATE: 27 August 2019
JOB NR: GS201908P
PROJECT NAME: Popo Molefe
TOWN: Rustenburg LM
CLIENT: King & Associates
TLB Contractor: Lucky
TLB Machine: Bell 315SL 4X4
TLB Operator: Aaron

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Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2			
0.3			
0.4			
0.5		P40-0,6	
0.6		●	
0.7			Dry to slightly moist, black, stiff, slicken slided & micro shattered sandy clay.
0.8			Reworked norite or hillwash.
0.9			
1.0			
1.1		P40-1,2	
1.2		●	
1.3			
1.4			
1.5			
1.6			
1.7			
1.8			
1.9			
2.0			
2.1			
2.2			
2.3			Dry to slightly moist, grey green speckled white & black, dense, intact norite gravel.
2.4			Slightly weathered norite.
2.5			
2.6			
2.7			
2.8			
2.9			
3.0			
3.1			Dry to slightly moist, grey white speckled black, dense, intact norite gravel.
3.2			Slightly weathered norite.

Notes:
1. Refusal on norite.
2. No groundwater was intersected.
3. ● Disturbed samples P40-0,6&1,2m.

Lat/long		X Coord:	25˚39'05,16" S
WGS84 datum		Y Coord:	27˚18'39,03" E

Soil Profile Nr: P40

Soil Profile Nr: P46

DATE: 27 August 2019
JOB NR: GS201908P
PROJECT NAME: Popo Molefe
TOWN: Rustenburg LM
CLIENT: King & Associates
TLB Contractor: Lucky
TLB Machine: Bell 315SL 4X4
TLB Operator: Aaron

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Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I		
0.2	I		
0.3	I		
0.4	I		Dry to slightly moist, black, stiff, slicken slided & micro shattered sandy clay.
0.5	I	P46-0,6	Reworked norite or hillwash.
0.6	I	●	
0.7	I		
0.8	I		
0.9	I		
1.0	I		Dry to slightly moist, grey white speckled black, dense, intact norite gravel.
1.1	I		Slightly weathered norite.

Notes:
1. Refusal on norite.
2. No groundwater was intersected.
3. ● Disturbed samples P46-0,6m.

Lat/long	X Coord:	25˚38'52,62" S
WGS84 datum	Y Coord:	27˚18'11,50" E

Soil Profile Nr: P46

Soil Profile Nr: P48

DATE: 27 August 2019
JOB NR: GS201908P
PROJECT NAME: Popo Molefe
TOWN: Rustenburg LM
CLIENT: King & Associates
TLB Contractor: Lucky
TLB Machine: Bell 315SL 4X4
TLB Operator: Aaron

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Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:I		
0.2	I:I:I:I:I:I:I:I		
0.3	I:I:I:I:I:I:I:I		
0.4	I:I:I:I:I:I:I:I		
0.5	I:I:I:I:I:I:I:I	P48-0,6	
0.6	I:I:I:I:I:I:I:I	●	
0.7	I:I:I:I:I:I:I:I		
0.8	I:I:I:I:I:I:I:I		Dry to slightly moist, black, stiff, slicken slided & micro shattered sandy clay.
0.9	I:I:I:I:I:I:I:I		Rew orked norite or hillw ash.
1.0	I:I:I:I:I:I:I:I		
1.1	I:I:I:I:I:I:I:I		
1.2	I:I:I:I:I:I:I:I		
1.3	I:I:I:I:I:I:I:I		
1.4	I:I:I:I:I:I:I:I		
1.5	I:I:I:I:I:I:I:I		
1.6	I:I:I:I:I:I:I:I		
1.7	I:I:I:I:I:I:I:I		
1.8	I:I:I:I:I:I:I:I		
1.9	I:I:I:I:I:I:I:I		
2.0	I:I:I:I:I:I:I:I		
2.1	I:I:I:I:I:I:I:I		
2.2	I:I:I:I:I:I:I:I		
2.3	I:I:I:I:I:I:I:I		Slightly moist, kaki grey, stiff, slicken slided & micro shattered sandy clay.
2.4	I:I:I:I:I:I:I:I		Rew orked norite.
2.5	I:I:I:I:I:I:I:I		
2.6	I:I:I:I:I:I:I:I		
2.7	I:I:I:I:I:I:I:I		
2.8	I:I:I:I:I:I:I:I		
2.9	I:I:I:I:I:I:I:I		
3.0	I:I:I:I:I:I:I:I		Dry to slightly moist, grey w hite speckled black, dense, intact norite gravel.
3.1	I:I:I:I:I:I:I:I		Slightly w eathered norite.

Notes:
1. Refusal on norite.
2. No groundwater was intersected.
3. ● Disturbed samples P48-0,6m.

Lat/long	X Coord:	25˚38'43,78" S
WGS84 datum	Y Coord:	27˚18'15,09" E

Soil Profile Nr: P48

Soil Profile Nr: P51

DATE: 27 August 2019
JOB NR: GS201908P
PROJECT NAME: Popo Molefe
TOWN: Rustenburg LM
CLIENT: King & Associates
TLB Contractor: Lucky
TLB Machine: Bell 315SL 4X4
TLB Operator: Aaron

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Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I		
0.2	I		
0.3	I		
0.4	I		
0.5	I	P51-0,6	Dry to slightly moist, black, stiff, slicken slided & micro shattered sandy clay.
0.6	I	●	Reworked norite or hillwash.
0.7	I		
0.8	I		
0.9	I		
1.0	I		
1.1	I		
1.2	I		Dry to slightly moist, grey white speckled black, dense, intact norite gravel.
1.3	I		Slightly weathered norite.

Notes:
1. Refusal on norite.
2. No groundwater was intersected.
3. ● Disturbed samples P51-0,6m.

Lat/long	X Coord:	25°38'44,38" S
WGS84 datum	Y Coord:	27°18'05,57" E

Soil Profile Nr: P51

Soil Profile Nr: P52

DATE: 27 August 2019
JOB NR: GS201908P
PROJECT NAME: Popo Molefe
TOWN: Rustenburg LM
CLIENT: King & Associates
TLB Contractor: Lucky
TLB Machine: Bell 315SL 4X4
TLB Operator: Aaron

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Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I		
0.2	I		
0.3	I		
0.4	I		
0.5	I	P52-0,6	Dry to slightly moist, black, stiff, slicken slided & micro shattered sandy clay.
0.6	I	●	Reworked norite or hillwash.
0.7	I		
0.8	I		
0.9	I		
1.0	I		
1.1	I		
1.2	I		
1.3	I		
1.4	I		
1.5	I		
1.6	I		Dry to slightly moist, grey white speckled black, dense, intact norite gravel.
1.7	I		Slightly weathered norite.

Notes:
1. Refusal on norite.
2. No groundwater was intersected.
3. ● Disturbed samples P52-0,6m.

Lat/long	X Coord:	25°38'37,31" S
WGS84 datum	Y Coord:	27°17'55,37" E

Soil Profile Nr: P52

Soil Profile Nr: P54

DATE: 27 August 2019
JOB NR: GS201908P
PROJECT NAME: Popo Molefe
TOWN: Rustenburg LM
CLIENT: King & Associates
TLB Contractor: Lucky
TLB Machine: Bell 315SL 4X4
TLB Operator: Aaron

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Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I		
0.2	I		
0.3	I		
0.4	I		
0.5	I	P54-0,6	Dry to slightly moist, black, stiff, slicken slided & micro shattered sandy clay.
0.6	I	●	Reworked norite or hillwash.
0.7	I		
0.8	I		
0.9	I		
1.0	I		
1.1	I		
1.2	I		
1.3	I		
1.4	I		
1.5	I		Dry to slightly moist, kaki speckled black, dense, intact norite gravel.
1.6	I		Slightly weathered norite.

Notes:
1. Refusal on norite.
2. No groundwater was intersected.
3. ● Disturbed samples P54-0,6m.

Lat/long	X Coord:	25˚38'43,68" S	
WGS84 datum	Y Coord:	27˚18'04,64" E	**Soil Profile Nr: P54**

Soil Profile Nr: P55

DATE: 27 August 2019
JOB NR: GS201908P
PROJECT NAME: Popo Molefe
TOWN: Rustenburg LM
CLIENT: King & Associates
TLB Contractor: Lucky
TLB Machine: Bell 315SL 4X4
TLB Operator: Aaron

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Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2			
0.3			
0.4			
0.5			Dry to slightly moist, black, stiff, slicken slided & micro shattered sandy clay.
0.6			Rew orked norite or hillw ash.
0.7			
0.8			
0.9			
1.0			
1.1		P55-1,2	
1.2		●	
1.3			
1.4			
1.5			
1.6			
1.7			
1.8			
1.9			Dry to slightly moist, kaki speckled black, dense, intact norite gravel.
2.0			Slightly w eathered norite.
2.1			
2.2			
2.3			

Notes:
1. Refusal on norite.
2. No groundwater was intersected.
3. ● Disturbed samples P55-1,2m.

Lat/long	X Coord:	25°38'23,28" S
WGS84 datum	Y Coord:	27°17'50,64" E

Soil Profile Nr: P55

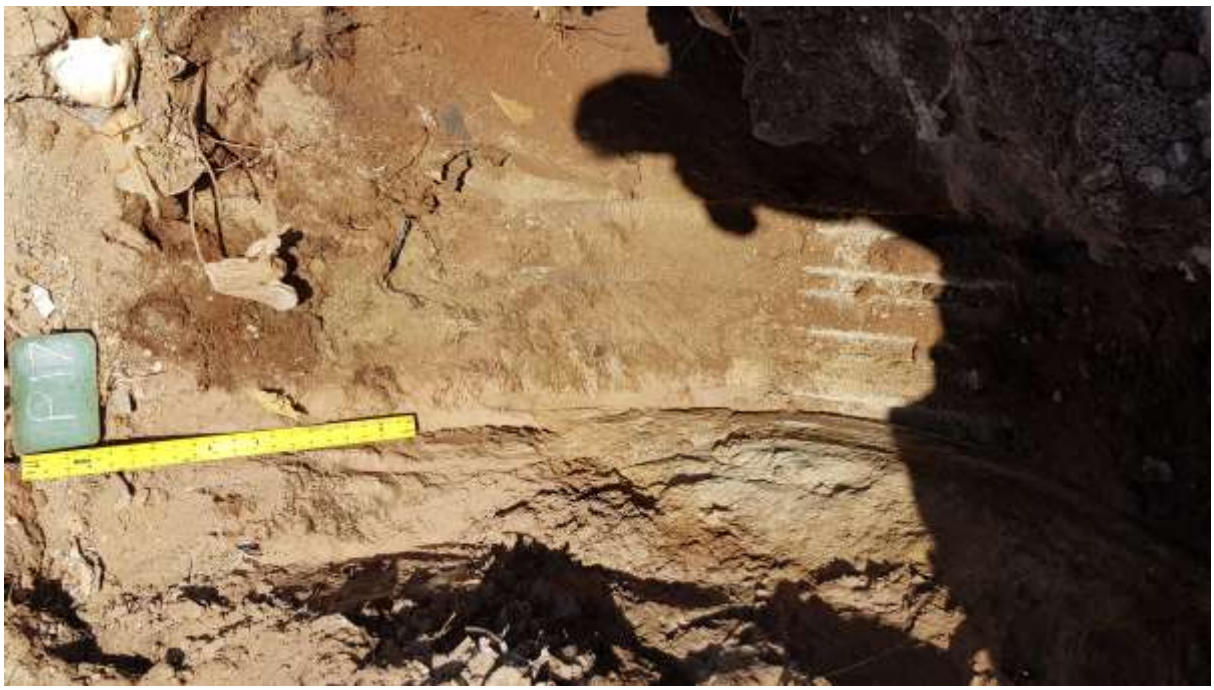

P3


P4


P5


P15


P16


P14


P19


P2.8


p30


P32


P34


P33


P40


P38


P48


P5


P35

APPENDIX C: LABORATORY RESULTS

Table A: Summary of Laboratory Results
STL Summary of Results
STL Laboratory Results

Table A Summary of Laboratory Results

Stats 26	Nr	Depth m	Material Description and Origin	Clay %	Classification Unified	Classification PRA	% Linear Shrinkage	Plasticity Index	Liquid Limit	Expan-siveness
1	P1	0.2	Silty sandy gravel	6	SC	A-2-4	4.5	10	25	L
2	P1	0.6	Silty sandy clay	37	CL	A-7-6	12	22	42	M
3	P1	2.0	Sandy silty clay	37	CL	A-7-6	13	25	43	H
4	P2	0.5	Silty clayey sand	26	CL	A-6	8	16	29	M
5	P2	1.7	Silty sandy clay	40	CL	A-7-6	14	29	49	H
6	P3	0.5	Sandy silty clay	56	CH	A-7-6	27.5	39	67	VH
7	P3	2.0	Sandy silty clay	55	CH	A-7-5	29	39	70	VH
8	P4	0.4	Silty clayey sand	38	CL	A-6	11	22	37	M
9	P5	0.4	Silty sand	16	SC	A-4	4.5	10	24	L
10	P5	1.6	Silty clayey sand	17	SC	A-6	5	11	25	L
11	P11	0.4	Clayey silty sand	9	SC-SM	A-2-4	3	7	23	L
12	P15	0.4	Silty sandy clay	37	CL	A-7-6	12	23	42	M
13	P19	0.3	Silty clayey sand	22	CL	A-6	7	15	30	M
14	P28	0.3	Silty sandy clay	37	CH	A-7-6	24.5	37	55	VH
15	P30	0.3	Silty sandy clay	40	CH	A-7-6	27	36	62	VH
16	P32	0.3	Sandy clay	39	CH	A-7-6	25	39	55	VH
17	P33	0.6	Sandy clay	49	CH	A-7-6	30.5	43	70	VH
18	P38	0.6	Sandy clay	56	CH	A-7-5	34	46	79	VH
19	P40	0.5	Silty clay	66	CH	A-7-5	36.5	48	86	VH
20	P40	1.2	Silty clay	59	CH	A-7-5	38.5	52	90	VH
21	P46	0.6	Silty clay	63	CH	A-7-5	34	49	82	VH
22	P48	0.6	Sandy clay	52	CH	A-7-5	34	46	87	VH
23	P51	0.6	Sandy clay	50	CH	A-7-5	31	42	75	VH
24	P52	0.6	Sandy clay	50	CH	A-7-5	33	47	82	VH
25	P54	0,6	Sandy clay	66	CH	A-7-5	34.5	51	90	VH
26	P55	1.2	Sandy clay	54	CH	A-7-6	27	39	65	VH
Material possibly expansive if value:				>12%			>8%	>12	>30	Exp?

	Table A Legend
	Unified
26	According to the revised ASTM-Standard on the "Unified Soil Classification System" (Weinert).
7	CL: Inorganic clay of low to medium plasticity, gravelly, sandy or silty clay, lean clay.
15	CH: Inorganic clay of high plasticity, fat clay.
3	SC: clayey sand, poorly graded sand clay mixtures.
1	SC-SM: Clayey to silty sand: poorly graded sand silt clay mixtures
	PRA / AASHTO
26	"Public Roads Classification" (Brink, Partridge & Williams).
2	A-2-4: Sand & gravel with low plasticity silt fines.
1	A-4: Low compressibility silt.
4	A-6: Low to medium compressibility clay.
9	A-7-5: High compressibility silty clay.
10	A-7-6: High compressibility high volume change clay.
26	Expansiveness according to Van der Merwe's method (Brink, Partridge & Williams).
4	L: Low
5	M: Medium
2	H: High
15	VH: Very High
	A clayey material is potentially expansive if it exhibits the following properties (Kantey and Brink, 1952):
24	a clay content greater than 12 percent,
20	a linear shrinkage of more than 8 percent,
22	a plasticity index of more than 12, and
22	a liquid limit of more than 30 percent
0	NP: Not plastic: sandy material with no cohesion
0	SP: Slightly plastic: material with little cohesion
0	ND: not determined

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Quality | Excellence | On Time

Client Name: Geoset
Project Name: Paardekraal, Rustenburg
Job Number: DVM-94
Date: 02-Oct-19
Method: SANS 3001 GR1, GR3 GR10, GR12 GR20, GR30, GR31, GR40, GR50, GR53, GR54 & BS 1377 (where applicable)

SUMMARY OF TEST DATA

Grading & Hydrometer Analysis (% Passing)

Sample	P1	P1	P1	P2	P2	P3	P3	P4
Depth (m)	0.2	0.6	2.0	0.5	1.7	0.5	2.0	0.4
Lab No	DVM-94-920	DVM-94-921	DVM-94-922	DVM-94-923	DVM-94-924	DVM-94-925	DVM-94-926	DVM-94-927
53.0	100	100	100	100	100	100	100	100
37.5	100	100	100	100	100	100	100	100
26.5	97	100	100	100	100	100	100	100
19.0	96	100	100	100	100	100	100	100
13.2	90	100	100	100	100	100	100	100
9.5	85	100	100	100	100	100	100	100
6.7	79	100	100	100	100	100	100	100
4.75	74	100	100	100	100	100	100	100
2.00	59	100	100	100	100	99	100	100
1.00	53	98	99	99	99	98	99	98
0.425	50	94	97	89	96	96	98	92
0.250	47	87	92	75	90	92	94	85
0.150	42	80	87	64	83	88	89	77
0.075	33	70	80	52	73	83	83	68
0.060	26	64	72	46	69	81	81	64
0.050	24	61	70	45	66	79	78	62
0.035	19	56	64	41	61	75	74	57
0.020	15	50	55	38	55	71	69	51
0.006	9	42	44	30	45	61	61	43
0.002	6	37	37	26	40	56	55	38
GM	1.58	0.36	0.23	0.59	0.31	0.22	0.19	0.40

Atterberg Limits

LL (%)	25	42	43	29	49	67	70	37
PI (%)	10	22	25	16	29	39	39	22
LS (%)	4.5	12.0	13.0	8.0	14.0	27.5	29.0	11.0

pH & Conductivity

pH								
EC (S/m)								

MDD / OMC

MDD (kg/m^3)								
OMC (%)								

CBR

100%								
98%								
97%								
95%								
93%								
90%								
Swell (%)								

UCS (MPa)

100%								
97%								
90%								

COLTO Classification

Remarks:

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Client Name: Geoset
Project Name: Paardekraal, Rustenburg
Job Number: DVM-94
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Method: SANS 3001 GR1, GR3 GR10, GR12 GR20, GR30, GR31, GR40, GR50, GR53, GR54 & BS 1377 (where applicable)

SUMMARY OF TEST DATA

Grading & Hydrometer Analysis (% Passing)

Sample	P5	P5	P11	P15	P19	P28	P30	P32
Depth (m)	0.4	1.6	0.4	0.4	0.3	0.3	0.3	0.3
Lab No	DVM-94-928	DVM-94-929	DVM-94-930	DVM-94-931	DVM-94-932	DVM-94-933	DVM-94-934	DVM-94-935
53.0	100	100	100	100	100	100	100	100
37.5	100	100	100	100	100	100	100	100
26.5	100	100	100	100	100	100	100	100
19.0	100	100	100	100	100	100	100	100
13.2	100	100	100	100	100	100	100	100
9.5	100	100	99	100	100	100	100	100
6.7	100	100	98	100	100	100	100	100
4.75	100	100	96	100	100	100	100	100
2.00	99	99	90	99	100	98	98	99
1.00	94	93	82	95	97	96	96	97
0.425	79	79	71	85	89	91	91	92
0.250	66	67	57	80	80	83	82	77
0.150	51	53	41	74	69	73	75	69
0.075	39	37	29	63	51	64	67	60
0.060	32	32	25	52	44	59	62	57
0.050	30	30	23	50	40	57	60	55
0.035	25	26	18	46	33	53	56	51
0.020	23	24	15	44	29	48	52	49
0.006	19	19	13	40	25	41	45	43
0.002	16	17	9	37	22	37	40	39
GM	0.83	0.85	1.10	0.53	0.60	0.47	0.44	0.49

Atterberg Limits

LL (%)	24	25	23	42	30	55	62	55
PI (%)	10	11	7	23	15	37	36	39
LS (%)	4.5	5.0	3.0	12.0	7.0	24.5	27.0	25.0

pH & Conductivity

pH								
EC (S/m)								

MDD / OMC

MDD (kg/m^3)								
OMC (%)								

CBR

100%								
98%								
97%								
95%								
93%								
90%								
Swell (%)								

UCS (MPa)

100%								
97%								
90%								

COLTO Classification

Remarks:

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[illegible] | [illegible] | [illegible]
Gerrie | 082 309 4448 | [illegible]
[illegible]

Quality | Excellence | On Time

Client Name: Geoset
Project Name: Paardekraal, Rustenburg
Job Number: DVM-94
Date: 02-Oct-19
Method: SANS 3001 GR1, GR3 GR10, GR12 GR20, GR30, GR31, GR40, GR50, GR53, GR54 & BS 1377 (where applicable)

SUMMARY OF TEST DATA

Grading & Hydrometer Analysis (% Passing)

Sample	P33	P38	P40	P40	P46	P48	P51	P52
Depth (m)	0.6	0.6	0.5	1.2	0.6	0.6	0.6	0.6
Lab No	DVM-94-936	DVM-94-937	DVM-94-938	DVM-94-938	DVM-94-940	DVM-94-941	DVM-94-942	DVM-94-943
53.0	100	100	100	100	100	100	100	100
37.5	100	100	100	100	100	100	100	100
26.5	100	100	100	100	100	100	100	100
19.0	100	100	100	100	100	100	100	100
13.2	100	100	100	100	100	100	100	100
9.5	100	100	100	100	100	100	100	100
6.7	100	100	100	100	100	100	100	100
4.75	100	100	100	99	100	100	99	100
2.00	98	97	98	97	99	99	96	98
1.00	96	95	96	95	99	99	94	97
0.425	92	93	95	94	98	98	91	96
0.250	84	89	92	92	97	91	87	93
0.150	78	85	90	91	94	86	85	91
0.075	72	81	88	87	90	80	80	87
0.060	68	78	84	88	86	74	73	84
0.050	67	76	83	86	85	72	72	82
0.035	64	71	80	83	82	70	70	79
0.020	60	67	77	74	76	64	66	72
0.006	54	60	70	65	66	56	58	57
0.002	49	56	66	59	63	52	50	50
GM	0.38	0.29	0.19	0.22	0.13	0.23	0.33	0.19

Atterberg Limits

LL (%)	70	79	86	90	82	87	75	82
PI (%)	43	46	48	52	49	46	42	47
LS (%)	30.5	34.0	36.5	38.5	34.0	34.0	31.0	33.0

pH & Conductivity

pH								
EC (S/m)								

MDD / OMC

MDD (kg/m^3)								
OMC (%)								

CBR

100%								
98%								
97%								
95%								
93%								
90%								
Swell (%)								

UCS (MPa)

100%								
97%								
90%								

COLTO Classification

Remarks:

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Quality | Excellence | On Time

Client Name: Geoset
Project Name: Paardekraal, Rustenburg
Job Number: DVM-94
Date: 02-Oct-19
Method: SANS 3001 GR1, GR3 GR10, GR12 GR20, GR30, GR31, GR40, GR50, GR53, GR54 & BS 1377 (where applicable)

SUMMARY OF TEST DATA

Grading & Hydrometer Analysis (% Passing)

Sample	P54	P55						
Depth (m)	0.6	1.2						
Lab No	DVM-94-944	DVM-94-945						
53.0	100	100						
37.5	100	100						
26.5	100	100						
19.0	100	100						
13.2	100	100						
9.5	100	100						
6.7	100	100						
4.75	100	100						
2.00	99	99						
1.00	98	98						
0.425	97	96						
0.250	94	89						
0.150	93	85						
0.075	90	79						
0.060	85	76						
0.050	84	75						
0.035	81	73						
0.020	77	66						
0.006	70	59						
0.002	66	54						
GM	0.14	0.26						

Atterberg Limits

LL (%)	90	65						
PI (%)	51	39						
LS (%)	34.5	27.5						

pH & Conductivity

pH								
EC (S/m)								

MDD / OMC

MDD (kg/m^3)								
OMC (%)								

CBR

100%								
98%								
97%								
95%								
93%								
90%								
Swell (%)								

UCS (MPa)

100%								
97%								
90%								

COLTO Classification

Remarks:

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Aggregate | Asphalt | Soil | Concrete
Quality | Excellence | On Time
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Gerrie | 082 309 4448 | gerrie@stlab.co.za
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Client Name: Geoset
Project Name: Paardekraal, Rustenburg
Job Number: DVM-94
Date: 2019-10-02
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

Grading & Hydrometer Analysis (Particle Size (mm) & % Passing)				Atterberg Limits & Classification			
Sample	P1	P1	P1	Sample	P1	P1	P1
Depth (m)	0.2	0.6	2.0	Depth (m)	0.2	0.6	2.0
Lab No	DVM-94-920	DVM-94-921	DVM-94-922	Lab No	DVM-94-920	DVM-94-921	DVM-94-922
53.0	100	100	100	Liquid Limit (%)	25	42	43
37.5	100	100	100	Plastic Limit (%)	15	20	18
26.5	97	100	100	Plasticity Index (%)	10	22	25
19.0	96	100	100	Linear Shrinkage (%)	4.5	12.0	13.0
13.2	90	100	100	PI of whole sample	5	21	24
9.5	85	100	100				
6.7	79	100	100	% Gravel	41	0	0
4.75	74	100	100	% Sand	33	36	28
2.00	59	100	100	% Silt	20	27	35
1.00	53	98	99	% Clay	6	37	37
0.425	50	94	97	Activity	1.7	0.6	0.7
0.250	47	87	92				
0.150	42	80	87	% Soil Mortar	59	100	100
0.075	33	70	80				
0.060	26	64	72	Grading Modulus	1.58	0.36	0.23
0.050	24	61	70	Moisture Content (%)	N / T	N / T	N / T
0.035	19	56	64	Relative Density (SG)*	2.65	2.65	2.65
0.020	15	50	55				
0.006	9	42	44	Unified (ASTM D2487)	SC	CL	CL
0.002	6	37	37	AASHTO (M145-91)	A - 2 - 4	A - 7 - 6	A - 7 - 6

Remarks: *: Assumed
N / T: Not Tested

Specialised Testing Laboratory (Pty) Ltd
Aggregate | Asphalt | Soil | Concrete
Quality | Excellence | On Time
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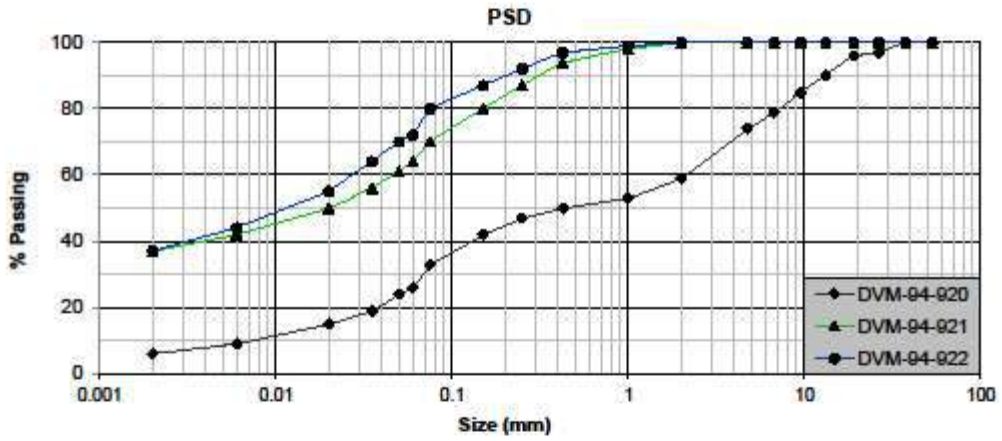
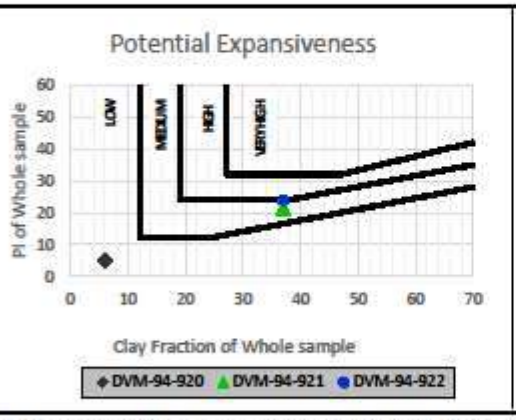
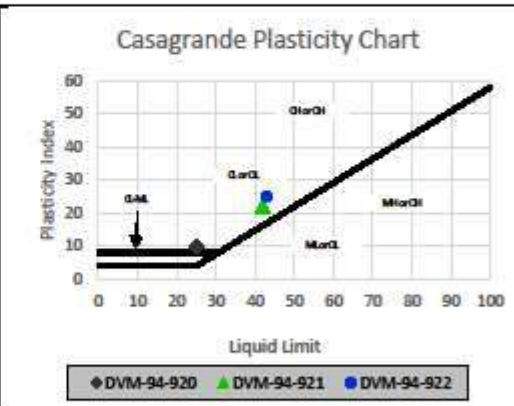
Project Name: Paardekraal, Rustenburg
Job Number: DVM-94
Date: 2019-10-02
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR







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Client Name: Geoset
Project Name: Paardekraal, Rustenburg
Job Number: DVM-94
Date: 2019-10-02
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

Grading & Hydrometer Analysis (Particle Size (mm) & % Passing)				Atterberg Limits & Classification			
Sample	P2	P2	P3	Sample	P2	P2	P3
Depth (m)	0.5	1.7	0.5	Depth (m)	0.5	1.7	0.5
Lab No	DVM-94-923	DVM-94-924	DVM-94-925	Lab No	DVM-94-923	DVM-94-924	DVM-94-925
53.0	100	100	100	Liquid Limit (%)	29	49	67
37.5	100	100	100	Plastic Limit (%)	13	20	28
26.5	100	100	100	Plasticity Index (%)	16	29	39
19.0	100	100	100	Linear Shrinkage (%)	8.0	14.0	27.5
13.2	100	100	100	PI of whole sample	14	28	37
9.5	100	100	100				
6.7	100	100	100	% Gravel	0	0	1
4.75	100	100	100	% Sand	54	31	18
2.00	100	100	99	% Silt	20	29	25
1.00	99	99	98	% Clay	26	40	56
0.425	89	96	96	Activity	0.6	0.7	0.7
0.250	75	90	92				
0.150	64	83	88	% Soil Mortar	100	100	99
0.075	52	73	83				
0.060	46	69	81	Grading Modulus	0.59	0.31	0.22
0.050	45	66	79	Moisture Content (%)	N / T	N / T	N / T
0.035	41	61	75	Relative Density (SG)*	2.65	2.65	2.65
0.020	38	55	71				
0.006	30	45	61	Unified (ASTM D2487)	CL	CL	CH
0.002	26	40	56	AASHTO (M145-91)	A - 6	A - 7 - 6	A - 7 - 6

Remarks: *: Assumed
N / T: Not Tested

Specialised Testing Laboratory (Pty) Ltd
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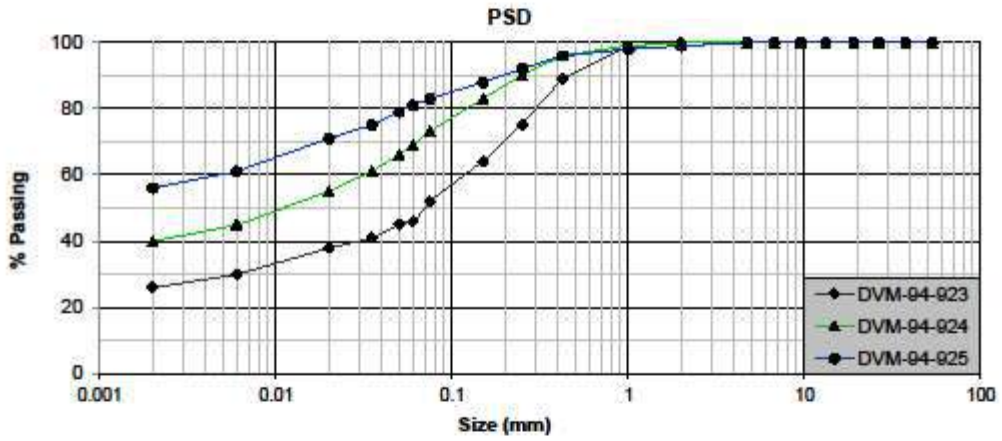
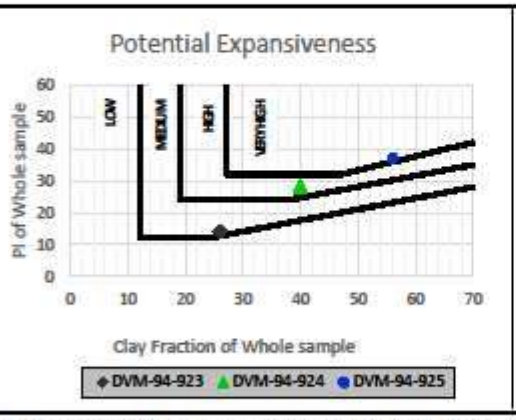
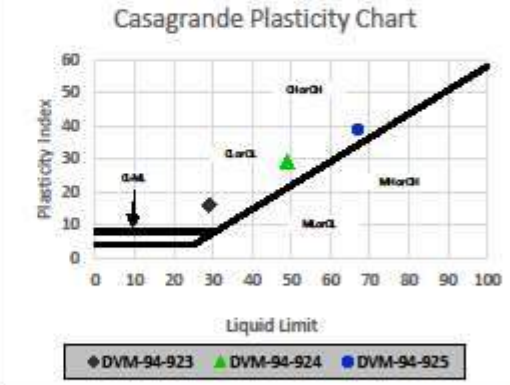
Job Number: DVM-94
Date: 2019-10-02
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR







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Client Name: Geoset
Project Name: Paardekraal, Rustenburg
Job Number: DVM-94
Date: 2019-10-02
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

Grading & Hydrometer Analysis (Particle Size (mm) & % Passing)				Atterberg Limits & Classification			
Sample	P3	P4	P5	Sample	P3	P4	P5
Depth (m)	2.0	0.4	0.4	Depth (m)	2.0	0.4	0.4
Lab No	DVM-94-926	DVM-94-927	DVM-94-928	Lab No	DVM-94-926	DVM-94-927	DVM-94-928
53.0	100	100	100	Liquid Limit (%)	70	37	24
37.5	100	100	100	Plastic Limit (%)	31	15	14
26.5	100	100	100	Plasticity Index (%)	39	22	10
19.0	100	100	100	Linear Shrinkage (%)	29.0	11.0	4.5
13.2	100	100	100	PI of whole sample	38	20	8
9.5	100	100	100				
6.7	100	100	100	% Gravel	0	0	1
4.75	100	100	100	% Sand	19	36	67
2.00	100	100	99	% Silt	26	26	16
1.00	99	98	94	% Clay	55	38	16
0.425	98	92	79	Activity	0.7	0.6	0.6
0.250	94	85	66				
0.150	89	77	51	% Soil Mortar	100	100	99
0.075	83	68	39				
0.060	81	64	32	Grading Modulus	0.19	0.40	0.83
0.050	78	62	30	Moisture Content (%)	N / T	N / T	N / T
0.035	74	57	25	Relative Density (SG)*	2.65	2.65	2.65
0.020	69	51	23				
0.006	61	43	19	Unified (ASTM D2487)	CH	CL	SC
0.002	55	38	16	AASHTO (M145-91)	A - 7 - 5	A - 6	A - 4

Remarks: *: Assumed
N / T: Not Tested

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Quality | Excellence | On Time
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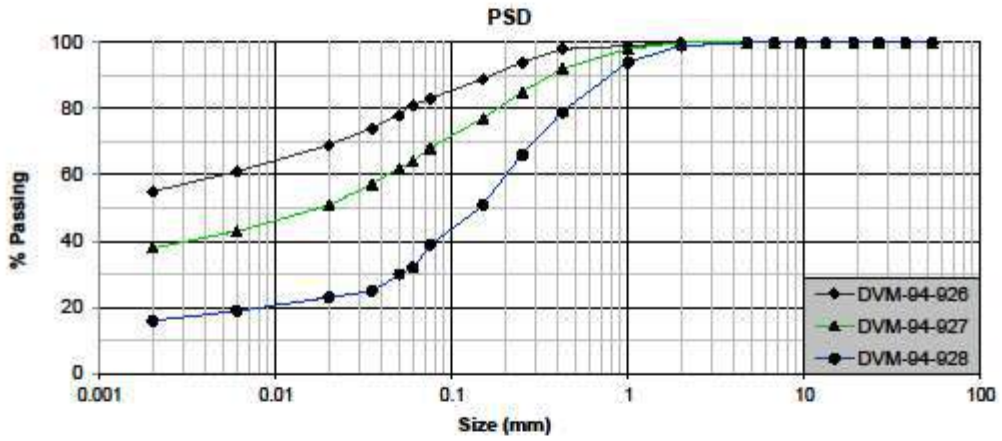
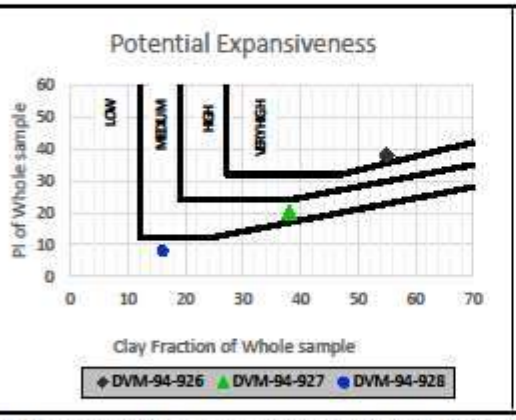
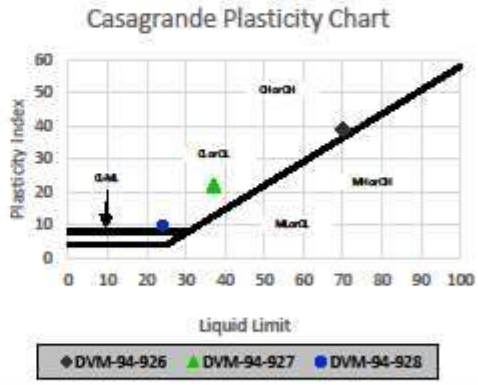
Client Name: Geoset
Project Name: Paardekraal, Rustenburg
Job Number: DVM-94
Date: 2019-10-02
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR







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Quality | Excellence | On Time
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www.stlab.co.za

Client Name: Geoset
Project Name: Paardekraal, Rustenburg
Job Number: DVM-94
Date: 2019-10-02
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

Grading & Hydrometer Analysis (Particle Size (mm) & % Passing)				Atterberg Limits & Classification			
Sample	P5	P11	P15	Sample	P5	P11	P15
Depth (m)	1.6	0.4	0.4	Depth (m)	1.6	0.4	0.4
Lab No	DVM-94-929	DVM-94-930	DVM-94-931	Lab No	DVM-94-929	DVM-94-930	DVM-94-931
53.0	100	100	100	Liquid Limit (%)	25	23	42
37.5	100	100	100	Plastic Limit (%)	14	16	19
26.5	100	100	100	Plasticity Index (%)	11	7	23
19.0	100	100	100	Linear Shrinkage (%)	5.0	3.0	12.0
13.2	100	100	100	PI of whole sample	9	5	20
9.5	100	99	100				
6.7	100	98	100	% Gravel	1	10	1
4.75	100	96	100	% Sand	67	65	47
2.00	99	90	99	% Silt	15	16	15
1.00	93	82	95	% Clay	17	9	37
0.425	79	71	85	Activity	0.7	0.8	0.6
0.250	67	57	80				
0.150	53	41	74	% Soil Mortar	99	90	99
0.075	37	29	63				
0.060	32	25	52	Grading Modulus	0.85	1.10	0.53
0.050	30	23	50	Moisture Content (%)	N / T	N / T	N / T
0.035	26	18	46	Relative Density (SG)*	2.65	2.65	2.65
0.020	24	15	44				
0.006	19	13	40	Unified (ASTM D2487)	SC	SC-SM	CL
0.002	17	9	37	AASHTO (M145-91)	A - 6	A - 2 - 4	A - 7 - 6

Remarks: *: Assumed
N / T: Not Tested

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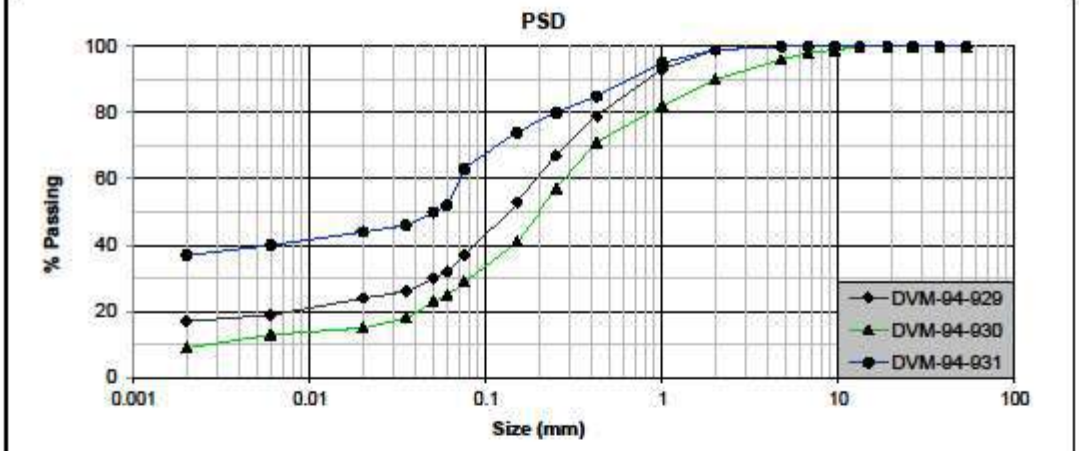

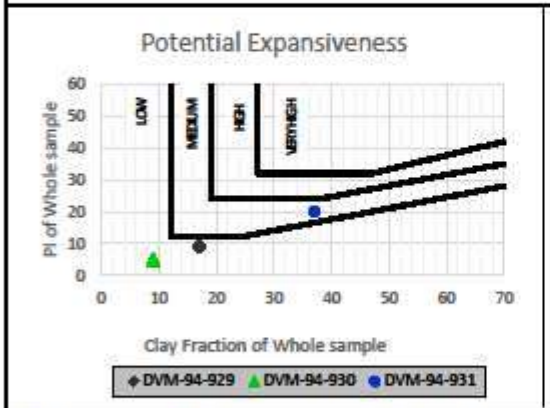

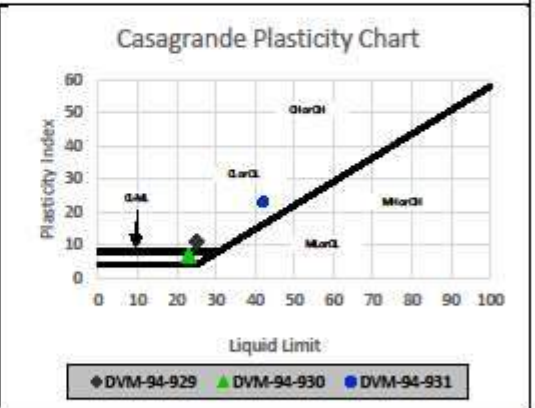

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Date: 2019-10-02
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FOUNDATION INDICATOR

Grading & Hydrometer Analysis (Particle Size (mm) & % Passing)				Atterberg Limits & Classification			
Sample	P19	P28	P30	Sample	P19	P28	P30
Depth (m)	0.3	0.3	0.3	Depth (m)	0.3	0.3	0.3
Lab No	DVM-94-932	DVM-94-933	DVM-94-934	Lab No	DVM-94-932	DVM-94-933	DVM-94-934
53.0	100	100	100	Liquid Limit (%)	30	55	62
37.5	100	100	100	Plastic Limit (%)	15	18	26
26.5	100	100	100	Plasticity Index (%)	15	37	36
19.0	100	100	100	Linear Shrinkage (%)	7.0	24.5	27.0
13.2	100	100	100	PI of whole sample	13	34	33
9.5	100	100	100				
6.7	100	100	100	% Gravel	0	2	2
4.75	100	100	100	% Sand	56	39	36
2.00	100	98	98	% Silt	22	22	22
1.00	97	96	96	% Clay	22	37	40
0.425	89	91	91	Activity	0.7	1.0	0.9
0.250	80	83	82				
0.150	69	73	75	% Soil Mortar	100	98	98
0.075	51	64	67				
0.060	44	59	62	Grading Modulus	0.60	0.47	0.44
0.050	40	57	60	Moisture Content (%)	N / T	N / T	N / T
0.035	33	53	56	Relative Density (SG)*	2.65	2.65	2.65
0.020	29	48	52				
0.006	25	41	45	Unified (ASTM D2487)	CL	CH	CH
0.002	22	37	40	AASHTO (M145-91)	A - 6	A - 7 - 6	A - 7 - 6

Remarks: *: Assumed
N / T: Not Tested

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Project Name: Paardekraal, Rustenburg
Job Number: DVM-94
Date: 2019-10-02
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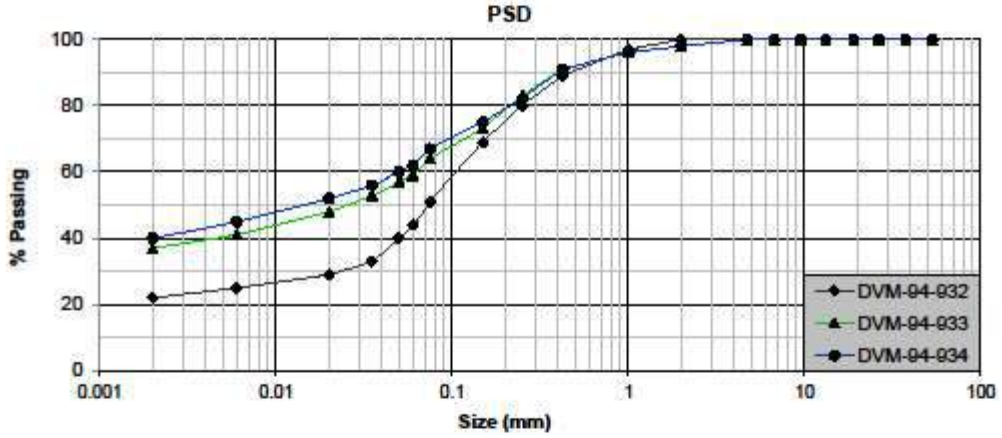

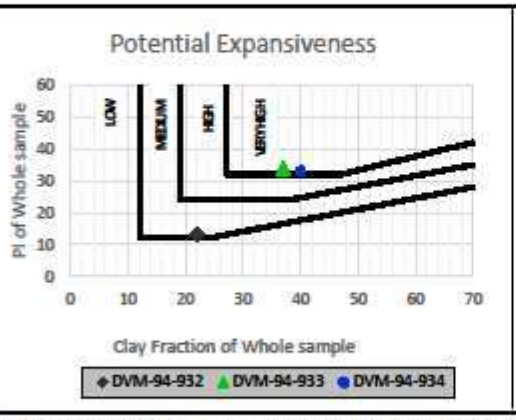

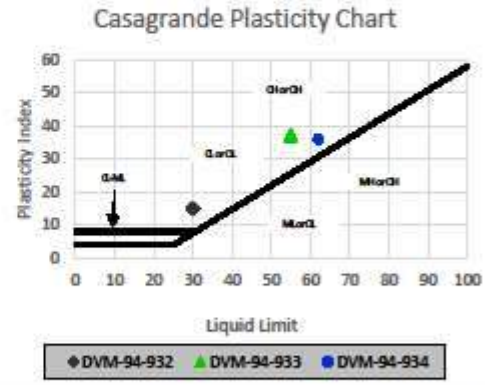

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Quality | Excellence | On Time

Client Name: Geoset
Project Name: Paardekraal, Rustenburg
Job Number: DVM-94
Date: 2019-10-02
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

Grading & Hydrometer Analysis (Particle Size (mm) & % Passing)				Atterberg Limits & Classification			
Sample	P32	P33	P38	Sample	P32	P33	P38
Depth (m)	0.3	0.6	0.6	Depth (m)	0.3	0.6	0.6
Lab No	DVM-94-935	DVM-94-936	DVM-94-937	Lab No	DVM-94-935	DVM-94-936	DVM-94-937
53.0	100	100	100	Liquid Limit (%)	55	70	79
37.5	100	100	100	Plastic Limit (%)	16	27	33
26.5	100	100	100	Plasticity Index (%)	39	43	46
19.0	100	100	100	Linear Shrinkage (%)	25.0	30.5	34.0
13.2	100	100	100	PI of whole sample	36	40	43
9.5	100	100	100				
6.7	100	100	100	% Gravel	1	2	3
4.75	100	100	100	% Sand	42	30	19
2.00	99	98	97	% Silt	18	19	22
1.00	97	96	95	% Clay	39	49	56
0.425	92	92	93	Activity	1.0	0.9	0.8
0.250	77	84	89				
0.150	69	78	85	% Soil Mortar	99	98	97
0.075	60	72	81				
0.060	57	68	78	Grading Modulus	0.49	0.38	0.29
0.050	55	67	76	Moisture Content (%)	N / T	N / T	N / T
0.035	51	64	71	Relative Density (SG)*	2.65	2.65	2.65
0.020	49	60	67				
0.006	43	54	60	Unified (ASTM D2487)	CH	CH	CH
0.002	39	49	56	AASHTO (M145-91)	A - 7 - 6	A - 7 - 6	A - 7 - 5

Remarks: *: Assumed
N / T: Not Tested

Specialised Testing Laboratory (Pty) Ltd
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Quality | Excellence | On Time
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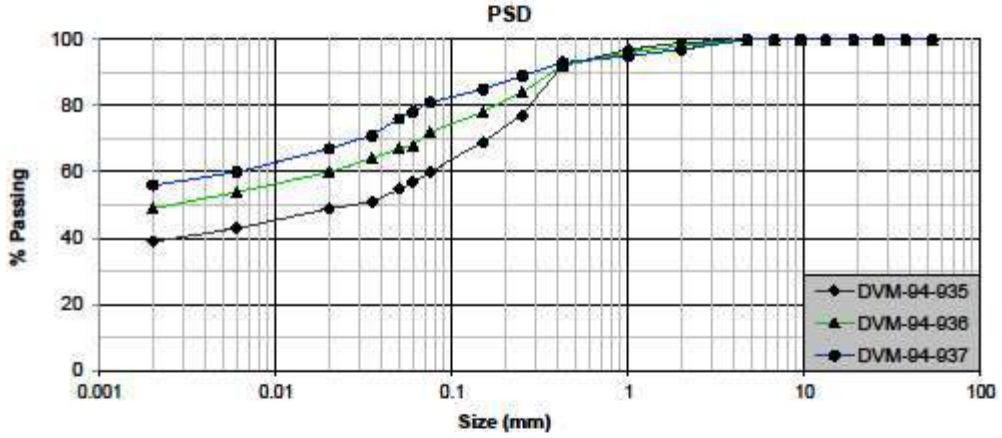
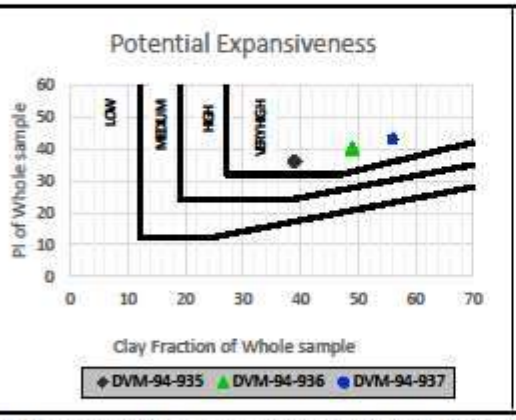
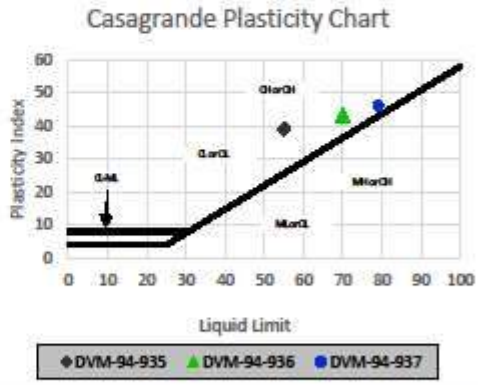
Client Name: Geoset
Project Name: Paardekraal, Rustenburg
Job Number: DVM-94
Date: 2019-10-02
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR







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Quality | Excellence | On Time

Client Name: Geoset
Project Name: Paardekraal, Rustenburg
Job Number: DVM-94
Date: 2019-10-02
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

Grading & Hydrometer Analysis (Particle Size (mm) & % Passing)				Atterberg Limits & Classification			
Sample	P40	P40	P46	Sample	P40	P40	P46
Depth (m)	0.5	1.2	0.6	Depth (m)	0.5	1.2	0.6
Lab No	DVM-94-938	DVM-94-938	DVM-94-940	Lab No	DVM-94-938	DVM-94-938	DVM-94-940
53.0	100	100	100	Liquid Limit (%)	86	90	82
37.5	100	100	100	Plastic Limit (%)	38	38	33
26.5	100	100	100	Plasticity Index (%)	48	52	49
19.0	100	100	100	Linear Shrinkage (%)	36.5	38.5	34.0
13.2	100	100	100	PI of whole sample	46	49	48
9.5	100	100	100				
6.7	100	100	100	% Gravel	2	3	1
4.75	100	99	100	% Sand	14	9	13
2.00	98	97	99	% Silt	18	29	23
1.00	96	95	99	% Clay	66	59	63
0.425	95	94	98	Activity	0.7	0.9	0.8
0.250	92	92	97				
0.150	90	91	94	% Soil Mortar	98	97	99
0.075	88	87	90				
0.060	84	88	86	Grading Modulus	0.19	0.22	0.13
0.050	83	86	85	Moisture Content (%)	N / T	N / T	N / T
0.035	80	83	82	Relative Density (SG)*	2.65	2.65	2.65
0.020	77	74	76				
0.006	70	65	66	Unified (ASTM D2487)	CH	CH	CH
0.002	66	59	63	AASHTO (M145-91)	A - 7 - 5	A - 7 - 5	A - 7 - 5

Remarks: *: Assumed
N / T: Not Tested

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Asphalt | Aggregate | Bitumen | Geotechnical
Quality | Excellence | On Time

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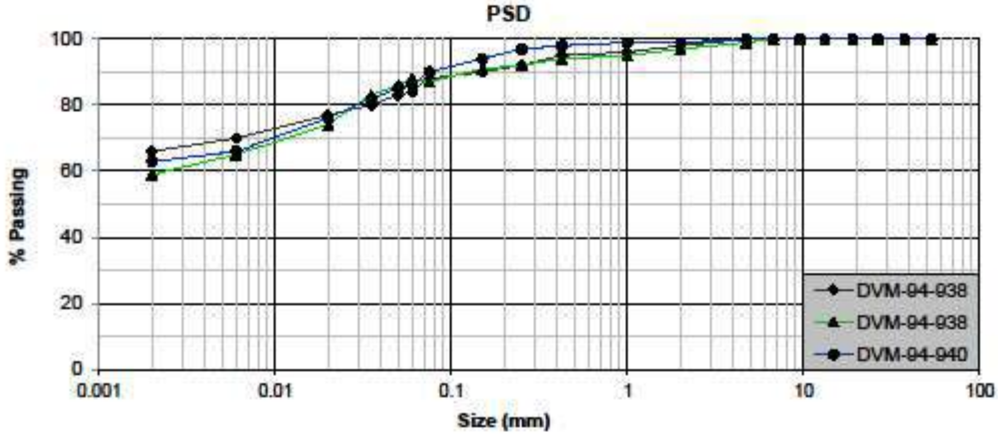
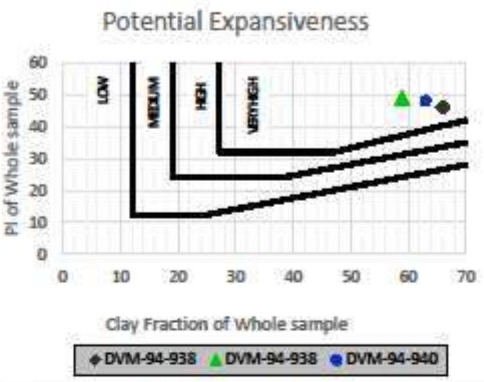
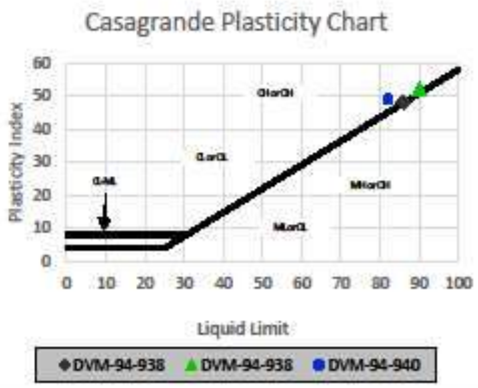
Client Name:	Geoset
Project Name:	Paardekraal, Rustenburg
Job Number:	DVM-94
Date:	2019-10-02
Method:	SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR







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Client Name: Geoset
Project Name: Paardekraal, Rustenburg
Job Number: DVM-94
Date: 2019-10-02
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

Grading & Hydrometer Analysis (Particle Size (mm) & % Passing)				Atterberg Limits & Classification			
Sample	P48	P51	P52	Sample	P48	P51	P52
Depth (m)	0.6	0.6	0.6	Depth (m)	0.6	0.6	0.6
Lab No	DVM-94-941	DVM-94-942	DVM-94-943	Lab No	DVM-94-941	DVM-94-942	DVM-94-943
53.0	100	100	100	Liquid Limit (%)	87	75	82
37.5	100	100	100	Plastic Limit (%)	41	33	35
26.5	100	100	100	Plasticity Index (%)	46	42	47
19.0	100	100	100	Linear Shrinkage (%)	34.0	31.0	33.0
13.2	100	100	100	PI of whole sample	45	38	45
9.5	100	100	100				
6.7	100	100	100	% Gravel	1	4	2
4.75	100	99	100	% Sand	25	23	14
2.00	99	96	98	% Silt	22	23	34
1.00	99	94	97	% Clay	52	50	50
0.425	98	91	96	Activity	0.9	0.8	0.9
0.250	91	87	93				
0.150	86	85	91	% Soil Mortar	99	96	98
0.075	80	80	87				
0.060	74	73	84	Grading Modulus	0.23	0.33	0.19
0.050	72	72	82	Moisture Content (%)	N / T	N / T	N / T
0.035	70	70	79	Relative Density (SG)*	2.65	2.65	2.65
0.020	64	66	72				
0.006	56	58	57	Unified (ASTM D2487)	CH	CH	CH
0.002	52	50	50	AASHTO (M145-91)	A - 7 - 5	A - 7 - 5	A - 7 - 5

Remarks: *: Assumed
N / T: Not Tested

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Quality | Excellence | On Time
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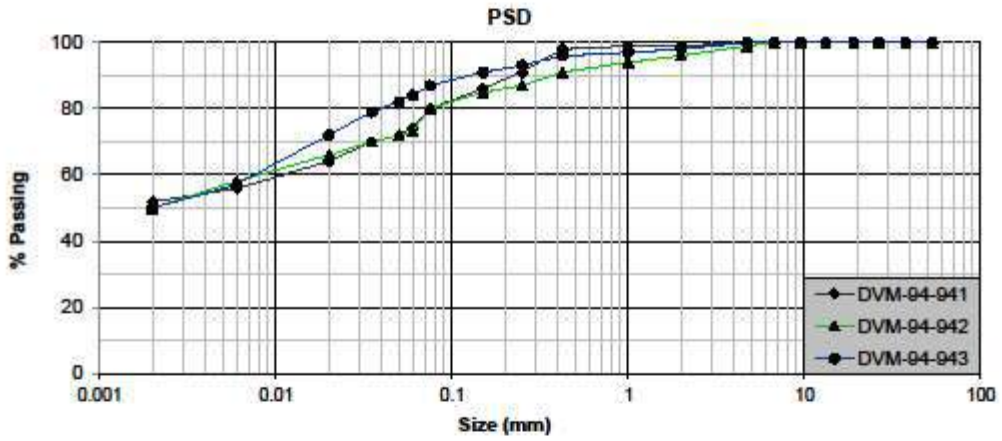
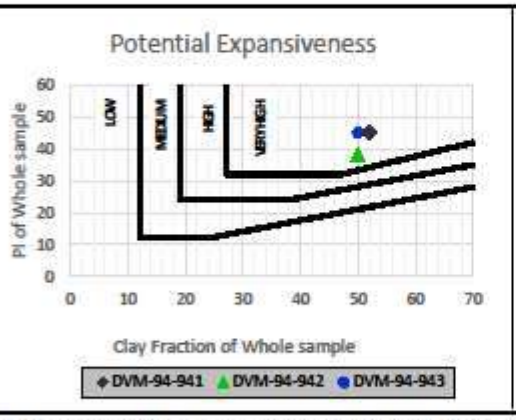
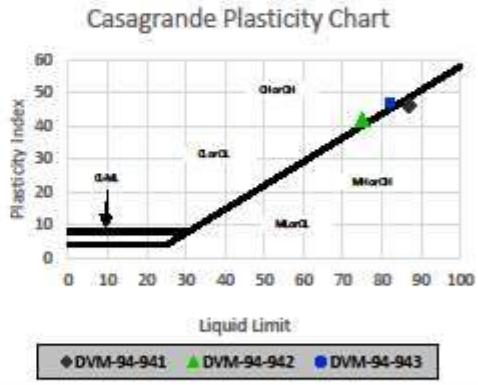
Client Name: Geoset
Project Name: Paardekraal, Rustenburg
Job Number: DVM-94
Date: 2019-10-02
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR







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FOUNDATION INDICATOR

Grading & Hydrometer Analysis (Particle Size (mm) & % Passing)				Atterberg Limits & Classification			
Sample	P54	P55		Sample	P54	P55	
Depth (m)	0.6	1.2		Depth (m)	0.6	1.2	
Lab No	DVM-94-944	DVM-94-945		Lab No	DVM-94-944	DVM-94-945	
53.0	100	100		Liquid Limit (%)	90	65	
37.5	100	100		Plastic Limit (%)	39	26	
26.5	100	100		Plasticity Index (%)	51	39	
19.0	100	100		Linear Shrinkage (%)	34.5	27.5	
13.2	100	100		PI of whole sample	49	37	
9.5	100	100					
6.7	100	100		% Gravel	1	1	
4.75	100	100		% Sand	14	23	
2.00	99	99		% Silt	19	22	
1.00	98	98		% Clay	66	54	
0.425	97	96		Activity	0.8	0.7	
0.250	94	89					
0.150	93	85		% Soil Mortar	99	99	
0.075	90	79					
0.060	85	76		Grading Modulus	0.14	0.26	
0.050	84	75		Moisture Content (%)	N / T	N / T	
0.035	81	73		Relative Density (SG)*	2.65	2.65	
0.020	77	66					
0.006	70	59		Unified (ASTM D2487)	CH	CH	
0.002	66	54		AASHTO (M145-91)	A - 7 - 5	A - 7 - 6	

Remarks: *: Assumed
N / T: Not Tested

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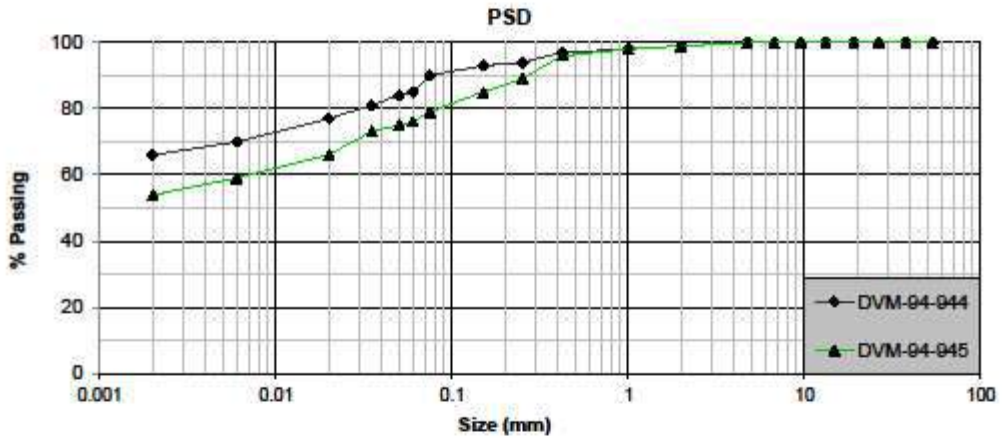
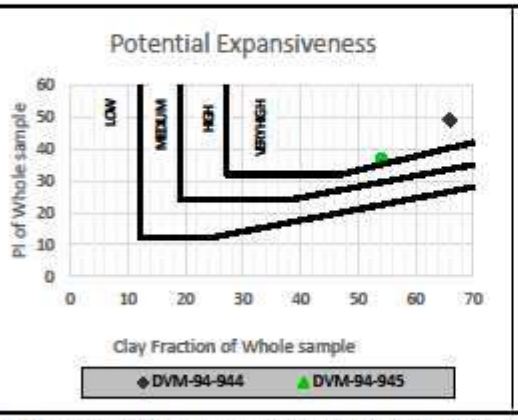
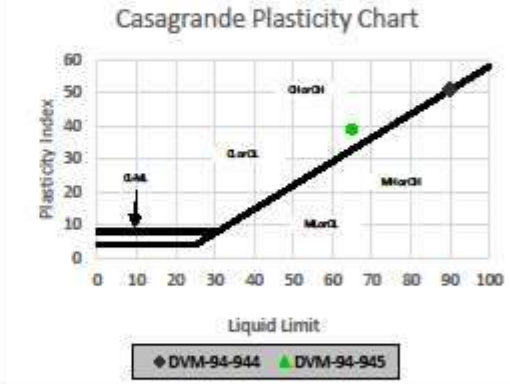
FOUNDATION INDICATOR







APPENDIX D: TABULAR EXPLANATION OF ZONING

Table1. Categories of Urban Engineering Geological Investigation

Table 2. Geotechnical CLASSIFICATION FOR Urban Development:
Partridge, Wood & Brink (1993)

Table 3. Residential Site Class Designations: SAICE, SAIEG & NHBRC(1995)

Table 1. CATEGORIES OF URBAN ENGINEERING GEOLOGICAL INVESTIGATION

Type	Planning Investigations		Urban Development Investigations		Specialised Investigations
Description	**Regional Engineering Geological Mapping (REGM)**	**Mapping for Urban Planning**	**Urban Development Investigation**	**Urban Development Investigation**	**Specialised Geotechnical Investigation**
Size of study area **and field work**	More than 1000 ha. Walk-over survey and limited test pits and soil sampling.	Less than 1000 ha. Walk-over survey.	Less than 10 ha. Test pits, trial holes and soil sampling.	More than 10 ha. Walk-over survey with trial pits and test holes and soil sampling.	Not relevant. Specific to type of specialised investigation.
Suggested number of test pits	A minimum of 3 test pits per land facet type.	None suggested. However, a limited number of test pits may be required at the discretion of the consultant.	Between 6 and 10 test pits.*	Between 1 and 6 test pits per 10 ha. depending on the size and variability of the a[ea to as much as 1 test pit per hectare for highly variable sites.*	Dependent on the type of specialised investigation performed.
Mapping unit	Land systems and land facets.	Terrain types: 1 - most favourable 2 - intermediate 3 - least favourable	Soil classes: C, H, Sand P and other (e.g. excavation, drainage features)	Soil classes: C, H, Sand P and other (e.g. excavation, drainage features)	Not applicable.
Reference	Brink, Partridge and Williams (1982)	Partridge, Wood and Brink (1993)	SAICE Code of Practice (1995)	SAICE Code of Practice (1995)	Not relevant.
Consultants	Engineering geologists.	Engineering geologists and to a lesser extent geotechnical engineers.	Both engineering geologists and geotechnical engineers.	Both engineering geologists and geotechnical engineers.	Geotechnical engineers And to a lesser extent engineering geologists.

* Note that these figures are not intended to be absolute and should serve only as a guideline.

Table 2. GEOTECHNICAL CLASSIFICATION FOR URBAN DEVELOPMENT (after Partridge, Wood and Brink 1993)

CONSTRAINT		Most favourable (1)	Intermediate (2)	Least favourable (3)
A	Collapsible Soil	Any collapsible horizon or consecutive horizons totalling a depth of less than 750 mm in thickness.*	Any collapsible horizon or consecutive horizons with a depth of more than 750 mm in thickness.	A least favourable situation for this constraint does not occur.
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 predicted. *	Moderate soil heave potential predicted.	High soil-heave potential predicted.
0	Highly compressible soil	Low soil compressibility expected.*	Moderate soil compressibility expected.	High soil compressibility expected.
E	Erodability of soil	Low.	Intermediate.	High.
F	Difficulty of excavation to 1,5 m 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.
G	Undermined ground	Undermining at a depth greater than 100 m below surface (except where total extraction mining has not occurred.)	Old undermined areas to a depth of 100 m below surface where stope closure has ceased. -	Mining within less than 100 m of surface or where total extraction mining has taken place.
H	Instability in areas of soluble rock	Possibly unstable.	Probably unstable.	Known sinkholes and dolines.
I	Steep slopes	Between 2 and 6 degrees (all regions).	Slopes between 6 and 18 degrees and less than 2 degrees (Natal and Western Cape). Slopes between 6 and 12 degrees and less than 2 degrees (all other regions).	More than 18 degrees (Natal and Western Cape). More than 12 degrees (all other regions).
J	Areas of unstable natural slopes	Low risk.	Intermediate risk.	High risk (especially in areas subject to seismic activity).
K	Areas subject to seismic activity	10% probability of an event less than 100 cm/s^2 within 50 years.	Mining-induced seismic activity more 100 cm/s^2.	Natural seismic activity more than 100 cm/s^2•
L	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 .within a known drainage channel Or floodplain.

* These areas are designated as 1 A, 1 C, 1 **D,** or 1 F where localised occurrences of the constraint may arise.

Table 3. **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 soil 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 movement 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 more 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/S 1 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 Class S1 or S2 a 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

APPENDIX E: DATA INPUT SHEETS

Site Specific Data Input Sheets

NORTH WEST PROVINCE
HOUSING DEPARTMENT

PROJECT-LINKED /RURAL PROJECT (PLEASE INDICATE P or R IN BOX)

SUBSIDY VARIATION CALCULATOR

DATA INPUT SHEET

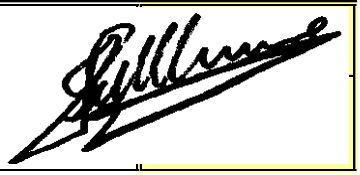
Version 1.10

Name of Project	**Popo Molefe Boitekong X39**		
Distance from nearest major centre in km (see list adjacent)	10 km	**Name of Centre (Only Potchefstroom, Klerksdorp, Rustenburg, Mafikeng, Brits or Tshwane)**	Rustenburg
Total Number of houses in Project			
How many houses with this classification?			
Subsidy amount for this development ?			

1	**VARIATION IN SITE CLASS**		
Site Classification			
House Size Class (30-40m²)			
Basic Site Class Designation (H1,C2,S1 etc or combination Please) (Dominant Mode)		H3R	
Note that for a combination classification (i.e C1/S2) the designer must select the dominant mode that will be used for design purposes (Contributory Mode)		H3R	
If the Site Classification is H3, what is the predicted differential movement?		>30mm	
Is the Site Underlain By Dolomites?			No
If so, what is the Dolomitic Area Designation?			N/A

2	**VARIATION IN SITE CONDITIONS**	
2.1	**Seepage/Ground Water**	**No**
2.1.1	Does the Site have a water table less than 1m from the surface?	No
2.1.2	Does the Site have a water table less than 1,5m but more than 1m from the surface?	No
2.2	**Soil Slope**	
2.3.2	What is the average slope of the erf in %?	<6 %
2.3	**Soil dispersion**	**No**
2.3.3	Is the uppermost soil horizon classified as SP,SM, CL or CH in terms of the Unified Soil Classification System?	CH 60%, CL 30%
2.4	**Difficulty of excavation**	
	What percentage of the uppermost soil horizon is classified as hard in terms SABS 1200 D?	40%

I certify that the above information is based on my assessment of the proposed housing site and that it is in my opinion representative of the General Site Conditions.

Name:	David S vd Merwe	Signature	
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