A DESK TOP STUDY ON THE AVAILABLE GEOTECHNICAL INFORMATION ON PORTION 1 OF THE FARM GROOTPOORT 168 NEAR VAN DER KLOOF, FREE STATE PROVINCE

2015/J192/EEC

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1 INTRODUCTION

1.1 Appointment

Soilkraft was appointed by an e-mail dated 22 September 2015 originating from Ms M Griessel of Environamics Environmental Consultants to undertake a desk top study of the available geotechnical information of the area of the farm Grootpoort 168 near Van Der Kloof in the Free State province. The purpose of such study is to provide background geotechnical information for the compilation of an environmental impact report for the construction of a solar farm.

1.2 Scope of the Report

The report serves as a general overview of the geotechnical conditions and factors influencing such conditions in the area of the farm Grootpoort 168 only. The report was compiled by studying available information obtained from standard reference works, maps and satellite imagery. A site visit was not conducted. The information provided cannot be regarded as suitable for design purposes.

2 SITE LOCALITY

Portion 1 of the farm Grootpoort 168 is located in the triangle formed by the towns of Luckhoff

to the northeast, Petrusville to the south and Orania to the east. It is situated some 8,7 kilometers to the north of the Orange River which forms the provincial boundary between the Northern Cape to the south, and the Free State to the north. Access to the site is directly from provincial road R48. From the available information the site appears to be approximately 135 hectare in area.

Refer to the attached Figure 1 : Locality Plan.

3 DISCUSSION

3.1 Landscape and Surface Drainage

The landscape of Portion 1 of the farm Grootpoort 168 is flat and open with a low hill along the western perimeter of the site. It is located between 1236mamsl and 1184mamsl. Slope across the land is from the west towards the northeast and southeast between 3,5% and 4,0%. There are no defined water courses on site. Drainage takes place by surface sheetwash and infiltration. Sheetwash ends up in a non-perennial stream located to the east of the site. This stream feeds into the Orange River located to the south of the site.

3.2 Vegetation and Climate

Mucina[Reference 6.1] describes the landscape as consisting of shrubland dominated by dwarf karoo shrubs, grasses and Acacia mellifera. Some other low growing trees also occur on sandy soils. Rainfall peaks in March and averages between 190mm and 400mm. The mean annual temperatures for De Aar are 39,0°C in January and -4,8°C in July. The Thornthwaite's moisture index is less than 40 and the Weinert N-value approximately 10. The importance of this statement is that mechanical breakdown of rock material will take place, rather than chemical weathering thereof, limiting the formation of active clays and vertical extent of the soil profile, even if the suitable parent material is available.

3.3 Geology

The area of investigation is located on sediments belonging to the Tierberg Formation, Ecca Group, Karoo Supergroup[Reference 6.2] and was deposited during the Paleozoic era. The Tierberg Formation is an argillaceous succession comprising almost entirely of dark blue-grey, laminated shale, rhythmically bedded shale and siltstone with a few thin layers of dark grey sandstone. Lenticular bodies of carbonate-rich rocks and nodules of limestone displaying cone-in-cone structures are commonly encountered. Fish scales and sponge structures may be present in the carbonate-rich material.

Figure 1 : Locality Plan (A3)

Much later in the geological history during the Jurassic period the Karoo sediments were intruded by dolerite in the forms of dykes and sills. Dolerite is regarded as a basic, intrusive, hypabyssal, igneous rock. The mineral assemblage is characterised by the presence of plagioclase and pyroxene, but other minerals could have been assimilated from the surrounding rock during intrusion. In an unweathered condition dolerite is present as blue grey to green grey, fine grained, very hard rock. UCS values exceeding 300MPa have been recorded on cores of unweathered dolerite. The properties of the dolerite may thus differ completely from the sedimentary rock into which it is intrusive, but zones of metamorphosis are present in the contact aureoles of the intrusions.

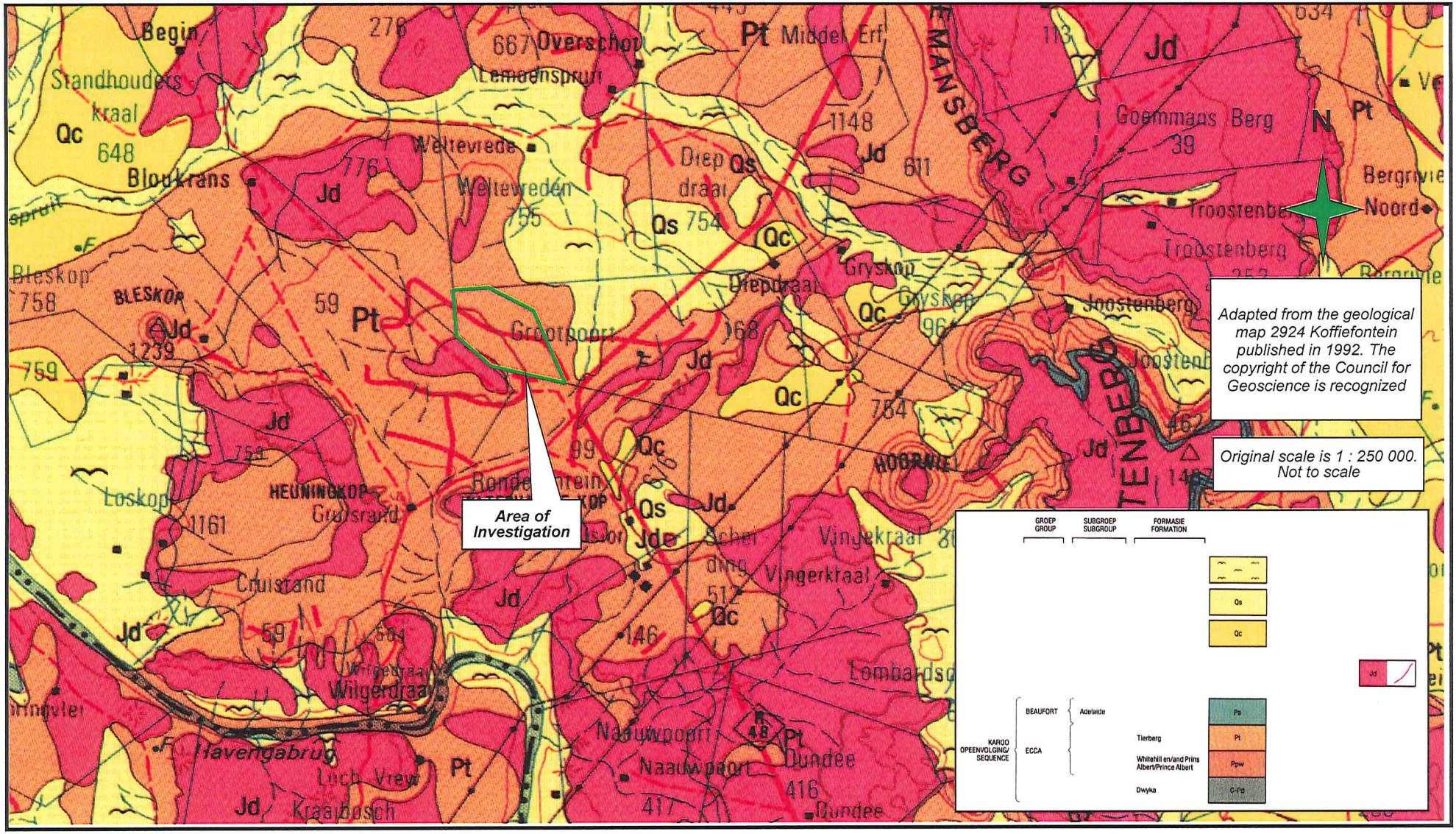
Studying the geology map and satellite imagery of the area, the presence of both types of intrusions were identified as follows :

- *Sill Intrusion* : The capping of the koppie present along the southwestern boundary of the site is formed by a sill intrusion. Sills usually intruded in the horizontally - or close horizontal – orientated discontinuities in the rock mass of the surrounding sedimentary rock. The dolerite is more resistant to weathering than the surrounding sedimentary rock and often occurs as flat cappings overlying the sedimentary rock.
- *Dyke Intrusions* : A dyke intrusion bisects the site roughly in an east to west direction through the Tierberg sediments. Dykes are usually of limited width, most often less than 10 meters. Dykes intruded across the discontinuities in the surrounding rock mass. Subsequently they are generally orientated close to vertical in the given geological scenario...

The regional geology of the area is indicated on Figure 2 : Regional Geology. On the figure the Tierberg Formation is indicated in orange and referenced as "Pt" ; while the dolerite is indicated in red and referenced as "Jd".

3.4 Soil Profiles

Brink[Reference 6.3] describes the soil profile in the area to consist of arenosols. Due to climatic conditions weathering of bedrock is limited and hence the soil profile is of limited depth. The parent material of these arenosols is the reddish aeolian sands of the Gordonia Formation, Kalahari Group. The modulus of compressibility in the saturated state is greater than at natural moisture content, therefore the soil matrix can be regarded as collapsible. The angle of internal friction is between 32° and 38°. Differential settlement on these soils is critical for shallow foundations. The density of the sand usually increases with depth and some sandy subsoils may be very dense.



SOIL KRAFT

REGIONAL GEOLOGY

FIGURE 2

3.5 Groundwater

- *Perched Water* : Considering the slope across the land, the absence of well-developed drainage features and the climatic conditions, it is most unlikely that seasonal perched water will be present on site. Any perched water that may occur, will be present only for short periods after events of precipitation.
- *Permanent Water* : Vegter[Reference 6.4] indicates the probability for drilling successfully for water in the area to be between 20% and 30%, and the probability that such a borehole will yield more than $2ls^{-1}$ to be between 40% and 60%. Groundwater is expected to occur at depths between 10 meters and 20 meters in compact, dominantly argillaceous strata. In the given climatic conditions dolerite intrusions may serve as important aquifers.

3.6 Seismic Activity

The closest source of seismic data maintained by the Council for Geoscience is at Britstown. Kijko[Reference 6.5] indicates the annual probability for an earthquake with intensity of 4,5 on the Modified Mercalli Scale to occur in the area to be less than 10^0 ; and with an intensity of 8,5 to occur the probability is 10^{-4}. A 10% probability exists that an earthquake with Peak Ground Acceleration exceeding of 0,08g may take place once in 50 years. To put this information into perspective : A 10% probability of an event with magnitude less than $100cms^{-2}$ to take place once in 50 years is regarded as most favourable ; natural seismic activity with magnitude exceeding $100cms^{-2}$ is regarded as unfavourable.

3.7 Other Considerations

Some issues will be briefly mentioned below. More detailed information can only be provided if a detailed geotechnical investigation has been undertaken.

- *Conditions of Excavation* : Bedrock of shale and dolerite is expected to be present at shallow levels. Excavation through soils will most probably be soft, but bedrock of both dolerite and shale can be regarded as hard excavation.
- *Materials Utilisation* : Weathered dolerite is usually an excellent source of construction gravel. Bedrock dolerite may be used for the production of high quality crushed stone. Shale is less suitable as source for construction aggregates. The locality plan, Figure 1, shows the presence of an excavation immediately adjacent to the area of investigation on the farm Gruisrand 59.
- *Soil Corrossivity* : Soils in the arid parts of the country are usually highly corrosive. Such corrossivity is brought about by the high soluble salt content. This high salt content also results in high conductivity thereof.

4 CONCLUSIONS

Based on the available geotechnical information a fatal flaw cannot be identified that may prematurely terminate the development of the proposed solar farm. Issues that may be of concern are the collapsing properties of the surface sands and hard rock excavation. However, the former issue can be designed for, and the latter issue can be addressed by proper documentation prior to construction.

5 RECOMMENDATIONS

Based on the results of this desk top study the planning of the facility may continue. However, it is essential that a full scale geotechnical investigation be conducted prior to construction of the facility. Such an investigation shall highlight especially the founding conditions, materials utilisation and soil corrossivity.

6 SOURCES OF REFERENCE

6.1 Mucina L et al : *The Vegetation of South Africa, Lesotho and Swaziland*, page 340, published in 2006 by SANBI.

6.2 Johnson MR et al : *Sedimentary Rocks of the Karoo Supergroup,* Section 22, pages 471 to 472 of The Geology of South Africa under editorship of MR Johnson, published in 2006 by the Council for Geoscience.

6.3 Brink ABA et al : *Engineering Geology of Southern Africa : Volume 4 – Post Gondwana Deposits*, pages 282 to 283, published in November 1985 by Building Publications.

6.4 Vegter JR : *An Explanation of a Set of National Ground Water Maps*, published by the Water Research Commission, in August 1995.

6.5 Kijko A et al : *Probabilistic Peak Ground Acceleration and Spectral Seismic Hazard Maps for South Africa*, Report 2003-0053 by the Council for Geoscience.

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9 October 2015