SUMMARY

This report presents the results of phase 1 geotechnical investigations for the proposed township proclamation on the farm Elandskuil 205IP and 206IP in Ventersdorp within the NW 405 Municipality (Ventersdorp/Tlokwe) in North West Province. The site is located on quartz-feldspar porphyry of the Makwassie Formation and amygdaloidal lava, agglomerate and tuff of the Rietgat Formation. These formations form part of the Platberg Group of the Kliprievirsburg Supergroup. They overlie quartzite and shale of the Orange Grove Formation of the West Rand Group, Witwatersrand Supergroup. These investigations involved field inspections, a review of available data, a comprehensive test pit excavation programme and soil profiling and sampling.

Based on the fieldwork, soil profiles, geological and hydrogeological data gathered during site investigation, the area is subdivided into two preliminary geotechnical (soil) Site Classes, namely: **2/r/H-H1/C/S1 and 2r2/H1-H3/C/S.** The site is characterised as developable with areas that may need precautionary or certain remedial measures.

The site is sub-divided into (soil) Site Class Sub-Areas defined in terms of NHBRC loading conditions and composite site classes using 'H' (active soils), 'C' (collapse soils), 'S' (settlement soils) and 'R' (rock) designations defined in the report. The test pitting and profiling was conducted in order to comply with the GFSH-2 and SANS specifications and recommendations. Soil Sub-Areas provide guidance for the planning of the site during the implementation phases of the development using the excavated test pits and available information.

Foundation recommendations and minimum precautionary measures are also included in the report.

GEOTECHNICAL INVESTIGATIONS FOR THE PROPOSED TOWNSHIP ESTABLISMENT ON THE REMAINDER OF THE FARM ELANDSKUIL 205IP AND 206IP IN THE VENTERSDORP LOCAL MUNICIPALITY, NORTH WEST PROVINCE.

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1. INTRODUCTION

This document details the outcome of surficial soils investigations for the proposed township proclamation on the farm Elandskuil 205IP and 206IP in Ventersdorp within the NW 405 Municipality (Ventersdorp/Tlokwe) in North West Province. The geotechnical investigations were conducted via fieldwork which included test pit excavations, soil profiling and sampling, and laboratory testing. The geological and hydrogeological data were also gathered during site investigation process. The geotechnical investigations were carried out to assess the geotechnical conditions of the site for the proposed development of new residential structures. The purpose of the report is also to identify anticipated geotechnical constraints that may impact on recommendations for foundation and structural designs for the planned housing units and to subdivide the site into geotechnical (soil) Site Class. The report also discusses the suitability of the *in situ* soils for the purposes of road and pavement construction and pipe bedding.

The report therefore documents an overview of the geotechnical properties and characteristics of the surficial soils underlying the area that is earmarked for the proposed development. It also describes the process that was undertaken during the geotechnical investigations.

2. TERMS OF REFERENCE AND SCOPE OF WORK

The report focuses on the geotechnical site investigation aimed at determining various geotechnical properties of the near surface soil horizons in accordance with the SAIEG guidelines, GFSH-2 guidelines, NHBRC Home Building Manuals, TRH4, TRH 14 guidelines and SANS guidelines. The geotechnical properties of the soils are determined in order to guide in the assessment of the engineering characteristics of soil underlying the site.

The geotechnical investigations were conducted in accordance with the program and scope of work that was discussed with Mr. V. M. Maila of Mamphele Development Planners via email correspondence of the 28th of August 2017. Based on the terms of reference, the program of work includes:

Desk study

- Review of existing information.

Fieldwork

- Minimum number of tests pits/trial holes/drilling per hectare.
- Soil profiling and sampling.
- Minimum number of laboratory tests.

Reporting

- Data analysis and interpretation
- Determination of geotechnical characteristics and provisional Soil Site Classes.
- Foundation recommendations.
- Construction materials (roads, pipe bedding, building materials)
- Geotechnical zonation.
- Other feasible land uses.

The investigation process was conducted in order to determine the engineering parameters and properties of the near surface soil conditions with regards to township planning and foundation and structural designs. The process is also aimed at identifying prevailing geotechnical constraints that may impact on foundations and related structural integrity for the proposed subsidy houses.

3. SITE DESCRIPTION AND LOCATION

The investigation was conducted on the farm Elandskuil 205IP and 206IP in Ventersdorp within the NW 405 Municipality (Ventersdorp/Tlokwe) in North West Province. The site lies adjacent and to the south of Tshing Township. It located approximately 2 km to the south-west of Ventersdorp Town and approximately 25 km. The site is rectangular in shape comprises greenfields land with some parts of the site currently being used for farming and covers approximately 257.48 Ha in extent. Civil infrastructures such as bulk sewer and water services have not been installed across the site. The site is bound by a railway line the south, Skoonspruit in east, farmland in the west and the N14 and R30 routes in the north. The site for the proposed township establishment is accessible via the N14 or R30 routes, (Figure 1)

Figure 1

4. AVAILABLE INFORMATION

The information that was used in the process of investigations and assessment of the site includes following:

- Topographic maps of the Director of Surveys at a scale of 1: 50 000: Sheet 2626BD Ventersdorp.

- Geological Map of the GSO: Scale 1: 250 000 Sheet – Geological series 2626 West Rand.

- Expansive Roadbed Treatment for Southern Africa: D J Weston (1980) 4th Int. Conf. on Expansive Soils, Vol. 1, Denver pp 339-360.

- Soil Survey for Engineering, Brink Partridge and Williams (1982).

- National Home Builders Registration Council: Home Builders Manual: Parts 1 and 2, Revision 1, February 1999.

- Code of Practice: Assessment of the performance of housing units in South Africa. The Joint Structural Division of SAICE and IStructE. June 2000.

- Geotechnical Site Investigations for Housing Developments – Generic Specification GFSH-2. National Department of Housing. September 2002

- SAICE's Guidelines for Urban Engineering Geological Investigations.

- Schwartz, K. (1985). Collapsible soils. The Civil Engineer in South Africa, July, p379-393.

- SAICE's Guidelines for Urban Engineering Geological Investigations.

- Technical Recommendations for Highways – TRH4 and 14 Guidelines for Road Construction Materials by the National Institute for Transport and road research of the Council for Scientific and Industrial Research, (1985).

- Site plans and satellite photographs supplied by the client.

5. CLIMATE

Based on the South African Explorer climatic data the average yearly rainfall in the Ventersdorp area is approximately 469 mm. This area generally receives most of its rainfall during the summer season with the maximum rainfall in January. Minimum rainfall is experienced during the winter months with the lowest in June. The average maximum temperature is approximately 30°C in summer with the minimum during the winter months at approximately 17.4°C. The site lies in an area with a Weinert N value that is less than 5, which indicates that chemical decomposition is the predominant form of weathering.

6. TOPOGRAPHY AND DRAINAGE

The topography of the investigated area is generally characterized by a gentle slope that falls toward the north-west. The slope falls from approximately 1502 in the south-east to approximately 1495 in the north-west. Scattered outcrops and sub-outcrops were not encountered across the site. Flat areas which may present retarded stormwater dispersion do occur across the site and erosion is generally via sheetwash. There are no major rivers, streams and/or drainage channels that traverse the site. There are two earth dams and a minor drainage channel that lie approximately 200 m from the northern boundary of the site, Figure 1.

7. GEOLOGY AND ANTCIPATED SOIL CONDITIONS

The 1: 250 000 scale Geological Map, Sheet 2626 West Rand, indicates that the investigated area is located on colluvial soils of the Quartenary stage, which overlies quartz-feldspar porphyry of the Makwassie Formation and amygdaloidal lava, agglomerate and tuff of the Rietgat Formation. These formations form part of the Platberg Group of the Kliprievirsburg Supergroup. They overlie quartzite and shale of the Orange Grove Formation of the West Rand Group, Witwatersrand Supergroup. These lithologies are overlain by their weathered soil derivatives, which are in turn mantled by variable thicknesses of transported soils i.e. hillwash, aeolian, alluvium and/or colluvial materials (Figure 2).

The various lithological units encountered on the sites are as follows:

LITHOLOGY	LITHOSTRATIGRAPHIC UNIT
Silts, sands, gravels, pedocretes	Recent deposits of mixed origin (hillwash and colluvium)
Quartz-feldspar porphyry	Makwassie Formation, Platberg Group, Kliprievirsburg Supergroup
Amygdaloidal lava, agglomerate and tuff	Rietgat Formation, Platberg Group, Kliprievirsburg Supergroup
Quartzite, shale	Orange Grove Formation, Witwatersrand Supergroup

Anticipated soil conditions

The residual soils derived from lava and shale generally comprise clayey soils that may exhibit low to medium expansive characteristics. Deep residual soils with a highly expansive grain structure are generally prevalent in old erosion channels and on pediments. Expansive clays generally change in volume as a result of change in moisture content. These clays will swell and increase in volume when the moisture content increases and will shrink with loss of moisture or as drying occurs. The shrink-swell characteristic may lead to differential movement on structural foundations and walls resulting in severe structural damage.

Residual soils derived from quartzite may also form silty sands that may exhibit a collapsible grain structure. These soils may competently bear imposed loads when dry, however, when inundation occurs and the soil is under load the colloidal 'bridges' in these voided soils fail and the soil typically collapses into a denser state, leading to differential settlement. The differential settlement may result in structural damage. 'Corners down' cracking of buildings is often observed in areas of collapsing soils.

Various forms of pedocretes (e.g. hardpan ferricrete, soft pan ferricrete, calcrete) form part of the altered transported and residual soils. The transported materials consist of aeolian sand and colluvial soils. Alluvial soils along drainage channels may also exhibit expansive characteristics. Aeolian soils generally exhibit a highly collapsible fabric, (Figure 2).

Figure 2

8. METHOD OF INVESTIGATION

8.1. Desk study

The investigation process generally begins with desk study where evaluation of available information is conducted. The existing information may include:

- Existing geotechnical reports of the area and/or its surrounds, topographic maps and geology maps.
- Aerial photography and satellite photography of the site.
- Site layout plans of the area

8.2. Field Reconnaissance

The desk study process was followed by field reconnaissance investigation which mainly involved a walk over survey. The walk over survey was undertaken to develop a clearer perspective of the actual site conditions including the layout of the area, accessibility, geomorphology, geology, etc. Some of the pertinent information evaluated such as outcrop/scattered outcrop, storm water runoff, etc., are mapped during this reconnaissance stage. Citing of test pit and profile positions was also conducted during this investigation phase.

8.3. Field Investigation

The site was investigated by excavating test pits via a Case 580 TLB (tractor loader backhoe) to a depth of at least 3.0 m or until refusal was encountered. A total of fifty-seven test pits were spread evenly and excavated over the entire site to cover the extent of the area earmarked for the township proclamation. These test pits were strategically located to give representative soil conditions of the area. A registered engineering geologist inspected and logged the ground profiles as recommended by SAIEG (1996) and according to the MCCSSO method of profiling by Jennings *et al*. The trial pit was loosely backfilled after profiling.

Test pit profiling is a visual and tactile method of assessing the soil characteristics of a site in order to classify it according to its geotechnical zones so as to give guidance on suitability of the site for the proposed/planned development. This process also provides guidance on the appropriate foundation and structural designs for the engineering structures, appropriate

aggregate and compaction material, and suitable pipe bedding material to be used. The test pit positions are plotted on the test pit locality plan, Drawing ZM014/1. Detailed soil profiles are attached in Appendix 2.

Twenty five disturbed soil samples were collected during the. Six bulk samples were collected during the phase 1 investigations, from test pits denoted with the same manner. These samples were submitted to Soilab Material Testing laboratory for foundation indicator testing including particle size distributions, Atterberg limits. CBR tests were conducted on the bulk disturbed soil samples. Undisturbed samples could not be retrieved from site for testing due to the crumbly nature of the soils on site. The laboratory tests were conducted in order to assist with the purpose of classification, description, and delineation of homogenous zones.

9. RESULTS

9.1. Terrain observations

The slope falls from approximately 1502 in the southeast to approximately 1495 in the northwest. Outcrops, scattered outcrops and sub-outcrops were not encountered across the site. There are no major rivers, streams and/or drainage channels that traverse the site and erosion is generally via sheet wash. The site is however bound by Skoonspruit steam in the east and Elandskuil dam lies approximately 1.2 km to the southwest of the site. The site is currently undeveloped and civil infrastructure (bulk sewer, water and electricity services) has not yet been installed. The area is currently being utilised as cultivating land. Tshing Township which has already been extensively developed lies adjacent and to the north of the proposed township establishment.

9.2 Field work

The fifty seven test pits that were excavated across the extent area of the proposed development are discussed below and the positions are shown in Drawing ZM014/1.

A typical soil profile comprises a relatively variable thickness of transported material (colluvium and alluvium, etc.), varying between 0.3 m and greater than 3.0 m in thickness, overlying pedogenic soils derived from the transported and residual granite. The transported horizon comprises mainly orangey brown, yellowish brown, greyish brown and reddish

brown silty sand, gravelly silt and silty clay. The pedogenic soils also comprise yellowish brown, greyish and orangey brown silty sand and sandy clay. The pedogenic layer varies in depth from approximately 0.3 m deep and greater than 2.6 m. Residual quartzite and shale soils were encountered between 0.5 m and greater than 3.0 m. Various forms of ferruginisation (friable, scattered and nodules and signs of ferruginisation/calcification) occur across the site.

9.3. Sampling and laboratory test results

Twenty five representative disturbed soil samples and six bulk samples were collected from the selected soil horizons for laboratory testing. The samples were submitted to Soilab Material Testing laboratories for the testing. Foundation indicator testing including Atterberg limits as well as grading analysis was conducted on the soil samples. CBR tests were conducted on the bulk disturbed soil samples. Undisturbed soil samples could not be retrieved for testing due to the crumbly nature of the soils on site. The results of the foundation indicator tests are summarised in Table 1 and results of the CBR and road indicators are summarised in Table 2. Detailed descriptions of the test pit profiles are included in Appendix A and the laboratory test results in Appendix B. The samples were taken from the test pit position denoted in the same manner.

Transported soils

Representative disturbed soil samples were retrieved from the transported soils and the Plasticity Index (PIwhole) of these samples ranges between non-plastic conditions and 12% with the Liquid Limit (LL) between non-plastic conditions and 51%, the clay percentage is between 7% and 35% and the Linear Shrinkage between 0% and 10%. These results indicate soils with low to medium potential expansiveness (Table 1 and Appendix 2).

Residual soils

Representative disturbed soil samples were retrieved from the residual and reworked residual soils and the Plasticity Index (PIwhole) of these samples ranges between slightly plastic conditions and 17% with the Liquid Limit (LL) between slightly plastic conditions and 52%, the clay percentage is between 10% and 49% and the Linear Shrinkage between 0.5% and 11%. These results indicate soils with low to medium potential expansiveness (Table 1 and Appendix 2).

10. EVALUATION OF GEOTECHNICAL PROPERTIES

One of the objectives of conducting geotechnical site investigations is to characterise the site into site classes so as to give guidance on appropriate foundation loading and appropriate pipe bedding material to be used. The process also seeks to establish the suitability of the *in situ* material as aggregates for road and pavement building. The site classification characterises the ground condition according to classes based on the severity of the anticipated differential movement. The site classifications in this instance are adopted from the NHBRC Home Building Manuals, SANS guidelines, SAICE code of practice and SAIEG's guidelines for urban engineering investigations site classification units. These site classification parameters are adopted in order to obtain a basis for sub-dividing the site into various site classes and for the purposes of appropriate foundation recommendations across the site.

The report focuses on the geotechnical site investigation aimed at determining various geotechnical properties of the near surface soil horizons with the aim of classifying the area into different site soil classes. The site classification system is discussed in the NHBRC Home Building Manuals, Code Of Practice for Foundations and Superstructures for single storey Residential Buildings of Masonry Construction compiled by the Joint Structural Division of the SAICE and the IstructE (COP) and SAICE's Guidelines for Urban Engineering Geological Investigations. The SANS recommendations were also used for the process of classifying the site. For the purposes of the existing structures the foundation recommendations are aligned with the single storey structures with standard masonry construction.

Geotechnical properties relevant to the development that were evaluated include:

- **Active soil** – Fine grained soils (generally with high clay content) that changes in volume in response to the change in moisture content. These soils may increase in volume (heave/swell) upon wetting and decrease in volume (shrink) upon drying out.

- **Collapsing settlement** – soils that exhibit sudden settlement under load when the soil is wetted.

- **Inundation** – areas that may be prone to flooding. These areas may occur near drainage channels such as rivers, streams, marshy areas, etc.

- **Consolidation settlement** – the vertical settlement or decrease in soil volume that occurs in a soil under applied static load owing to the slow time-related reduction in volume of the voids.

- **Compressible soils** – A soil whose bulk volume may gradually decrease with time when subjected to an applied load.

- **Excavatability** – areas where difficulty in excavation for either foundations or civil servicing may be experienced.

- **Groundwater table** – areas where a shallow groundwater table may be encountered.

- **Slope instability** – areas that may be susceptible to slope failures.

- **Problem soils** – areas that may occur in marshy zones, deep unconsolidated fills, and/or areas that may be underlain by dolomite related instabilities, etc.

Table 3 below gives the basis of the soil site classification that was applied during the investigation. The table was adapted according to the site classification system detailed in the NHBRC Home Building Manual, GFSH-2 document, SAIEG guidelines and the Code of Practice (COP) by the Joint Structural Division SAICE and IStructE. The designation for the excavatability class was further subdivided in this document to allow for various levels of difficulty in excavation.

Table 3: Residential site class designation (adopted from the NHBRC Home Building Manual and the COP)

GEOTECHNICAL CATEGORY AND SITE CLASS DESIGNATION	**GEOTECHNICAL CHARACTERISTICS**
Active soils (heave/shrink) - (H) H H1 H2 H3	Expected range of total movement at surface: < 5 mm 5 – 15 mm 15 – 30 mm > 30mm
Collapsible Soils – (C) C C1 C2	Expected range of total movement at surface: < 5 mm 5 – 10 mm > 10 mm
Compressible soils (S) S S1 S2	Expected range of total movement at surface: < 5 mm 5 – 15 mm > 15 mm

GEOTECHNICAL CATEGORY AND SITE CLASS DESIGNATION	GEOTECHNICAL CHARACTERISTICS
Excavation – (R) r1 r2 r3	 sub outcrop scattered outcrop and sub-outcrop outcrop, scattered outcrop and sub-outcrop
P – Problem soils	Dolomitic Areas, marshy areas, contaminated areas, abandoned borrow areas, land fill, mining subsidence and mine waste fill, shallow undermined areas, exploration pits or adits.
Inundation and seepage – (W)	Wet area, drainage line, seepage zone

Based on terrain types the GFSH-2 documents and the SAIEG guidelines subdivide areas that are earmarked for development according Geotechnical Sub-Areas. These Geotechnical Sub-Areas give an indication of the development potential of the site with regards to various geotechnical, geological and geomorphological constraints. The GFSH-2 and SAIEG documents have identified three main Geotechnical Sub-Areas that are simplified in Table 4 below. These classifications appear with the site soil classifications as prefixes.

Table 4: Geotechnical Classification for Urban Development (adopted from the GFSH-2 and SAIEG)

Geotechnical Sub-Area	Definition
1	Areas recommended or favourable for development
2	Areas where development can be considered with certain precautionary measures.
3	Areas that are not recommended for development

10.1. Active soils

Active/expansive soils – soils that change in volume by expanding or shrinking as a result of change in moisture content and are denoted as expansive soils **(H)** according to the SAICE/SAIGE site classes. The expansive soils can be classified as H, H1, H2 or H3 according to the severity of the predicted/anticipated volume change. The prediction of volume change was conducted using Van der Merwe's. This method gives swell differences between dry state and full saturation.

The site is underlain by transported soils (colluvial soils) and pedogenic soils derived mainly from transported and residual granite soils. The soil profiling conducted during the

investigations indicates that parts of the site is underlain by cohesive soil that exhibit a slickensided structure, which indicates that the major part of the site will exhibit medium to high expansive potential. Aeolian soils were not encountered across the site. Colluvial soils horizons exhibiting low potential expansive conditions were also encountered across the site. Residual soils were encountered in some of the excavated test pits and they also exhibit low heaving conditions. Reworked and pedogenic soils also exhibit low expansive conditions.

Foundation indicator tests i.e. grading analysis as well as the Atterberg limits were performed on the soil samples retrieved from the transported soil horizons, reworked and pedegenic soils, and the residual soils. The results of the tests (discussed in Section 9.3) showed that the transported soils, residual soils and the pedogenic soils generally will exhibit a low expansive potential, Table 1 and Appendix 2. The prominent soil site class of the area will therefore H to H3 according to the SAICE and NHBRC site classification system, Drawing ZM014/2.

10.2. Collapsing soils

Collapse and/or consolidation settlement soils denoted as C are soils that have a potential for collapse and are commonly open-textured with a high void ratio (Brink, 1985). These soils may include ‘loose’ to ‘medium dense’ colluvium material, aeolian sands as well as residual soils that are derived from granite.

The geological map indicates that the investigated area is generally underlain by quaternary deposits comprising mainly colluvial soils. These soils are generally not characterised by an open-textured/voided structure and they generally do not exhibit a potentially collapsible soil fabric therefore the site may be considered as not possessing a potentially collapsible soil fabric. Aeolian soils were not encountered across the site during the fieldwork process. Residual granite soils were encountered in some of the excavated test pits. These soils may exhibit minor collapsing conditions. Undisturbed samples could not be retrieved for collapse potential testing due to the crumbly nature of the soils across the site. From the site observations it is therefore anticipated that the site will exhibit a low potential collapsible fabric; C(C1) according to SAICE and NHBRC soil site classification system.

10.3. Compressible soils

Compressible soils – Typically fine grained soils such as clay, clayey sand and clayey silt with low plasticity. Gravelly and sandy soil are commonly compressible soils, which classify as site class **S** soil. According to the severity of subsurface conditions the NHBRC site class may be designated as S, S1 or S2.

The site is generally underlain by non-cohesive soils with low plasticity values. Uncontrolled fill was not encountered in all the excavated test pits. It is anticipated that soil conditions that may exhibit potentially low to medium compressible characteristics may occur across the site. From the site observations it is anticipated that the site will exhibit a low potential compressible fabric with some areas exhibiting medium settlement conditions; S(S1) according to the SAICE and NHBRC soil site classification system, Drawing ZM014/2

10.4. Excavatability

Excavatability of the ground relates to the degree of difficulty at which the ground can be excavated, to a depth of 1.5 m, for foundations as well as for services. Areas of poor/hard excavatability are characterised by outcrop, near-surface bedrock, hardpan pedocretes, etc. Although these areas present favourable founding conditions they also present a high cost factor with regard to services installation.

The average depth of the test pits in the investigated area ranges from approximately 0.4 m to greater than 3.0 m. Most of the test pits encountered difficult excavation, near refusal and refusal on dense hardpan ferruginised soils. Scattered outcrops, sub-outcrops and shallow bedrock were not encountered across the site. It is anticipated that excavatability problems may be encountered across the site on the hardpan ferricrete during civil servicing, generally below 0.9 m, however foundation excavations are not anticipated to encounter major excavatability problems (Drawing ZM014/2).

Allowance of local “difficult excavation”, “boulder class” and “intermediate class” excavation in term of the SANS excavation specifications should however be made.

10.5. Groundwater table

A shallow/perched groundwater table normally presents a problem of rising damp on engineering structures therefore appropriate remedial measures such as damp proofing need to be implemented in areas where a shallow/ perched water table is anticipated. The presence of various forms of pedogenic soils (friable, scattered, uncemented nodular ferricrete/calcrete and signs of ferruginisation/calcarisation) is an indication of a fluctuating or seasonally perched water table conditions caused by retarded vertical infiltration and percolation rates.

Groundwater seepage was not encountered in all of the excavated trial pits however various forms of ferruginisation as well as signs of seepage were observed in most of the test pits. The site is underlain mainly by colluvial soils overlying pedogenic soils, residual granite soils and a well-developed ferricrete horizon. The pedogenic and ferricrete horizons are characterised by very poor internal drainage. The investigated site is generally characterised by a gentle slope toward the north-west. It is anticipated that the major part of the site will be characterized by a low to moderate flow of storm water however vertical flow may be retarded due to the occurrence of the ferricrete horizons. It is therefore imperative that mitigating measures such as damp proofing, extensive storm water management and subsurface drainage should be considered.

10.6. Slope instability

The site is currently not developed however an extensively developed residential area/township and commercial developments with an extensive civil infrastructure such as water pipes, electricity and sewage system lies adjacent and to the south of the investigated site. The site lies in an area with a relatively minor slope toward the north-west with a gradient generally at less than 6%. There are no major man-made slopes on the site and it surrounds therefore related slope stability problems are not anticipated.

10.7. Inundation

Seepage may be anticipated to daylight or occur at shallow depth near the drainage lines. Floodlines must be determined by the relevant Competent Person. All drainage boundaries near wet areas or drainage lines must also be confirmed by the relevant Competent Person.

There were no major rivers or streams that traverse the site however Skoonspruit striking in the north-south direction lies to the east of the site. Elandskuil Dam lies approximately 1.2 km to the southwest of the site. It is recommended that a Competent Person floodline specialist be engaged for advice on 1 in 50 years and 1 in 100 year floodlines.

The site in generally has a gentle slope however surface ponding is anticipated to occur during heavy rains in some portions of the site.

10.8. Subsidence

There is no past or current undermining activity beneath the site; therefore, the potential for mining subsidence is not foreseen. Areas of fill such as dumping of ash or refuse and peat deposits per se, normally give rise to loosely compacted materials and the potential for uneven settlement. Such areas of dump/fill material were not encountered on this site. Minor uncontrolled fill and surface dumping was encountered across area and in some of the excavated test pits. The site may have borrow areas that were backfilled and covered with vegetation and therefore not identified during these investigations. If such areas of fill are encountered during services installation or foundation/roads excavation, the Competent Person must be consulted in order that appropriate remedial measures may be recommended and implemented at that stage. All rubble and dump material must be removed prior to construction of houses, roads, pavements or any new structures.

10.9 Problem soils

Problem soils such as dolomite and/or marshy areas were not encountered across the site.

11. RECOMMENDATIONS

11.1. Provisional site classification

The geotechnical investigations indicate that the site is underlain by relatively variable material comprising mainly silty and sandy gavel, gravelly sands and sandy and clayey silts. These soils are generally characterised by medium bearing capacities with a low expansive potential. Slickensiding was not encountered across the site. The foundation indicator test

results indicate that the transported material, residual soils and the pedogenic soils that underlie the site are characterised by low plasticity values and therefore will exhibit low potential expansiveness. Shallow excavatible areas characterised by outcrops, sub-outcrops and shallow bedrock were not encountered across the site, however shallow hardpan ferricrete is prevalent across the site. It is therefore anticipated that major shallow excavatible conditions may be experienced during the excavation for services in some portions of the site, Drawing ZM014/2.

From the above discussion the site is classified into two soil sub-area namely **2/r/H-H1/C/S1 and 2r2/H1-H3/C/S** Drawing ZM014/2.

The development potential has been broadly classified in terms of one Geotechnical Sub-Areas based on field observations/investigation – geological, hydrogeological, and geomorphological - and laboratory soil testing of soil samples.

11.2. Foundations recommendations

The site is underlain by relatively variable material comprising mainly sandy clayey silts and sandy silty clays. Localised areas of the site are anticipated to be underlain by soils that may exhibit low bearing pressures with low plasticity. These soils may be prone to settlement under structural load. The foundation indicator test results indicate that the transported material, residual soils and the pedogenic soils that underlie the site are characterised by low to high plasticity values and therefore will exhibit low to high potential expansiveness. It is also anticipated that the site is underlain by soils that may exhibit a low potentially compressible fabric.

The foundation recommendations that are tabulated below are listed in order of preference with regards to functionality and cost effectiveness. The competent person design engineer will select foundation type based on the structural loads, the structural design and the type of structure. It is also recommended to consider the following:

2r2/H1-H3/C/S

Sub-Area	**Construction Type**	**SAICE Selected foundation recommendation and Building procedures**
2r2/H1-H3/C/S	Stiffened or cellular raft.	• Raft with articulated lightly reinforced masonry top structure. • Site drainage and plumbing/service precautions. • Bearing capacity not to exceed 100 kPa.
	Strip footings on soil mattress	• Excavate and remove all the expansive material to competent layer and beyond the footprint. Replace with G7 material or better and compact in layers of 150 mm to between 93% and 95 % MOD AASHTO at –1 to +2 optimum moisture content, based on the competent person design engineer's specifications

2/r/H-H1/C/S1

Sub-Area	Construction Type	SAICE Selected foundation recommendation and Building procedures
2/r/H-H1/C/S1	Reinforced strip footings	• Remove *in situ* material below the foundation and 1.5 m beyond to a depth of 1.5 times the foundation width or to a competent horizon. Replace with G7 material compacted to 93% MOD AASHTO in 150 mm layers at 1% to +2% optimum moisture content.
	Soil raft, Stiffened or cellular raft.	• Soil/Stiffened cellular raft with articulated lightly reinforced masonry top structure. • Site drainage and plumbing/service precautions. • Bearing capacity not to exceed 50 kPa.

11.3. Precautionary measures

Precautionary measures for the in the area must include:

- Extensive site drainage and plumbing/service precautions.
- Extensive stormwater management. It is recommended that efficient drainage of stormwater channels, draining into the municipal stormwater system, must be considered.
- Extensive damp proofing angainst shallow flactuating groundwater table.
- A 1.5 m apron slab around the structures.
- The site must be graded to prevent ponding of storm water,
- Walkways and drive ways must be paved to allow easy access to the property during wet seasons.
- Planting of grass/lawn around the area must be considered.

12. CONCLUSIONS

The purpose of this report is to provide a general overview of the prevailing geotechnical conditions on the site, to guide decision-making with regards to the proposed township establishment including foundation and structural designs. The classifications were based on desk study information and fieldwork.

- A wide range of geotechnical conditions were evaluated in order to characterise the site into prevailing geotechnical zones.
- Site investigations and laboratory test results indicated that the site is underlain mainly by colluvial, alluvial and residual soils characterised by a low active conditions.

- A poorly developed to well-developed pedogenic horizon is characteristic of the area. Shallow groundwater seepage was not encountered in all the excavated test pits. Signs seepage and shallow pedigenic soils were encountered across the site. Good site drainage and damp proofing in foundations must be implemented across the site.

- Outcrops and sub-outcrops were not encountered in the area however shallow hardpan ferricete do occur extensively across the site; therefore excavatability problems are anticipated.

- The geotechnical zonation show that the site is developable albeit with precautions and/or remedial measures.

- Backfill/dumping areas were not encountered on site. Local areas of such material may be present between the points of investigation.

- Imported engineered soil will be required for road building and construction of pavements.

- The investigated site is characterised by a minor slope however flat areas do occur across the site. Shallow well developed pedogenic soils were encountered across the site which may lead to poor stormwater drainage. The site must be shaped to improve stormwater runoff and extensive stormwater management must be considered.

- The recommended foundation designs for the prevailing conditions across the major part of the site include lightly reinforced strip footings.

ZwaMavu Consult
Engineers and Developers

Plot 178 Boundary Road,
Mnandi AH, Ext. 1,
Centurion, 0157
Tel: 011 5160037, Fax: 086 691 8866
Email: humbulani@zwamavu.co.za

Figures and Drawings

Appendix 1:

Soil profiles

Appendix 2:

Laboratory test results