AFRICA EXPOSED
CONSULTING ENGINEERING GEOLOGISTS CC

Erf 117 Lelamo Estate
Kromdraai Road
Kromdraai
Mogale City
P.O. Box 68
Honeydew
2040
Fax (086) 633-7332
Phone: (083) 658-0900
Cell: (083) 230-1300
E mail: ian@africaexposed.co.za

# ENGINEERING GEOLOGICAL INVESTIGATION OF HOLDING 369, NORTH RIDING AGRICULTURAL HOLDINGS, RANDBURG.

**Prepared for: Schalk Botes Town and Regional Planners**

*Report No. 11408*
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Member: J.K.A.ARKERT Pr.Sci.Nat BSc (Hons) Eng. Geol. MSAIEG
CK No. 1998/009563/23

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## 1. INTRODUCTION

### 1.1 Preamble

On 2nd September 2008, Mr. Schalk Botes, of Schalk Botes Town and Regional Planners invited Africa Exposed Consulting Engineering Geologists to submit a proposal for the completion of an engineering geological investigation on Holding 369, North Riding Agricultural Holdings in the Randburg.

Subsequently an email was received on 2nd October 2008, confirming Africa Exposed's appointment to complete the investigation.

### 1.2 Database

The following information was supplied to Africa Exposed;

- an untitled cadastral plan, showing the location of the site.
- The site is approximately 3.2ha in extent.
- The site is to be rezoned for residential purposes.

### 1.3 Objectives

The objectives of the investigation were:

- to identify the soil and rock conditions below the site to a depth of 3.0m or refusal.
- to recommend suitable foundation systems, and founding depths for the proposed structures.
- to comment on any perceived geotechnical problems which may affect either the design or construction of the project.
- to classify the site in terms of the National Home Builders Registration Council (NHBRC) of 1999.

# 2. FACTUAL REPORT

## 2.1 Programme of Work

### 2.1.1 *Literary Review*

A literary review was conducted in order to obtain data from previous investigations carried out in the area. The 1: 250 000 geological map, No 2626 West Rand was consulted to determine the regional geology in the vicinity of the site.

A geological map of the Johannesburg-Pretoria Dome , published by C.R. Annhaeusser (1971), together with the accompanying paper "The Geology and Geochemistry of the Archaean Granites and Gneisses of the Johannesburg-Pretoria Dome was used to identify the geological structures present in the immediate vicinity of the site.

### 2.1.2 *Field Work*

On 7th October 2008, six test pits were excavated by hand at positions that were determined on site. The layout of the test pits are shown on the Site Plan in Appendix 1. Each hole was profiled by an engineering geologist according to the Jennings, Brink and Williams system, sampled as necessary and backfilled. The detailed profile logs are shown in Appendix 2.

### 2.1.3 *Office and Laboratory Work*

From the soil samples recovered, three were selected for Foundation Indicator Tests, and two undisturbed samples were recovered to determine the Collapse Potential of the underlying soils.

Both the individual test results and a summary thereof are included in Appendix 3 of this report.

## 2.2 Site Description

The site, which covers an area of some 3.2ha, is situated on the southeastern side of Boundary Road in North Riding, Randburg. The stand investigated is currently bound by Boundary Road to the northwest, while the remaining boundaries of the property are defined by existing agricultural small holdings.

The site slopes down to the southeast at a gradient of 2% to 4% and is currently partially developed with a residential dwelling and associated outbuilding located in the northwestern corner of the site.

The vegetation on the property is characterised by natural veld grasses.

## 2.3 Site Geology

From the available literature as well as the observations during the site investigation, it is evident that the site is underlain by granitic rocks of the Basement Complex, as exposed in

the Johannesburg-Pretoria Dome. Typically these Archaean intrusive igneous rocks are cross cut by diabase dykes of various ages, and may contain a prominent structural fabric. As a result of deep and extensive chemical weathering, the rockmass has been reduced to residual sandy soils which often preserve the original mineral fabric.

By experience it is known that the depth of weathering in these granitic rocks is highly variable, with the possibility of corestone remnants. Patches of highly collapsable and kaolinised residual soils are common, particularly in the elevated areas above 1 600 mamsl.

2.4 Hydrology

The average annual rainfall in this area is approximately 750 mm, most of which occurs as heavy, isolated thunder showers between October and March. Stormwater runoff from the site is primarily in the form of sheetwash, towards the southeast and no shallow depressions or other drainage features were noticed on the site that will concentrate run off.

No groundwater seepage was noted in any of the test pits, and no zones of potential seasonal inundation were recorded in the soil profiles exposed.

2.5 Observations

The detailed description of the soils which blanket the site are summarised below.

2.5.1 ***Transported Soils***

The entire site is covered by a thin layer, on average 0.6m thick, of silty sand, of hillwash origin. The soil is generally of loose consistency, and is rich in organic matter.

2.5.2 ***Pebble Marker***

The pebble marker is a horizon consisting of angular quartz gravels, in a matrix of greyish brown sand, which demarcates the base of the transported soils. The consistency of the horizon is loose to medium dense and is on average 0.2 m thick.

2.5.3 ***Residual Granite***

The residual granite soil which originates from the in-situ weathering of the granite parent rock underlies the entire site. The soil is of medium dense to dense consistency, and shows the typical relict joints often seen in granitic soils. The material is a silty coarse sand, often with scattered angular quartz gravels.

2.5.4 ***Granite Bedrock***

Two test pits met with refusal on highly weathered soft rock granite. It was also noted that isolated outcrops of moderately weathered medium hard to hard rock granite occur on the southern side of the site.

## 2.6 Laboratory and Field Test Results

### 2.6.1 *Indicator testing*

For more accurate identification and classification purposes, Particle Size Distribution and Atterberg Limits Tests were carried out on representative samples of the various soil horizons present within the area. The results are shown in Appendix 3 of this report and are summarised in Table 1 below.

The results indicate that in general the soils in the area are of low plasticity and the potential expansiveness is therefore low. These soils are therefore non heaving.

TABLE 1 Indicator test results

| TP No. | Depth (m) | Material | Sand (%) | Silt (%) | Clay (%) | PI (%) | USCS Class | Activity |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.3-1.5 | Silty gravelly sand. Residual Granite | 7 | 4 | 1.06 | 11.4 | G6 | Low |
| 3 | 0.6-0.7 | Silty fine sand. Hillwash | 12 | 7 | 0.84 | 9.3 | G7 | Low |
| 4 | 1.0-1.2 | Silty coarse sand. Residual Granite | 10 | 5 | 0.89 | 11.9 | G7 | Low |

### 2.4.2 *Collapse Potential Testing*

In order to establish the collapse potential of the overlying hillwash which blankets the site, one Collapse Potential Test was carried out on a representative block sample of the soil. The sample was placed under load in an oedometer, and soaked at an applied load of 200 kPa.

The results are summarised in table 2 below, and show that the transported hillwash and the residual granite is potentially collapsable, with the degree of severity ranging from 3.1% to 4.2%. According to Jennings and Knight (1975), this represents "Moderate trouble".

TABLE 2 Collapse Potential Test

| TP No. | Depth | Material | Dry Density (kg/m³) | Moisture Content % | Collapse Potential % |
|---|---|---|---|---|---|
| 1 | 1.3-1.5 | Silty coarse sand. Residual Granite | 1467 | 10.9 | 3.1 |
| 4 | 1.0-1.2 | Silty coarse sand. Residual Granite | 1494 | 12.2 | 4.2 |

# 3. INTERPRETIVE REPORT

## 3.1 Discussion of Results

The Collapse Potential test and the Consolidation test results completed on the residual granite indicated that these soils are collapsible and marginally compressible. The magnitudes of the anticipated settlements are shown in table 3 below. These values have been calculated by assuming that 700mm wide strip footings will be placed at an average depth of 0.8m below natural ground surface and the foundations would apply a bearing pressure of 100kPa.

**TABLE 3: Calculated Total Settlements**

| Position | Collapse Settlement (mm) | Consolidation Settlement (mm) | Total Settlement (mm) |
|---|---|---|---|
| TP 1 | 25 to 30 | 15 to 20 | 40 to 50 |
| TP 2 | 0 | 5 to 10 | 5 to 10 |
| TP 3 | 0 | 5 to 10 | 5 to 10 |
| TP 4 | 25 to 30 | 15 to 20 | 40 to 50 |
| TP 5 | 20 to 25 | 15 to 20 | 35 to 45 |
| TP 6 | 0 | 5 to10 | 5 to10 |

## 3.2 Classification of Site.

In order to classify the geotechnical characteristics of the underlying soils, the geotechnical classification method proposed in the National Home Builders Registration Council (NHBRC) of 1999 has been applied to this site. Table 4 shown below indicates the various geotechnical characteristics and the criteria used to evaluate the soils.

**TABLE 4: Residential Site Class Designations**

| Typical Founding Material | Character of Founding Material | Typical Range of Soil Movement (mm) | Assumed Differential Movement (% of Total Movement) | Site Class |
|---|---|---|---|---|
| Fine grained soils (clayey silts and clayey sands of low plasticity), sands, sandy and gravelly soils | COMPRESSIBLE SOIL | <10<br>10-20<br>>20 | 50%<br>50%<br>50% | S<br>S1<br>S2 |
| Silty sands, sands, sandy and gravelly soils | COMPRESSIBLE AND POTENTIALLY COLLAPSIBLE SOILS | <5,0<br>5,0-10<br>>10 | 75%<br>75%<br>75% | C<br>C1<br>C2 |

In terms of the National Home Builders Registration Council (NHBRC) of 1999 site classification system, the site has been classified as shown below.

**C2** >10mm consolidation and collapse settlement anticipated.
**S** <10mm consolidation settlement anticipated

3.3 Design Solutions

3.3.1 ***Structures***

3.3.1.1 *Site Classification C2.*
(>10mm consolidation and collapse settlement anticipated)

Portion of the northern side of the site have been classified a **C2** site and the potential founding solutions for all units to be constructed within this zone are presented below.

I. *Stiffened Strip Footings.*
It is recommended that the external and internal walls of the units are founded on reinforced strip footings placed at an average depth of 0.8m below current ground level. The foundations must be reinforced and construction may proceed with brick force included between each course in the plinth wall for a minimum of 6 courses. Articulation joints must be included at all external and internal doors and openings.

Particular attention must be placed on drainage precautions as well as ensuring the competence of all water bearing services.

For the surface bed preparation, the in-situ soils must be removed to a depth of 450mm, and replaced in 150mm thick layers with inert material, compacted to a minimum density of 93% of Mod AASHTO at -1 to +2% OMC.

The maximum allowable bearing pressures must not exceed 80kPa.

II. *Soil raft.*
Remove in situ materials to 1.0m beyond perimeter of building (ie. the foot print of the structure) to a depth of 1.5 times the widest foundation, measured from the underside of the footings. Replace with the excavated material in compacted 150mm thick layers to 93% Mod AASHTO density at -1% to +2% of OMC. Bearing capacity of the soil raft will be in the order of 100kPa. Foundations must be placed at a depth of 600mm below the top of the mattress and normal construction may proceed with brick force included between each course in the plinth wall for a minimum of 6 courses. The surface bed may be constructed directly on the soil raft.

III. *Compaction of soils below individual footing.*
Remove the in-situ soils below the foundations (both internal and external walls) to a depth of 1.5 times the foundation width or to a competent horizon. Replace with the excavated material compacted to 93% Mod AASHTO density at -1% to +2% of optimum moisture content, in layers not exceeding 150mm thick. Particular attention must be paid to the compaction at the edges of the trenches and at corners. Nominally reinforced foundations must be placed at a depth of 600mm below the top of the mattress and construction may proceed with brick force included between each course in the plinth wall for a minimum of 6 courses. The maximum allowable bearing pressures must not exceed 100kPa.

For the surface bed the in-situ soils must be removed to a depth of 450mm, and replaced in 150mm thick layers with the same excavated material, compacted to a minimum density of 93% of Mod AASHTO at -1 to +2% OMC.

iv. *Concrete raft.*
A concrete raft designed by a competent structural engineer to tolerate the anticipated settlement.

Due to the risk of collapse settlement occurring in the natural soils it is imperative that good site drainage is provided around individual structures, and excess moisture should not be allowed to accumulate adjacent to foundations.

3.3.1.2 *Site Classification S*
(<10mm consolidation settlement anticipated)

A portion of the site along the southern side has been classified as an **S** site and is characterised by a thin surface horizon of transported soils which is underlain by residual granite or bedrock within 1.0m of the surface.

Negligible consolidation settlement is anticipated under assumed applied pressures of less than 100kPa and total settlements of less than 10mm have been determined, using the assumptions presented in section 3.1.

It is recommended that structures built within this zone should be founded using normal strip footings placed on dense to very dense residual granite or very soft rock granite at an average depth of 0.6m. The maximum allowable bearing capacity of the residual granite is 150kPa, and on the granite bedrock bearing pressures must not exceed 300kPa.

It must be stressed that the foundations must be placed on uniform materials and should be founded completely on bedrock or completely on residual soils. Should the footings straddle rock and soil, it is strongly recommended that the entire structure is placed on soil mattress in order to prevent differential settlement occurring. The rock should be removed to a minimum depth of 1.0m below the proposed founding level. A suitable G7 to G8 quality fill material should be placed in layers of 150mm, compacted to 93% Mod AASHTO at -1% to +2% OMC. The final two layers below the foundations should be compacted to 95% Mod AASHTO. The structures may be placed on conventional strip footings, applying a maximum load of 100kPa.

3.3.2 ***Roads and Terraces***

The results of the indicator tests have been used to classify the in-situ soils to determine the suitability of this material for the construction of terraces and pavement layers. The soil classification varies fro G6 to G7 material and may therefore be used in the construction of the terraces and as in-situ sub-grade. Suitable materials for use in the sub-base and base course layers must be imported from a commercial source.

3.3.3 ***Excavation Classification***

In the zones marked as **C2,** it is expected that the excavation class will be "soft" according to SABS 1200 D: Earthworks, up to a depth of 1.5m. It is anticipated that the excavation will be "soft with some intermediate" in the zones shown as **S.** It must also be expected that some "hard" excavation will be encountered throughout the site, this will obviously be applicable in the areas of the site where bedrock is exposed at the surface.

3.3.4 ***Stormwater Management***

It is good practice to implement sound stormwater management around each building and it is therefore suggested that the precautions presented below are considered to limit the amount of moisture reaching the foundation and thereby reducing the risk of settlement occurring.

i. All water bearing services must be provided with flexible couplings where pipes enter the buildings.

ii. A 1200mm wide apron paving must be provided around the perimeter of the structures. Joints between the paved areas and the walls of the buildings should be sealed with a flexible sealant to prevent moisture reaching the foundations.

iii. Storm water management around the structures must facilitate the efficient disposal of excess water from the site.

iv. No flower beds, garden taps, trees or down pipe discharge must be allowed adjacent to the structures, and must be placed as far away as possible.

3.4 General

3.4.1 ***Insecticides***

Some termite activity was recorded in a number of the test pits on the site and it is therefore recommended that a recognised, environmentally acceptable pesticide/insecticide be used to combat the threat of ants/termites and rodents to the integrity of the foundations.

3.4.3 ***Buried services***

Due to the potentially mildly acidic groundwater environment, non-ferrous or plastic pipes are recommended.

3.5 Construction Problems

It must be anticipated that corestones and boulders may be encountered in the excavations. Areas of shallow bedrock immediately beneath the surface may be exposed, and limited blasting may be required for service trenches.

3.6 Additional Investigations

This investigation was completed for the purposes of township proclamation, and whilst the site has been zoned and generalised foundation recommendations have been presented for typical residential structures, the results contained in this report should not be used for site specific foundation design purposes. Additional detailed geotechnical investigations would be required for structures other than single and double storey residential units.

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