Report to SiVEST SA (PTY) LTD

Desktop Geotechnical Specialist Study for the:

# PROPOSED CONSTRUCTION OF THE HEUWELTJIES WIND ENERGY FACILITY AND ASSOCIATED INFRASTRUCTURE, NEAR BEAUFORT WEST, WESTERN CAPE PROVINCE, SOUTH AFRICA

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GaGE CONSULTING

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|---|---|
| Duan Swart<br>*MSc (Eng Geology) MSAIEG Pr.Sci.Nat* | Steven Bok<br>*BSc Hons (Geology) Pr.Sci.Nat* |

# PROPOSED CONSTRUCTION OF THE HEUWELTJIES WIND ENERGY FACILITY AND ASSOCIATED INFRASTRUCTURE, NEAR BEAUFORT WEST, WESTERN CAPE PROVINCE, SOUTH AFRICA
# DESKTOP GEOTECHNICAL SPECIALIST STUDY

## Executive Summary

This desktop geotechnical specialist study was undertaken for the development of the 240MW Heuweltjies Wind Energy Facility (WEF) and BA Process for the associated connection infrastructure near Beaufort West in the Western Cape Province. The assessment area is underlain by rock units of Teekloof and Abrahamskraal Formations that form the Adelaide Subgroup of the Beaufort Group found in the Karoo Supergroup. Some geotechnical constraints have been identified, and includes the following: primarily shallow bedrock which may cause excavation difficulties, thick transported material (alluvium and scree), and localised steep slopes. These constraints may be mitigated via standard engineering design and construction measures.

The topography over the assessment area is gently undulating terrain sloping at gradients less than 1:20 (5%) with minor amounts of localised areas seemingly sloping at gradients greater than 1:20.

The proposed developments are assessed to have a "Negative Low impact - the anticipated impact will have negligible negative effects and will require little mitigation" provided that the recommended mitigation measures are implemented. These include avoiding development on the steeper sections of the site. The remaining mitigation measures provided to minimise the impacts relate to the appropriate engineering design of earthworks and site drainage, erosion control and topsoil and spoil material management. These do not exceed civil engineering and construction best practice.

No fatal flaws or 'no-go' areas have been identified that would render any assessment areas unsuitable from a geological and geotechnical perspective. No geologically or geotechnically sensitive areas were identified within or near the assessment area. It is recommended however that areas of steeper slope gradients are avoided when determining the final infrastructure layout. Substation Option 2 footprint appears overlie the confluence of two drainage lines and may therefore be prone to occasional flooding and loose alluvial soils may be encountered. Substation Option 1 appears more favourable from a geotechnical perspective.

Further intrusive geotechnical investigations should be undertaken to confirm the engineering recommendations provided in this report.

## NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998 (ACT NO. 107 OF 1998) AND ENVIRONMENTAL IMPACT REGULATIONS, 2014 (AS AMENDED) - REQUIREMENTS FOR SPECIALIST REPORTS (APPENDIX 6

| Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6 | Section of Report |
|---|---|
| 1. (1) A specialist report prepared in terms of these Regulations must contain-<br>a) details of-<br>i. the specialist who prepared the report; and<br>ii. the expertise of that specialist to compile a specialist report including a curriculum vitae; | <br><br>1.3<br>Appendix B |
| b) a declaration that the specialist is independent in a form as may be specified by the competent authority; | Appendix A |
| c) an indication of the scope of, and the purpose for which, the report was prepared; | 1.1, 1.2 |
| (cA) an indication of the quality and age of base data used for the specialist report; | 1.4, References |
| (cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change; | 5, 6 |
| d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment; | Not applicable |
| e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used; | 1.4, Appendix C |
| f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives; | 3, 6, 7 |
| g) an identification of any areas to be avoided, including buffers; | None identified |
| h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers; | No sensitivities identified |
| i) a description of any assumptions made and any uncertainties or gaps in knowledge; | 2 |
| j) a description of the findings and potential implications of such findings on the impact of the proposed activity, (including identified alternatives on the environment) or activities; | 5,6,7 |
| k) any mitigation measures for inclusion in the EMPr; | 6.1 Appendix D |
| l) any conditions for inclusion in the environmental authorisation; | 6.1 Appendix D |
| m) any monitoring requirements for inclusion in the EMPr or environmental authorisation; | 6.1 Appendix D |
| n) a reasoned opinion-<br>i. (as to) whether the proposed activity, activities or portions thereof should be authorised;<br>(iA) regarding the acceptability of the proposed activity or activities; and<br>ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan; | 6.1, 8<br><br><br><br>6.1 Appendix D |
| o) a description of any consultation process that was undertaken during the course of preparing the specialist report; | Not applicable |
| p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and | None |
| q) any other information requested by the competent authority. | None |
| 2) Where a government notice *gazetted* by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply. | Not applicable |

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## Figures



## Tables

# 1. Introduction

GaGE Consulting (Pty) Ltd has been appointed by SiVEST SA (PTY) Ltd (hereafter referred to as "SiVEST"), on behalf of South Africa Mainstream Renewable Power Developments (Pty) Ltd (hereafter referred to as "Mainstream"), to undertake a geotechnical assessment of the proposed construction of the 240MW Heuweltjies Wind Energy Facility (WEF) and associated infrastructure near Beaufort West in the Western Cape Province. Mainstream has appointed SiVEST to undertake the required Environmental Impact Assessment (EIA) process for the WEF.

In terms of the EIA Regulations, which were published on 04 December 2014 and amended on 07 April 2017 [promulgated in Government Gazette 40772 and Government Notice (GN) R326, R327, R325 and R324 on 7 April 2017], various aspects of the proposed development are considered listed activities under GNR 327 and GNR 324 which may have an impact on the environment and therefore require authorisation from the National Competent Authority (CA), namely the Department Forestry and Fisheries & the Environment (DFFE), prior to the commencement of such activities. This desktop geological and geotechnical specialist study has been commissioned to assess and verify the WEF, Battery Energy Storage System (BESS) and associate infrastructure.

## 1.1. Scope and Objectives

Assess the impacts associated with the installation of the 240 MW Heuweltjies WEF and the associated infrastructure, including potential fatal flaws, if present.

The following key considerations were taken into account during the desktop study:

- The geological and geotechnical conditions (ground conditions) and the influence thereof on the competency of founding of civil infrastructure and structures
- Site topography and influence thereof on the site stability and suitability
- The presence of geological or geomorphological features such as faults, lineaments and unstable ground
- The presence of problem soils, geotechnical constraints, shallow groundwater conditions
- Geologically significant or sensitive features such as ridges, outcrops and exposures

## 1.2. Terms of Reference

The terms of reference were provided by SiVEST to allow a consistent approach to the various specialist studies and allow comparison of environmental impacts, efficient review, and collation of the specialist studies into their Environmental Impact Assessment report. This study is undertaken in accordance with the requirements provided in Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6.

A detailed description of the infrastructure required for the project including layouts of the proposed development were provided by SiVEST.

## 1.3. Specialist Credentials

This study has been undertaken by Duan Swart, a Professional Natural Scientist registered by the South African National Council for Natural Scientific Professions (SACNASP) registration number 137549 (Geological Science). The report was reviewed by Steven Bok, a Professional Natural Scientist registered by the SACNASP registration number 400279/07 (Geological Science). Mr Swart's and Mr Bok's CVs are attached in Appendix B.

### 1.4. Assessment Methodology

The assessment involved a review of the following information:

i) 1:250 000 Scale Geological Map 3222 Beaufort West (Council for Geoscience,1979)
ii) 1:250 000 Scale Geological Map 3322 Oudtshoorn (Council for Geoscience,1979)
iii) A review of the 1:50 000 scale of Topo-cadastral Maps 3222DC and 3322BA
iv) Aerial photographs (Google Earth imagery, current and historical)
v) Technical report titled "Desktop Study for the proposed construction of the Heuweltjies and Kraaltjies Wind Energy Facility" written by GaGE for SiVEST dated December 2020
vi) Screening Report for Environmental Authorisation (national web based environmental screening tool)
vii) Literature as referenced within this report

An Environmental Impact Assessment matrix was used to quantify the impacts of the project on the receiving environment (provided by SiVEST and attached as Appendix C).

## 2. Assumptions and Limitations

The services performed by GaGE Consulting (Pty) Ltd were conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the geotechnical profession practising under similar conditions in the locality of the project. The interpretation of the site conditions is based on available information, experience in the general project area and professional judgement and is considered to provide sufficient confidence to meet the objectives of this specialist study. The nature of geotechnical engineering is such that conditions at variance with those described may be encountered on site. Engineering recommendations provided in this report are preliminary and must be confirmed through further intrusive investigations.

Third party information has been utilised in good faith.

A site visit was not undertaken.

## 3. Technical Description

### 3.1. Project Location

The proposed WEF and associated infrastructure is located approximately 70 km south of Beaufort West in the Western Cape Province and is within the Prince Albert Local Municipality, in the Central Karoo District Municipality. The general location is show in Figure 3-1.

#### 3.1.1. WEF

The WEF application site, as shown in Figure 3-2 on the locality map, is approximately 4017.6 hectares (ha) in extent and incorporates the following farm portions:

- Remainder of the Farm Witpoortje No 16
- Portion 8 of the Farm Klipgat No 114

A smaller buildable area (1673 ha) has however been identified as a result of a preliminary suitability assessment undertaken by Mainstream and this area is likely to be further refined with the exclusion of sensitive areas determined through various specialist studies being conducted as part of the EIA process.

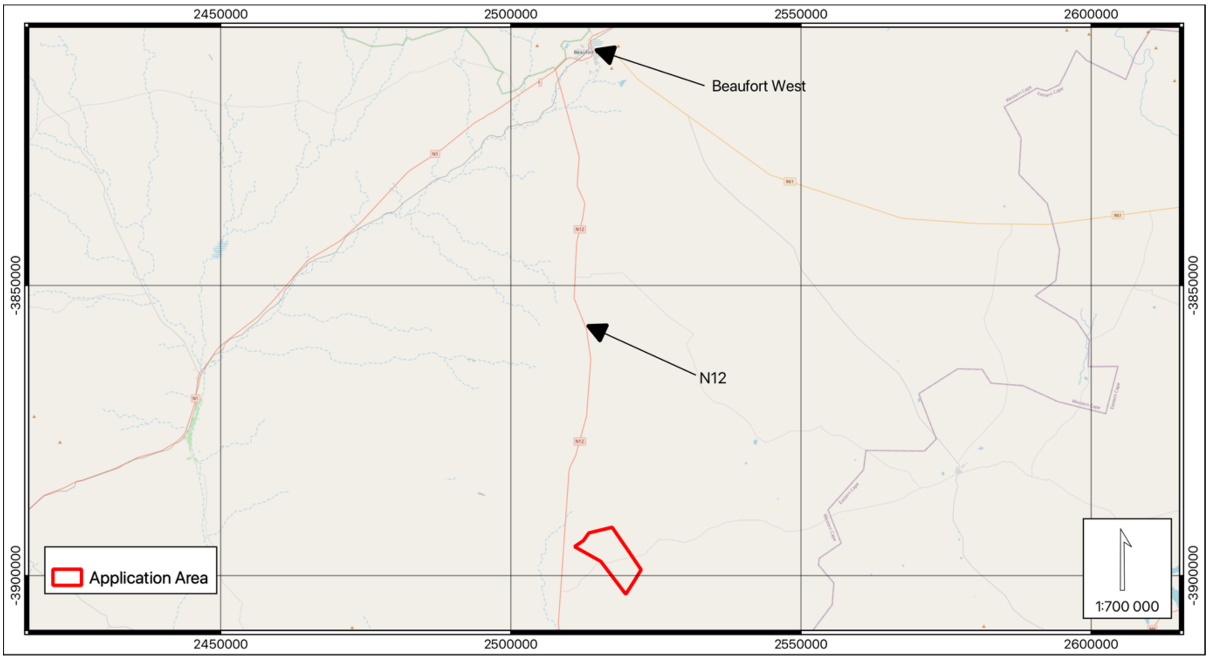



**Figure 3-1 Location of the proposed WEF and associated infrastructure application area**

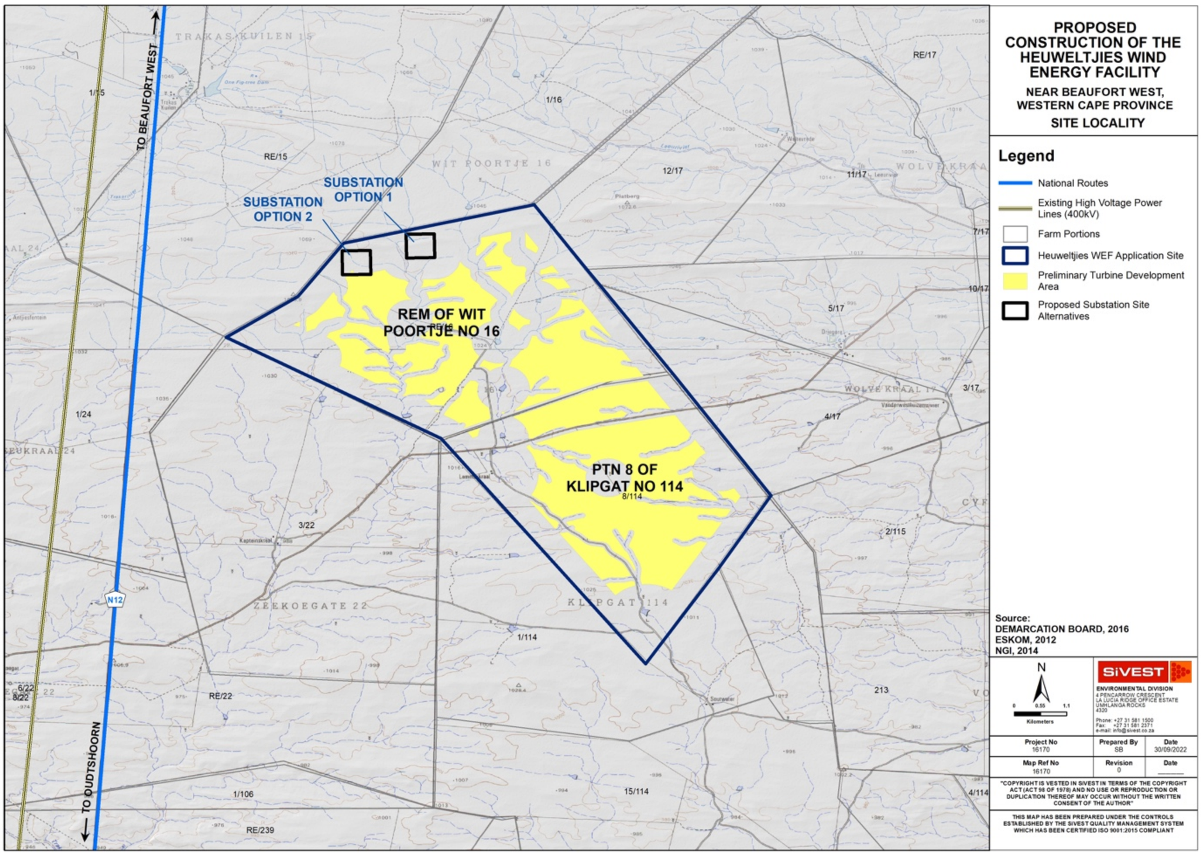



**Figure 3-2 Location of the Heuweltjies WEF**

## 3.2. Project Description

It is anticipated that the proposed Heuweltjies WEF will comprise of maximum sixty (60) wind turbines with a maximum total energy generation capacity of up to approximately 240 MW. The electricity generated by the proposed WEF development will be fed into the national grid via a 132kV overhead power line. The 132 kV overhead power line will however require a separate EA and is subject to a BA process, which is currently being undertaken in parallel to this EIA process.

### 3.2.1. Wind Farm Components

- Up to sixty (60) wind turbines with a maximum export capacity of approximately 240 MW. This will be subject to allowable limits in terms of the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). The final number of turbines and layout of the WEF will, however, be dependent on the outcome of the Specialist Studies conducted during the EIA process;
- Each wind turbine will have a hub height of between 120 m and 200 m and rotor diameter of up to approximately 200 m;
- Permanent compacted hardstanding areas / platforms (also known as crane pads) of approximately 90 m x 50 m (total footprint of approx. 4 500 m$^2$) per turbine during construction and for on-going maintenance purposes for the lifetime of the proposed development;
- Each wind turbine will consist of a foundation of up to approximately 15 m x 15 m in diameter. In addition, the foundations will be up to approximately 3 m in depth;
- Electrical transformers (690 V / 33 kV) adjacent to each wind turbine (typical footprint of up to approximately 2 m x 2 m) to step up the voltage to 11-33 kV;
- Associated infrastructure of approximately 25ha which includes;
  - One (1) new 11-33/132 kV IPP on-site substation including associated equipment and infrastructure The proposed substation will be a step-up substation and will include an Eskom portion and an IPP portion, hence the substation has been included in the WEF EIA and in the grid infrastructure (substation and 132 kV overhead power line) BA to allow for handover to Eskom. Following construction, the substation will be owned and managed by Eskom.
  - A Battery Energy Storage System (BESS) will be located next to the onsite 11-33/132 kV substation. The storage capacity and type of technology would be determined at a later stage during the development phase, but most likely comprise an array of containers, outdoor cabinets and/or storage tanks;
  - One (1) construction laydown / staging area. It should be noted that no construction camps will be required in order to house workers overnight as all workers will be accommodated in the nearby town;
  - Operation and Maintenance (O&M) buildings, including offices, a guard house, operational control centre, O&M area / warehouse / workshop and ablution facilities to be located on the site identified for the substation.
- The wind turbines will be connected to the proposed substation via medium voltage (11-33 kV) underground cabling and / or overhead power lines;
- Internal roads with a width of up to approximately 8 m wide will provide access to each wind turbine. Existing site roads will be used wherever possible, although new site roads will be constructed where necessary. Turns will have a radius of up to 50 m for abnormal loads (especially turbine blades) to access the various wind turbine positions. It should be noted that the proposed application site will be accessed via the N12 National Route;
- A wind measuring lattice (approximately 140 m in height) mast has already been strategically placed within the wind farm application site in order to collect data on wind conditions;
- No new fencing is envisaged at this stage. Current fencing is standard farm fence approximately 1-1.5 m in height. Fencing might be upgraded (if required) to be up to approximately 2 m in height; and

- Water will either be sourced from existing boreholes located within the application site or will be trucked in, should the boreholes located within the application site be limited.

## 3.3. Alternatives

### 3.3.1. Wind Energy Facility

No other activity or site alternatives are being considered. Renewable Energy development in South Africa is highly desirable from a social, environmental and development point of view and a wind energy facility is considered suitable for this site due to the high wind resource in this area.

The choice of technology selected for the Heuweltjies WEF is based on environmental constraints and technical and economic considerations. No other technology alternatives are being considered as wind energy facilities are more suitable for the site than other forms of renewable energy due to the high wind resource.

The size of the wind turbines will depend on the development area and the total generation capacity that can be produced as a result. The choice of turbine to be used will ultimately be determined by technological and economic factors at a later stage.

Design and layout alternatives will be considered and assessed as part of the EIA. These include alternatives for the Substation locations and also for the construction / laydown area. The proposed preliminary layout is shown in Figure 3-2.

### 3.3.2. No-go Alternative

The 'no-go' alternative is the option of not undertaking the proposed project. Hence, if the 'no-go' option is implemented, there would be no development, and thus no associated environmental impacts on the site or the surrounding area. It provides the baseline against which other alternatives are compared and will be considered throughout the report.

The 'no-go' option is a feasible option; however, this would prevent the proposed development from contributing to the environmental, social and economic benefits associated with the development of the renewable energy sector.

# 4. Legal Requirement and Guidelines

The desktop study was undertaken according to the guidelines provided by The South African Institution of Civil Engineering Site Investigation (SAICE) Code of Practice published by The Geotechnical Division of SAICE, 2010.

This report has been prepared to meet the requirements for a specialist report as provided in Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6.

# 5. Description of the Receiving Environment

The following description of the receiving environment is relevant to assessing the geological and geotechnical impacts.

## 5.1. Climate

The area surrounding Beaufort West and in the Karoo is considered to have a desert climate with little rainfall all year long. The area can be classified as hot desert climate (BWk) according to the Köppen-Geiger climate classification (Beck et al, 2018). The average annual rainfall is 224 mm with the average maximum and minimum temperatures of 23.6°C and 10.9°C, respectively.

Climate plays a fundamental role in rock weathering and soil development. The effect of climate on the weathering processes (i.e. soil formation) in a particular area can be determined from the climatic N-value, defined by Weinert (1980). A climatic N-Value of 5 or less implies a water surplus and the dominant mode of weathering is chemical decomposition. These climatic conditions are favourable for the development of a deep residual soil profile. Where the climatic N-value is greater than 5, mechanical disintegration is the predominant mode of rock weathering. In these drier areas residual soils are typically shallow. Climatic N-values of greater than 10 imply an arid climate with a limited or absent residual soil profile.

Weinert's climatic N-value for the site is greater than 10, approximately 15, which indicates a scarcity of water. Physical disintegration will dominate resulting in a thin gravelly residual soil and a shallow bedrock (unless covered with transported soils). This climate is conducive to the formation of pedogenic calcrete.

## 5.2. Topography and Drainage

Based on the Google imagery and local topo-cadastral maps, the general area is relativity flat with gently undulating terrain. Localised areas exhibit slightly steeper slopes adjacent to high points and ridge lines are scattered across the site. The watershed between the river catchments Gamtoos River and Gourits River systems runs in an east-west direction through the middle of the Beaufort West Cluster. According to the topo-cadastral maps, the greater area of the site is scattered with non-perennial drainage features. Google Earth imagery indicates signs of overland surface flow and occasional rills converging towards the distinct drainage features.

The extract of the 3222DC and 3322BA topo-cadastral maps, presented in Figure 5-1, indicate the highest point of the Heuweltjies site area is located in the north-western portion of the site at 1056 m AMSL, with the lowest point of the site being in the south eastern portion of the site at approximately 1000 m AMSL. The site can be described as gently sloping undulating terrain with scattered non-perennial streams and erosion features across the site. The northern to western portions of the site will drain towards the Kapteinskraal River. The south-eastern portions of the site will drain towards the Kouka River to the east of the site. The extreme southern portion of the site will drain towards the Rondawel River that flows south from the site boundary. The Kapteinskraal, Kouka and Rondawel Rivers all join the Traka river and forms part of the Gourits River Catchment system.

The entire site area can be described as gently undulating terrain sloping at gradients less than 1:20 (5%) with minor amounts of localised areas seemingly sloping at gradients greater than 1:20. This entails that terracing may be required for construction in the steeper sections, greater than 1:20, of the site. No areas of the site are expected to exhibit steep slopes exceeding 12.5% (1:8).

The site area is bestrewed with earth dams located in the drainage channel of the streams and rivers presented on site.

The extent and detailed nature of the drainage features and slopes within the area of interest could not be confirmed in the desk study.

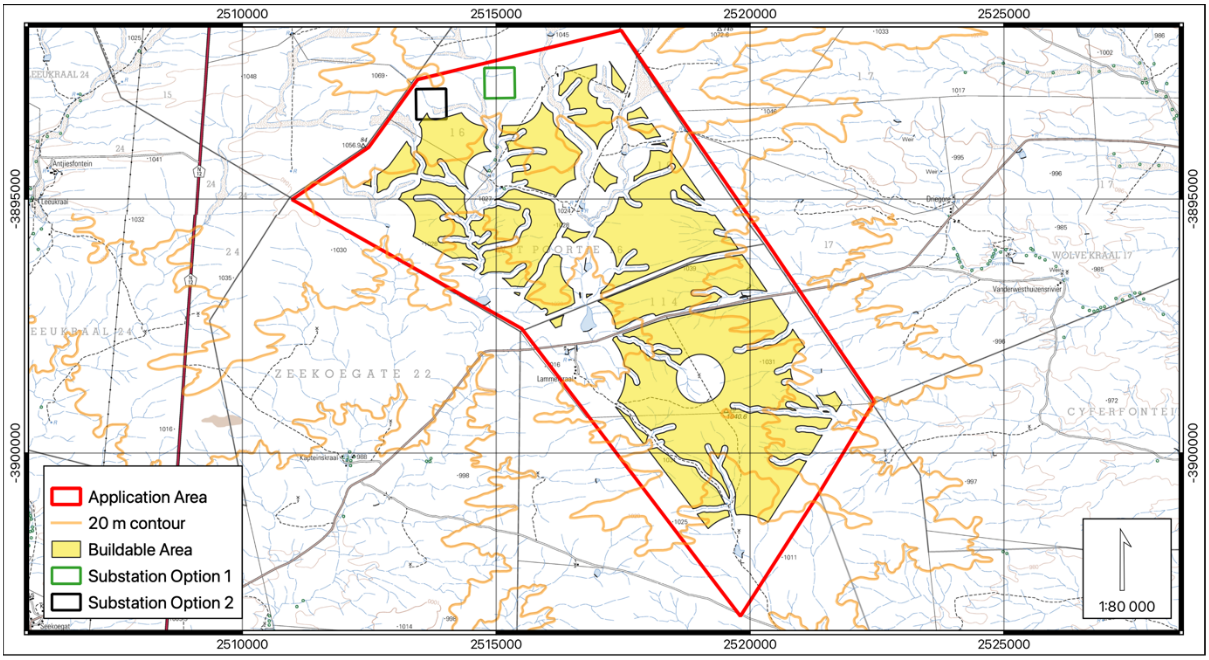



**Figure 5-1 Extract of local topo-cadastral map with the Heuweltjies WEF buildable area indicated**

## 5.3. Seismicity

The site area can generally be considered a region with a low seismic hazard (peak ground acceleration of 0 – 0.2 $m/s^2$). According to the Seismic Hazard Map of South Africa contained in SANS 10160-4 (2017) the peak ground acceleration (g) with a 10% probability of being exceeded in a 50-year period for the site is in the order of 0.10 $m/s^2$. The seismic hazard in the area is seemingly associated with natural seismic activity.

## 5.4. Bedrock Geology

According to the 1:250 000 scale geological maps 3222 Beaufort West and 3322 Oudtshoorn, the WEF site is underlain by Permian-aged alternating bluish-grey, greenish grey or greyish red mudrocks and grey, very fine to medium-grained lithofeldspathic sandstone of the Teekloof and Abrahamskraal Formations that form the Adelaide Subgroup of the Beaufort Group found in the Karoo Supergroup. The formations boundaries are linked to specific sandstone-rich marker units (Johnson et al 2006). A number of greenish chert bands, existing from a few centimetres to two metres thick, and pink tuff beds have been recorded to exist in the Abrahamskraal Formation. Calcareous nodules and concretions occur in mudstones throughout the Beaufort Group. Adelaide Subgroup is highly faulted with numerous anticline and syncline formations, as well as a few faults, striking generally in an east-west direction. The rock units of the Beaufort Group in the vicinity of the site dip towards the north and south, due to numerous anticline and synclines, varying between dip angles of 10° and 40°.

The rocks in the Beaufort Group are fossil bearing and fossil locations near the site have been noted, as show in the local geology map. The geology is illustrated in Figure 5-2 along with the legend presented in Figure 5-3.

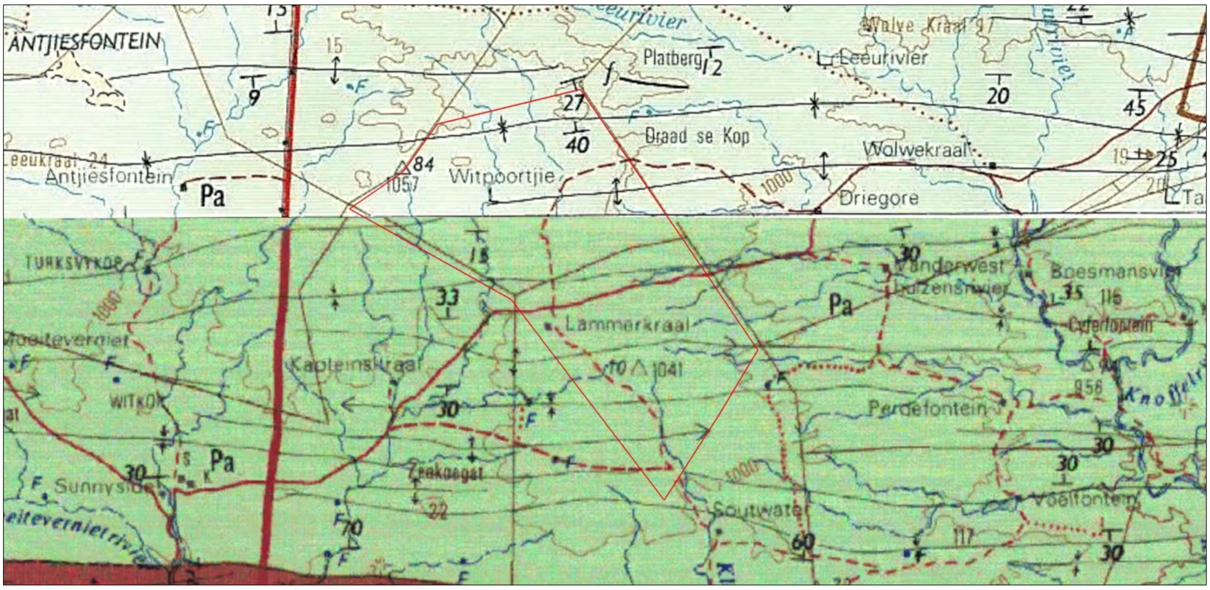


Figure 5-2 Extract from the 1:250 000 Geological Map sheets 3222 Beaufort West and 3322 Oudtshoorn

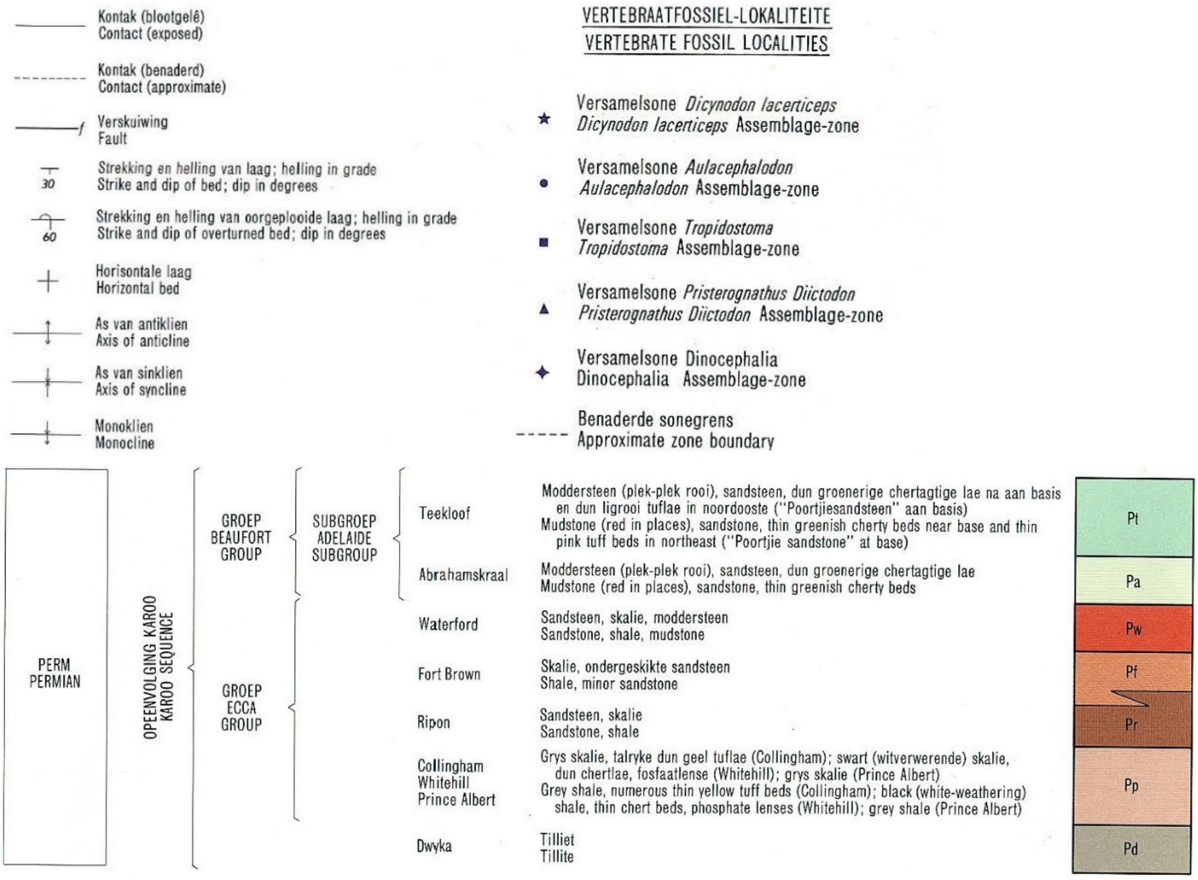


Figure 5-3 1:250 000 Geological Map Legend; Structures and Geological Sequences

## 5.5. Engineering Geology

The site's geology and climate will result in thin gravelly to sandy transported and residual soils overlying shallow bedrock. A photograph of an excavation sidewall, provided by SiVEST with the exact location unknown, within the Heuweltjies site area indicates that shallow bedrock is overlain by a thin surficial transported horizon. It is expected that the majority of the site will be underlain by shallowly occurring bedrock, unless covered by transported material within the streams, flood areas and bottom of relativity steep slopes.

It is anticipated that the wind turbines will be located on ridges, where shallower soil cover is anticipated. Access roads will therefore need to be constructed up and along the ridges from existing access points. We understand that the turbines will be connected to substations via underground cables and overhead lines, which will require significant trenching.

The sandstone and shale bedrock anticipated to be encountered at shallow depths at the turbine locations should provide an adequate founding medium to allow the use of shallow foundations or gravity foundations for the turbines. Intermediate to hard excavation conditions are anticipated at shallow depths (> approximately 0.50 m) and the use of pneumatic breakers or blasting will be required to excavate for gravity foundations.

The interlayered nature of the bedrock, coupled with the presence of faults, folds and other geological structures, may result in complex and variable geotechnical conditions, even beneath individual foundation footprints. It is possible for less competent shale to be encountered below more competent sandstone layers and for zones of preferential weathering to occur within un-weathered surrounding rock.

The formation of duripan (in the form of a variable calcrete horizon ranging from nodules to hardpan calcrete) is expected to occur locally in parts of the site.

The charts provided by SiVEST indicate that slopes exceed gradients of 1:50, and potentially as steep as 1:20, within the WEF assessment area. It is expected that local areas with gradients greater than 1:20 will exist on site. This entails that terracing and additional earthworks for roads and platforms may be required for construction in the steeper sections of the site.

### 5.6. Desktop Geotechnical Appraisal

Based on the desktop study, the assessment areas may be divided into four (4No.) Ground Units (GU), I, II, III and IV are presented in Figure 5-4 where similar geotechnical conditions are anticipated. GU I is defined by shallow occurring bedrock covered by thin, loose transported material and varying degrees of cemented calcrete. GU II can be defined by talus deposits on steep slopes greater than 1:20 that is linked to GU III that defines the high lying outcropping bedrock. Many of the very localised areas defined as GU II and GU III cannot be mapped at the scale of the infrastructure plans provided, due to the limited information at desktop study level. These areas are not necessarily illustrated in Figure 5-4 but will be located on and adjacent to higher lying ridge line areas.

GU IV is confined to low lying areas that are underlain by relativity thicker alluvial deposits, identifiable by erosion paths, rills and continuous drainage features.

The boundaries between of the zones are approximate only and will need to be confirmed on site through intrusive investigations. The boundaries of Ground Units were drawn with the assistance of the satellite imagery and other available data.

The assessment area is considered suitable for the development of the proposed infrastructure, from a geotechnical viewpoint, provided that standard engineering design and construction measures are implemented to mitigate the identified geotechnical constraints. The anticipated geotechnical constraints and mitigation measures are summarised in Table 5-1.

**Table 5-1 Summary of geotechnical conditions**

| Ground Unit | Shallow Geology | Geotechnical Conditions / Constraints | Impacts on Engineering Design and Construction |
|---|---|---|---|
| I | Fairly shallow shale and sandstone bedrock covered by thin transported and calcrete material | • Shallow bedrock<br>• Thin soil cover<br>• Intermediate to hard excavation conditions with depth<br>• Overlain by alluvial soils of variable thickness in some areas | • Good founding conditions for structures at shallow depths<br>• Conventional shallow foundations suitable<br>• Conventional subgrade preparation for roads<br>• Intermediate to hard excavation conditions for pole planting / trenching / earthworks<br>• Overbreak is anticipated during trenching |
| II | Steep slopes | • Mass earthworks on gradients greater than 1:20<br>• Potentially unstable slopes | • Terracing and slope stabilisation required |
| III | Outcropping bedrock | • Hard excavation conditions | • Blasting, heavy plant machinery / pneumatic methods / required for excavations (pole planting earthworks / trenching / foundations)<br>• Good founding conditions for structures<br>• Overbreak is anticipated during trenching |
| IV | Alluvium | • Loose sandy soils<br>• Potentially collapsible soils<br>• Moderate soil cover<br>• Moderate bedrock depth<br>• Increased erosion potential | • Deeper spread footings (found below alluvial sands)<br>• Soft excavation conditions becoming intermediate with depth<br>• Unstable trench sidewalls – shoring/battering required<br>• Erodible soils<br>• Surface drainage measures required to minimise risk of flooding and erosion |

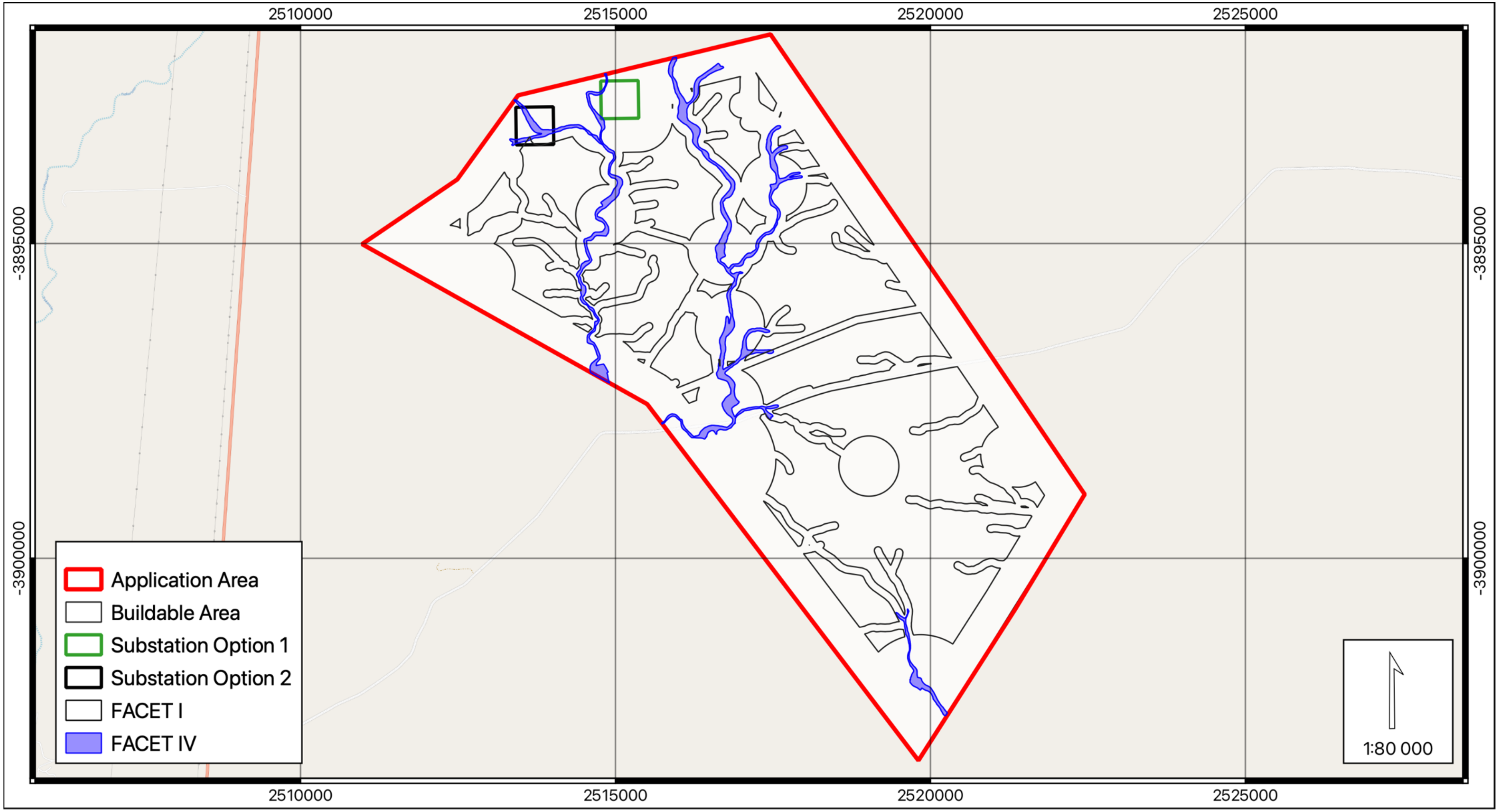



**Figure 5-4 Inferred Ground Units for WEF application area (Google Earth, 2021)**

## 6. Identification and Assessment of Impacts

No fatal flaws or 'no-go' areas have been identified that would render any assessment areas unsuitable from a geological and geotechnical perspective.

The impact of the WEF will be caused by the construction of access roads to the turbine positions (designed to carry large abnormal loads), earthworks required for the construction of crane pads, excavations of the turbine foundations (up to 30 m in diameter, typically excavated up to 5 m into the ground) as well as trenching for underground cables and / or overhead powerlines. Given the required grades and radius requirements for transporting the large turbine components as well as the large size of the crane pads, significant earthworks would be required, particularly in steep topography. Additional impacts would be caused by the opening of borrow pits that may be undertaken to obtain construction materials. This impact will be addressed at a later stage if borrow pits are deemed necessary. The impact of the substation and internal WEF powerlines on the geological environment is limited to topsoil stripping, excavations for plinth foundations, trenching, the construction of access roads and associated light infrastructure.

### 6.1. Impact of the Project on the Geological Environment

The main impact of the proposed development from a geological perspective is the displacement and removal of soil and rock materials. These activities will predominantly take place during the construction phase. The degree of disturbance is largely dependent on the topography of the project site and the nature of the proposed infrastructure. Steep slopes are unfavourable as these require bulk earthworks to create working platforms and access roads. Earthworks on steep slopes increases the risk of soil movements or slope failure.

The risk of soil erosion is also increased during construction activities, by the removal of vegetation and by possible disturbance to the natural surface drainage environment. These activities may prevent infiltration of rainwater, increase surface runoff and cause concentration of surface water flow. Erosion will increase the disturbance and displacement of soils and the impact may extend beyond the infrastructure footprint/s over time.

The effects of the proposed development on the geological environment were evaluated using an Environmental Impact Assessment (EIA) Methodology, provided by SiVEST, which aids in determining the significance of an environmental impact on an environmental parameter through a systematic analysis. The EIA methodology is attached as Appendix C.

Based on the impact significance ratings, presented in Appendix D, the development of the proposed construction of the Heuweltjies Wind Energy Facility (WEF) and associated infrastructure, from a geological and geotechnical perspective, will be "Negative Low impact", provided that the recommended mitigation measures are implemented.

The topography of the major portion of the site is gentle and significant earthworks are not anticipated in these areas (although some bulk earthwork will be required). However, seldomly moderately steep to very steep slopes occur with talus on the slopes occur in localised areas, and it is recommended the steepest slopes (greater than 1:15 if any) are avoided when determining the final infrastructure layout. Access routes should be carefully planned to avoid these areas, where possible.

It is recommended that construction materials are obtained from cuttings and excavations rather than through the establishment of borrow pits. Detailed geotechnical materials investigations should be undertaken to assess the suitability of the in-situ materials and the need for processing (e.g. crushing, stabilisation).

The soils do not render the site particularly susceptible to soil erosion, although mitigation measures need to be implemented, particularly within the lower-lying sections of the site where concentrated surface flow is anticipated after heavy rainfall events. The crest of the ridges are expected to be characterised by outcropping or very shallow bedrock.

This will provide good founding for large structures but will hinder excavations for turbine foundations, services and road construction.

## 7. Comparative Assessment of Alternatives

Substation Option 2 footprint appears overlie the confluence of two drainage lines and may therefore be prone to occasional flooding and loose alluvial soils may be encountered. Substation Option 1 appears more favourable from a geotechnical perspective

## 8. Conclusion and Summary

### 8.1. Summary of Findings

This desktop geotechnical specialist study was undertaken for the development of the 240MW Heuweltjies WEF and associated infrastructure near Beaufort West in the Western Cape Province. The assessment area is underlain by rock units of Teekloof and Abrahamskraal Formations that form the Adelaide Subgroup of the Beaufort Group found in the Karoo Supergroup. Some geotechnical constraints have been identified, primarily shallow bedrock which may cause excavation difficulties, thick transported (alluvium and scree) and localised steep slopes and outcropping rocks. These constraints may be mitigated via standard engineering design and construction measures.

No fatal flaws or 'no-go' areas have been identified that would render any assessment areas unsuitable from a geological and geotechnical perspective.

The proposed developments are assessed to have a "Negative Low impact - the anticipated impact will have negligible negative effects and will require little mitigation" provided that the recommended mitigation measures are implemented. These include avoiding development on the steeper sections of the site. The remaining mitigation measures provided to minimise the impacts relate to the appropriate engineering design of earthworks and site drainage, erosion control and topsoil and spoil material management. These do not exceed civil engineering and construction best practice.

The Substation Option 2 footprint appears overlie the confluence of two drainage lines and may therefore be prone to occasional flooding and loose alluvial soils may be encountered. Substation Option 1 appears more favourable from a geotechnical perspective

Further intrusive geotechnical investigations should be undertaken to confirm the engineering recommendations provided in this report.

### 8.2. Impact Statement and Conclusion

From a geotechnical and geological perspective, no fatal flaws or sensitivities have been identified within or close to the WEF assessment area. It is therefore recommended that the proposed activity be authorised.

## References

Beck, H. E. et al., Present and future Köppen-Geiger climate classification maps at 1-km resolution. Sci. Data. 5:180214 doi: 10.1038/sdata.2018.214, 2018.

Brink, A.B.A. Engineering Geology of Southern Africa, The Karoo Sequence, Volume 3. Building Publications, 1983

Brink, A.B.A. Engineering Geology of Southern Africa, Post-Gondwana Deposits, Volume 4. Building Publications, 1985.

Johnson, M.R. Anhaeusser, C.R. Thomas, R.J. The Geology of South Africa. Council for Geoscience, 2006.

Thamm, A. G., Johnson, M. R., Anhaeusser, C. R., & Thomas, R. J. The Cape Supergroup. The Geology of South Africa, 443-460, 2006.

# Appendix A. Specialist Declaration of Interest and Undertaking Under Oath

environmental affairs

Department:
Environmental Affairs
**REPUBLIC OF SOUTH AFRICA**

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

| | (For official use only) |
|---|---|
| File Reference Number: | |
| NEAS Reference Number: | DEA/EIA/ |
| Date Received: | |

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

**PROJECT TITLE**

ENVIRONMENTAL IMPACT ASSESSMENT (EIA) FOR THE PROPOSED HEUWELTJIES WIND ENERGY FACILITY AND ASSOCIATED INFRASTRUCTURE, NEAR BEAUFORT WEST, WESTERN CAPE PROVINCE, SOUTH AFRICA

**Kindly note the following:**

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
3. A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
5. All EIA related documents (includes application forms, reports or any EIA related submissions) that are faxed; emailed; delivered to Security or placed in the Departmental Tender Box will not be accepted, only hardcopy submissions are accepted.

**Departmental Details**

**Postal address:**
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Private Bag X447
Pretoria
0001

**Physical address**:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Environment House
473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

## 1. SPECIALIST INFORMATION

| | | | | |
|---|---|---|---|---|
| Specialist Company Name: | GaGE Consulting | | | |
| B-BBEE | Contribution level (indicate 1 to 8 or non-compliant) | 1 | Percentage Procurement recognition | 135% |
| Specialist name: | Duan Swart | | | |
| Specialist Qualifications: | BSc BSc(Hons) MSc | | | |
| Professional affiliation/registration: | Professional Natural Scientist<br>SACNASP Reg. No. 137543 | | | |
| Physical address: | 17 Cowley Road, Bryanston, Johannesburg | | | |
| Postal address: | PO Box 71572, BRYANSTON | | | |
| Postal code: | 2021 | Cell: | | |
| Telephone: | 010 823 1621 | Fax: | | |
| E-mail: | duan@gageconsulting.co.za | | | |

## 2. DECLARATION BY THE SPECIALIST

I, ________ Duan Swart ___________________, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

___________________________________

Signature of the Specialist

GaGE Consulting

Name of Company:

01/24/2023

Date

## 3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, ____ Duan Swart____________________, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

______________________________

Signature of the Specialist

GaGE Consulting

Name of Company

24/01/2023

Date

GUSTAF SWART PLS 1444 (PROFESSIONAL LAND SURVEYOR)

Signature of the Commissioner of Oaths

24/01/2023

Date

# Appendix B. Specialist CVs

# DUAN SWART

## Senior Engineering Geologist

**MSc (Engineering Geology), PrSciNat, MSAIEG**

**DATE OF BIRTH**
30 July 1993

**NATIONALITY**
South African

**LANGUAGES**
English
Afrikaans

**QUALIFICATIONS**

Professional registered SACNASP, PrSciNat (137543), MSAIEG, Master of Science (Engineering Geology), *Doctoral Candidate (Engineering Geology), Bachelor of Science (Hons) (Engineering Geology), Bachelor of Science (Environmental and Engineering Geology)

**KEY SKILLS**
Geotechnical Investigations, Dolomite Investigations, Borrow Pit and Quarry Investigations, Slope Stability Assessments, Materials Assessments, Vadose Zone Hydrology, Unsaturated Soil Mechanics, Limited Equilibrium Analysis.

**INTERNATIONAL EXPEREINCE**
Democratic Republic of Congo, Botswana, Swaziland.

### SUMMARY OF CREDENTIALS

Duan is a registered engineering geologist, with six years' consulting experience, who has undertaken fieldwork and reporting of data for various renewable projects including solar energy facilities, wind energy facilities and associated sub-station and grid infrastructure. His responsibilities ranged from providing costing, planning site investigations, managing sub-contractors and in-situ geophysical testing, scheduling laboratory test and assisting in trial pile designs across various soil and rock conditions.

Additionally, Duan has seven years academic experience. His doctoral research aims to improve the understanding of the variably saturated saprolitic soil found within the complex vadose zone and he uses this understanding in everyday consultancy. His Master's dissertation revealed interesting mineral occurrences within residual dolomite that contributes to the material's unique behaviour.

His experience has developed through numerous intrusive and non-intrusive site investigation methods for both rock and soil orientated projects.

Key professional experience and skills includes:

- Designing and executing detailed geotechnical investigations for the relevant infrastructure types according to guidelines as set out by: SAICE Geotechnical Division Code of Practice (2010); SANS 634; GFSH-2; as well as SANS 1936 for development on dolomite land.

- Competency in: soil profiling, chip and core logging as detailed in industry standards as set out by Brink and Bruin (2001); as well as material classification; on-site supervision; on-site testing and sampling.

- Skills in project management, such as: compiling cost estimates; client communication and liaison; health and safety compliance; delegating work to junior engineering geologists and students; as well as understanding responsibilities as part of a team of scientist and engineers within a project.

In addition to the professional work experience gained in industry, a strong set of skills have been accomplished in academia as a researcher and is a technical team member of the Water Research Commission (WRC) project, K5/2326. Currently, his Ph.D. research contributes to the WRC project Complex Vadose Zone Hydraulics (K5/2826).

Key research experience includes:

- Investigating and executing fundamental scientific research questions on flow through variably saturated residual soil found in South Africa, as well as the influence of unique mineral occurrences on water storage of residual soils.

- Skills in research project management that include: working as a research team; addressing input from experts forming part of a reference group; managing a budget; managing and reviewing work of post-graduate students; and compiling deliverables as well as final research reports.

- Presenting research findings: at several conferences; as well as published papers in peer reviewed scientific journals and chapters in books, and as large research reports.

- Lecturing and mentoring to both undergraduate and postgraduate students in the Department of Geology at the University of Pretoria.

**EXPERIENCE: KEY PROJECTS**

Buffels Solar, Klerksdorp (2022)
Client: Kabi Solar / Solar Pack
Position: Engineering Geologist – The Buffels Solar Project comprises the installation of a 240 MW Solar Energy Facility (SEF) in the North West Province of South Africa. The project included the investigation and design of ground mounted solar photovoltaic (PV) systems covering an approximate area of 100 Ha and associated substation and access roads. Duan was responsible for the costing proposal, managing on-site works, guiding sub-contractors, and writing up of the report. The site was underlain by dolomitic land and Duan liaised with the Council for Geoscience to ensure the correct dolomite stability investigated procedures were followed. The total project costs were R 1.4 million.

Sutherland Cluster, Sutherland (2022)
Client: Mainstream Renewables
Position: Engineering Geologist – The Sutherland Cluster comprised the installation of 2040 MW Wind Energy Facility (WEF) in the Northern Cape Province of South Africa. The WEF formed part of the Round 5 of South Africa's Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). The project includes the investigating of 97 wind turbines and associated access roads, laydown areas and grid infrastructure. Duan was responsible for the costing proposal, managing on-site works, guiding sub-contractors, and writing up of the report. The total project cost was R 11 million.

Simandou Ore Mine, GUINEA (2022)
Client: Rio Tinto / WSP
Position: Engineering Geologist – The Simandou mountain range contains one of the largest iron ore reserves in the world. The proposed mine will be one of the largest operating iron ore mines in the world. Duan was the engineering geologist for the geotechnical bulk earthworks of the entire mine, associated infrastructure, haul roads, and new airport, including upgrade of the existing 1.80 km dirt runway. The work included slope designs, material utilisation and integration with technical teams such as geometrics, water management and structures. Duan was responsible for the geological model and ground profiles for all the road cuttings and bulk earthworks. Furthermore, Duan was task to design slopes for road cuttings ranging from 30 m high to 125 m high. Duan compiled sections of the 85% and 100% design review report, and presented weekly and work closely with technical staff in WSP Group, Rio Tinto and SRK UK.

Luphohlo – Ezulwini Hydro-Electric Scheme, Mbabane, SWAZILAND (2022)
Client: Swaziland Electricity Company
Position: Engineering Geologist – The scheme comprises a 45m high earth cored rockfill dam, which impounds a reservoir of 24 million cubic metres total capacity on the Lusushwana River. Water is drawn through an intake on the eastern side of the reservoir and transferred through the Luphohlo Mountain in a 4.3km long low-pressure tunnel to a surge chamber on the Ezulwini valley side of the mountain. The project involves the inspection of the 4.2 km long low-pressure tunnel. The tunnel inspection was carried out on foot from the intake down to the rock traps / access audit. Duan was responsible for inspection of tunnel features such as concrete lining; moisture drains and rock condition along the length of the tunnel. Duan wrote up sections within the geological and interpretive reports.

N4 Montrose Interchange, Mpumalanga, SOUTH AFRICA (2019-21)
Client: Trans African Toll Concession (TRAC) / South African National Roads Agency (SANRAL) SOC Limited
Agency (SANRAL) SOC Limited
Position: Engineering Geologist - The project involves the widening and upgrade of the National Route 4 at the intersection of the Ngodwana and Schoemanskloof bypasses. Geotechnical works comprises the investigation and design of cut and fill retaining walls, soil and rock slopes, structure abutments, foundations for the widening of the bridge over the Crocodile River, and identification of material sources. Duan was responsible for supervision of part of the site investigation, borehole core logging and write up of sections within the geological, materials and interpretive reports.

R574 Groblersdal, Limpopo, SOUTH AFRICA (2020-22)
Client: Nathoo Mbenyane Engineers/ South African National Roads Agency (SANRAL) SOC Limited
Position: Engineering Geologist - The project involves the widening and upgrade on the National Road R574 (District Road D1547) Section 1 from R33 Groblersdal (km 0.0) to R579 Morwaneng (km 38.9). Geotechnical works comprises the investigation and design of soil and rock slopes, structure abutments, foundations for the widening of the bridges, and identification and investigation of material sources. Duan was responsible for building the bill of quantities, supervision of the site investigation, borehole core logging and write up of sections within the geological, materials and interpretive reports.

R36 Tzaneen, Limpopo, SOUTH AFRICA (2020-22)
Client: Nathoo Mbenyane Engineers/ South African National Roads Agency (SANRAL) SOC Limited
Position: Engineering Geologist - The project involves the widening and upgrade of National Road R36 Section 6 from Manchabeni (Km 4.70) to Tzaneen (Km 33.50). Geotechnical works comprises the investigation and design of soil and rock slopes, structure abutments, foundations for the widening of the bridges, and identification and investigation of material sources. Duan was responsible for building the bill of quantities and write up of sections within the factual and interpretive reports.

R578 Giyani Materials, Limpopo, SOUTH AFRICA (2020-22)
Client: SMEC/ South African National Roads Agency (SANRAL) SOC Limited
Position: Engineering Geologist - The project involves the widening and upgrade of National Road R578 Section 1 from Nwamatatani (Km56.0) to R81 (Km 90.70). Geotechnical works comprises the on-site identification and investigation of material sources. Duan was responsible for building the bill of quantities, on-site investigation, write up of sections within the geological and materials reports.

N3 Mariannhill, Kwa-Zulu Natal, SOUTH AFRICA (2020-22)
Client: SMEC/ South African National Roads Agency (SANRAL) SOC Limited
Position: Engineering Geologist - The project involves the widening and upgrade of the National Route 3 between Key Ridge and Mariannhill Toll Plaza. Geotechnical works comprises the drilling and test pitting of existing cuts and laboratory testing. Duan was responsible for a portion of the on-site investigation, drawing of the geological models, write up of sections within the interpretive report.

KZN Quarries, Kwa-Zulu Natal, SOUTH AFRICA (2019-22)
Client: FDKL/ South African National Roads Agency (SANRAL) SOC Limited
Position: Engineering Geologist - The project involves the identification of potential quarry sources to prospect and secure for future SANRAL contracts in the KZN province. Geotechnical works comprise the on-site identification of material sources. Duan was responsible for developing and implementing of a Quarry-Potential Rating system to categorize and prioritize all sites quantitatively, building the drilling BoQ, writing up of sections in the preliminary assessment report.

N1 R36 Quarries, Free State, SOUTH AFRICA (2021)
Client: HHO/ South African National Roads Agency (SANRAL) SOC Limited
Position: Engineering Geologist - The project involves the identification of potential quarry sources, between Welkom and Koppies, for use on the N1-R34 Route Upgrade project. Geotechnical works comprise the identification and investigation of potential material sources. Duan was responsible for logging and supervising logging of core (1300 m) and percussion chips (950 m) retrieved during the investigation.

## EXPERIENCE: OTHER MAJOR PROJECTS

Upgrades to Damani Water Treatment Plant, SOUTH AFRICA (2019)
Client: EVN Africa Consulting Engineers (Pty) Ltd
Position: Engineering Geologist - The project involved the investigation for the addition of 12 new water reservoirs in the Vhembe District Municipality as part of the upgrading of the Damani Water Treatment Plant. Duan was tasked to undertake visual inspections of soil profiles, in excavations and on slopes, and rock outcrops to make recommendations on foundation solutions for elevated steel tanks and large water reservoirs. Duan was responsible for the site investigation, interpretation and writing of reports.

Kisanfu Geotechnical Investigation, DEMOCRATIC REPUBLIC OF THE CONGO (2019)
Client: Piteau Associates
Position: Engineering Geologist - The project encompassed the drilling of rotary core and trial pit excavations by means of a 40-ton excavator to investigate the overburden materials above an enriched ore deposit in the Democratic Republic of Congo (DRC). The nature and depth to the ore deposit necessitated the establishment of an open cast mine. The investigation was undertaken to determine the overburden properties for design input of cut slopes, haul roads and material utilization. Duan was responsible for 2 months on-site supervision while surveying and logging over 150 trial pits and 800 m of core from boreholes and was responsible for sample retrieval and laboratory testing supervision.

Umlazi and Amatikwe Housing Project, KwaZulu-Natal, SOUTH AFRICA (2019-2020)
Client: Asande Projects Consulting & Engineering
Position: Engineering Geologist - The project involves construction of low-cost housing in the areas of Umlazi and Amatikwe, near Durban in the KwaZulu-Natal Province. Geotechnical works comprises the site investigation, NHBRC classification of the site and the recommendations on foundation design. Duan was responsible for planning of site investigation, supervision of the site investigation, test pit logging and write up of the final geotechnical report. The total project costs are estimated to be R 150 million.

New Ermelo Housing Project, Mpumalanga, SOUTH AFRICA (2020-2021)
Client: Asande Projects Consulting & Engineering
Position: Engineering Geologist - The project involves construction of low-cost housing in the areas of New Ermelo, near Ermelo in the Mpumalanga Province. Geotechnical works comprises the site investigation, NHBRC classification of the site and the recommendations on foundation design. Duan was responsible for planning of site investigation, supervision of the site investigation, test pit logging and write up of the final geotechnical report. The total project costs are estimated to be R 1.3 billion.

## PROFESSIONAL HISTORY

| | |
|---|---|
| 2019 (Oct) – to date: | GaGE Consulting (Pty) Ltd, Johannesburg –Engineering Geologist |
| 2019(Jan)-2019(Sep): | RockSoil Consult – Engineering Geologist |
| 2018 – 2019: | University of Pretoria, Geology Dept. – Lecturer for the following modules: Groundwater (GLY 265), Engineering Geology (GLY 363), Rock Mechanics (GLY 364) |
| 2018 - 2019: | JL Van Rooy - Graduate Engineering Geologist |

## PROFESSIONAL STANDING, MEMBERSHIPS AND COMMITTEES

Registered Natural Scientist the South African Council for Natural Scientific Professions (SACNASP): PrSciNat 137543
Member of the South African Institute of Engineering and Environmental Geologists (SAIEG): MSAIEG 21/526
Water Research Commission – Karst Research Group K5/2326 (2018 – 2020)

Water Research Commission – Complex Vadose Zone Research Group K5/2826 (2020 – 2022*)

University of Pretoria – Geology Dept. External Examiner BSc and BSc(Hons) (2020-2022)

## TECHNICAL QUALIFICATIONS

| | | |
|---|---|---|
| 2020* | PhD Engineering Geology (**Candidate**) | University of Pretoria |
| 2019 | Master of Science (Engineering Geology) | University of Pretoria |
| 2017 | Bachelor of Science (Hons) (Engineering Geology) | University of Pretoria |
| 2016 | Bachelor of Science (Environmental and Engineering Geology) | University of Pretoria |

## TECHNICAL COURSES AND CONFERENCES PRESENTED

| | |
|---|---|
| 2022 | **Presenter**, Kirkham Conference, Soil Science Society of America, Skukuza, Kruger National Park, South Africa. |
| 2022 | **Presenter**, Proceedings of the 20th International Conference on Soil Mechanics and Geotechnical Engineering, Sydney 2022. |
| 2021 | Attendee, Foundation Design for Housing: a short course presented by Stellenbosch University |
| 2021 | **Presenter**, Webinar on Vadose Zone Hydraulics and unsaturated soil mechanics, University of Pretoria |
| 2020 | Attendee, Construction Material Seminar, South African Institute of Engineering and Environmental Geologists (SAIEG), Salt Rock, South Africa. |
| 2018 | **Presenter**, Dolomite: (dis)solution 2018, SAICE Geotechnical Division/GSSA Groundwater Division/South African Institute of Engineering and Environmental Geologists/University of Pretoria, Pretoria, South Africa |

## TECHNICAL PUBLICATIONS

- **Swart, D**., Dippenaar, MA., Van Rooy JL., (2022) Identification of silts. Bulletin of Engineering Geology and the Environment.
- Dippenaar, MA., Jones BR., Van Rooy JL., Maoyi M., **Swart, D**. (2022) The Karst Vadose Zone: Influence on Recharge, Vulnerability and Surface Stability. Water Research Commission Report No. TT 869/21.
- **Swart, D**., Gaspar, T.A.V., & Dippenaar, M. (2022). Testing of hydromechanical properties of the variable saturated residual dolomite (wad). Proceedings of the 20th International Conference on Soil Mechanics and Geotechnical Engineering, Sydney.
- Dippenaar, MA., **Swart, D.**, Van Rooy JL., Diamond RE. (2019) The Karst Vadose Zone: Influence on Recharge, Vulnerability and Surface Stability. Water Research Commission Report No. TT 779/19.
- **Swart, D**., Dippenaar, M., & Van Rooy, J. (2019). Mechanical and hydraulic properties of residual dolomite and wad. South African Journal of Geology, 122(3).
- **Swart, D** (2019). Hydromechanical Properties of wad and residual dolomite. Proceedings of the 7th African Young Geotechnical Engineers Conference, 7-12.

GaGE CONSULTING

# STEVEN BOK

## Principal Engineering Geologist

**PrSciNat BSc (Hons.)**

**DATE OF BIRTH**
30 May 1979

**NATIONALITY**
South African

**LANGUAGES**
English
Afrikaans

**QUALIFICATIONS**
Professionally registered SACNASP 400279/07 (Geological Science), Bachelor of Science (Geology, Geography), Bachelor of Science (Honours) (Geology)

**KEY SKILLS**
Geotechnical site investigations
Desktop & feasibility studies
Materials investigations
Technical report writing
Project Management

**INTERNATIONAL EXPERIENCE**
Botswana, Democratic Republic of the Congo, Lesotho, Madagascar, Mozambique, Sierra Leone, South Africa, Zambia,

**MEMBERSHIP**
GSSA 971552

### SUMMARY OF CREDENTIALS

Steven is a registered professional natural scientist with 20 years of experience in the field of engineering geology and geotechnical engineering. He has broad exposure to infrastructure developments and is adept at undertaking and managing geotechnical site investigations, materials investigations and geotechnical report writing. He also has experience in geotechnical verification and monitoring during construction projects.

Steven has worked throughout South Africa and in Africa providing services to private-sector clients in the mining, consulting and construction industries as well as to government and parastatals.

His technical strengths are the planning and undertaking of site investigations for roads, dams, railways, residential and commercial buildings, township development, large infrastructure (e.g. reservoirs, pipelines, bridges, tailings facilities) and lateral support. Materials investigations (borrow pit and quarry identification and assessment) are an area of particular interest.

Many of the projects on which he has worked represent, complex, multi-disciplinary infrastructure developments. He has been responsible for undertaking and managing the geotechnical component of a major coal mine development in Mpumalanga as well as the new Sol Plaatjie University project in Kimberly. He was the Project Leader and undertook the detailed geotechnical investigation for the Kazungula Bridge over the Zambezi River and the new ash dam facility at the Eskom Camden Power Station

He has vast experience in undertaking geotechnical investigations for housing development, for private developers and organs of state in across South Africa.

He has also been involved with several investigations for large dams including the proposed Ludeke Dam (Eastern Cape), a weir and off-channel storage dam on the Black Umfolozi River (Kwa-Zulu Natal), Thuni Dam (Botswana) and three ash dam projects at Eskom power stations.

He has undertaken geophysical investigations for quarries and borrow pits, groundwater identification and bridge and dam site investigation. Geophysical methods used are seismic refraction surveys, 2D resistivity and EM-34 electromagnetic surveys.

Steven has mentored young engineering geologists as a technical manager at a large South African consulting engineering firm.

He ensures that geotechnical investigations are undertaken in accordance with the Occupational Health and Safety Act and the Mine Health and Safety Act. He has experience in Risk Assessment and the preparation of Health & Safety files in terms of current regulations and client requirements.

## STEVEN BOK: EXPERIENCE - KEY PROJECTS

**Mafube Life Extension Project, Middleburg, Mpumalanga, SOUTH AFRICA, (2013-2019)**
**Client: Mafube Coal (Anglo Coal/Exxaro JV)**
**Lead Engineering Geologist** – the project involved design and construction of mine infrastructure required to utilise the Nooitgedacht coal reserve, located 7km from the existing colliery. This included 7km of overland conveyor, 5km of haul roads, pollution control and water return dams, a new ROM tip, road over rail bridge, major culverts, HMV workshops and associated infrastructure. Steven was responsible for undertaking or overseeing all site investigation work, from preliminary design commencing in 2013 to detailed design and geotechnical construction supervision during 2018/2019. Services included location and monitoring of rockfill and borrow materials. Effective use of mine overburden and borrow materials during construction resulted in a significant cost saving for the Client.
*Project Value: US$200million.*

**N4 Upgrades, Rustenburg, SOUTH AFRICA (various phases, 2010 - 2019)**
**Client: Bakwena**

**Lead Engineering Geologist** – Various upgrade and duelling projects along the N4 between Brits and Swartruggens. Steven was responsible for undertaking and overseeing road prism, materials and bridge investigations required for the detailed design of upgrades between Rustenburg and Swartruggens and duelling along Sections 9, 10 and 13 (approximately 60 km of new carriageway between Brits and Rustenburg). Work included mitigation of highly expansive “black turf” subgrades and sourcing of construction materials. Drilling investigations were undertaken for approximately 12 bridges, including a new bridge over the Crocodile River. Construction supervision and verification of founding conditions.

**New Sol Plaatjie University, Kimberly, South Africa (2015-2017)**
**Client: WITS / Sol Plaatjie University**
**Project Leader for Geotechnical Consultant** – the project involved the construction of a new university in Kimberly. Steven was the Project Leader for the geotechnical consultant responsible detailed site investigations and geotechnical construction supervision. The university complex is constructed on variably weathered dolerite bedrock, which posed a challenge for foundation design. The use of geophysics, detailed rock mass characterisation and targeted drilling, coupled with monitoring of the founding conditions during construction, allowed the design engineers to triple the foundation loads determined during the preliminary design phase.

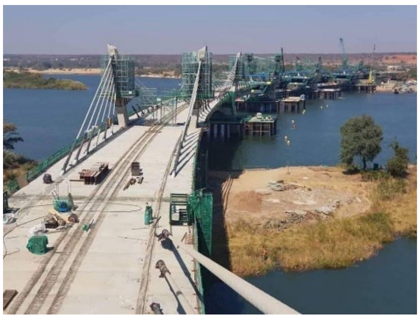
**Camden Power Station new ash dam, water return dam, Ermelo, SOUTH AFRICA (2016)**
**Client: Eskom 2016**

**Project Engineering Geologist** – the project involved the detailed design and subsequent construction of a new Ash Dam Facility, water return dam and associated slurry pipelines and access roads. Steven was responsible for undertaking the geotechnical site investigations as part of the design team. The investigation involved a detailed materials investigation, specialised laboratory and in-situ testing and included extensive interaction with the design and Eskom’s technical teams. The presence of nearby undermining necessitated the use of various geophysical methods to delineate the extent of tunnels, which could have lead to instability of the ADF.

**Various Eskom Substations, SOUTH AFRICA (2013-2015)**
**Client: Eskom SOC Limited**
**Project Leader for Geotechnical Consultant** – detailed geotechnical investigations for 5 major new substations across South Africa, namely the Northrand Substation (Johannesburg), Nieuwehoop Substation (Northern Cape), Dwaalboom Substation (Limpopo), Upington Substation and Firgrove Substations (Somerset West). Steven undertook the site investigations which included assessment of construction materials and geophysical surveys. Engineering geological models were produced for each site, which assisted Eskom's civil design team to optimise the platform layout and earthworks design. The appointment included conceptual platform and subsoil drainage design. The completed Firgrove Substation is illustrated.

**Various Bulk Water Supply pipelines, Gauteng, SOUTH AFRICA, (2009-2013)**
**Client: Rand Water SOC Ltd**
**Project Engineering Geologist / Project Leader –** Steven managed or undertook detailed geotechnical investigations for a major proportion of Rand Water's pipeline construction projects between 2009 and 2013. Work included investigations for sections of the F5, H35, R5, H37, G37, B19, O5, O6 and C25 pipelines. In total, approximately 80 km of route was investigated, for pipelines ranging from 800 mm to 2500 mm diameter, including detained investigations at numerous pipe jacking positions. The investigation outputs included the compiling detailed geotechnical long sections of the pipeline routes highlighting excavation conditions and geotechnical risks. Most of the projects have been successfully constructed.

**Various Rand Water Reservoirs & Pumping Stations, Gauteng, SOUTH AFRICA, (2010-2016)**
**Client: Rand Water SOC Ltd**
**Project Engineering Geologist / Project Leader –** Detailed site investigations (typically drilling investigations) were undertaken for an additional reservoir a the Palmiet Pumping Station (100 Ml) the Amanzimtoti Reservoir (20 Ml), Bronberg Reservoir (100 Ml), extensions to the Palmiet Pumping Station and sections of the Zuikerbosch and Vereeniging WTW extension projects. Steven was involved with geotechnical site supervision during construction on many of the projects. Palmiet Pumping Station is illustrated.



**Kazangula Bridge over the Zambezi River, BOTSWANA, (2011),**
**Client: EGIS BECOM International**
**Project Engineering Geologist for detailed geotechnical investigations –** the 923-metre-long Kazangula Bridge, currently nearing completion, crosses the Zambezi River at Kasane, Botswana. The bridge provides a road and rail crossing between Botswana and Zambia and passes through Namibia, where the country's borders meet. Steven was the project Engineering Geologist for the contractor who undertook the site investigation and was responsible for ensuring that the investigations were undertaken in accordance with European standards and technical reporting. He undertook full-time supervision of the drilling and in-situ testing works, which were undertaken from a jack-up barge. The reporting included rock mass characterisation beneath the bridge piers, settlement estimates and provision of foundation recommendations.

## EXPERIENCE: OTHER PROJECTS

**R578 Giyani Materials, Limpopo (2020-22)**
**Client: SMEC/ South African National Roads Agency (SANRAL) SOC Limited**
**Engineering Geologist –** Preliminary GI for material sources.

**N1 R36 Quarries, Free State(2021)**
**Client: HHO/ South African National Roads Agency (SANRAL) SOC Limited**
**Engineering Geologist –** Logging of core and percussion chips for material sources.

**Khwezela Life Extension Project (2019)**
**Client: Anglo Coal**
**Project Leader (PL) & Senior Engineering Geologist -** haul road materials investigation and pavement design project, including construction supervision as part of a coal mine expansion project.

**Kriel Ash Dam Stability Analysis (2017-2018)**
**Client: Eskom**
**Senior Engineering Geologist -** responsible for geotechnical investigations to characterise an existing wet ash dam facility.

**Hendrina Step-in-and-go-higher project (2015)**
**Client: Eskom**
**Project Engineering Geologist** – geotechnical investigation for the proposed raising of the ash dam facility at Hendrina Power Station.

**Leeuwpan OI BFS External Roads Package (2015)**
**Client: Exxaro**
**Project Leader** – a road prism and materials investigation for the realignment of the R50 provincial road around the Leeuwpan Colliery, Ogies, Mpumalanga.

**Three story office building at Camden Power Station (2012/13)**
**Client: Eskom**
**Project Leader** - site investigations, pilling supervision & pile integrity verification

**Belfast Mine Leachate Dams (2011)**
**Client: Exxaro**
**Senior Engineering Geologist -** GI for preliminary design of two lined earthfill return water dams

**Foundation investigations for approx. 80 Eskom Telecommunication Towers (2010-2014)**
**Client: Eskom**
**Project Leader -** term appointment for undertaking site investigations for foundation design of new Eskom telecommunication towers throughout South Africa

**Sierra Leone centre line & materials investigation (2010)**
**client: African Minerals**
**Senior Engineering Geologist -** road prism and materials investigation for 50km of new haul road / railway line in Sierra Leone, including foundation investigations for bridges.

**Dumbe Coal Line Stability Analysis (2009-2010)**
**Client: Transnet**
**Project Leader & Senior Engineering Geologist -** GI for slope stability analysis for widening of 6 km of cuttings on the Coal Line near Paulpietersburg.

**Lesotho Lowlands Geotech Zone 4&5 (2007)**
**Client: Lesotho Ministry of Natural Resources**
**Engineering Geologist –** Detailed GI for 350 km bulk supply pipeline, 46 Reservoirs & pump stations

**Thuni Dam, in Eastern Botswana (2005)**
**Client: DWA Botswana**
Engineering Geologist: Detailed geotechnical investigations and materials investigation for a large earthfill dam

## PROFESSIONAL HISTORY

2019 – date: GaGE Consulting (Pty) Ltd, Cape Town – Principal Engineering Geologist.

2002 – 2019: JG Afrika (Pty) Ltd Engineering & Environmental Consulting. Engineering Geologist (Pietermaritzburg, 2002 to 2007), Senior Engineering Geologist (Pietermaritzburg, 2007 to 2009), Senior Engineering Geologist (Johannesburg, 2009 – 2013), Associate (Johannesburg, 2013 – 2019).

## TECHNICAL QUALIFICATIONS

| | | |
|---|---|---|
| 2000 | Bachelor of Science (Geology, Geography) | Nelson Mandela University |
| 2001 | Bachelor of Science (Honours) (Geology) | Nelson Mandela University |

## TECHNICAL COURSES AND CONFERENCES ATTENDED

2014 Attendee, SAICE Young Geotechnical Engineers Conference, Stellenbosch.

2008 Attendee, SAICE Young Geotechnical Engineers Conference, Durban.

2005 Attendee, SAICE Young Geotechnical Engineers Conference, Swadini.

# Appendix C. Environmental Impact Assessment (EIA) Methodology

# 1 ENVIRONMENTAL IMPACT ASSESSMENT (EIA) METHODOLOGY

The Environmental Impact Assessment (EIA) Methodology assists in evaluating the overall effect of a proposed activity on the environment. Determining of the significance of an environmental impact on an environmental parameter is determined through a systematic analysis.

## 1.1 Determination of Significance of Impacts

Significance is determined through a synthesis of impact characteristics which include context and intensity of an impact. Context refers to the geographical scale (i.e. site, local, national or global), whereas intensity is defined by the severity of the impact e.g. the magnitude of deviation from background conditions, the size of the area affected, the duration of the impact and the overall probability of occurrence. Significance is calculated as shown in **Table 1**.

Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The total number of points scored for each impact indicates the level of significance of the impact.

## 1.2 Impact Rating System

The impact assessment must take account of the nature, scale and duration of effects on the environment and whether such effects are positive (beneficial) or negative (detrimental). Each issue / impact is also assessed according to the various project stages, as follows:

- Planning;
- Construction;
- Operation; and
- Decommissioning.

Where necessary, the proposal for mitigation or optimisation of an impact should be detailed. A brief discussion of the impact and the rationale behind the assessment of its significance has also been included.

***The significance of Cumulative Impacts should also be rated (As per the Excel Spreadsheet Template).***

### *1.2.1 Rating System Used to Classify Impacts*

The rating system is applied to the potential impact on the receiving environment and includes an objective evaluation of the possible mitigation of the impact. Impacts have been consolidated into one (1) rating. In assessing the significance of each issue the following criteria (including an allocated point system) is used:

**Table 1:** Rating of impacts criteria

| | | |
|---|---|---|
| **ENVIRONMENTAL PARAMETER** | | |
| A brief description of the environmental aspect likely to be affected by the proposed activity (e.g. Surface Water). | | |
| **ISSUE / IMPACT / ENVIRONMENTAL EFFECT / NATURE** | | |
| Include a brief description of the impact of environmental parameter being assessed in the context of the project. This criterion includes a brief written statement of the environmental aspect being impacted upon by a particular action or activity (e.g. oil spill in surface water). | | |
| **EXTENT (E)** | | |
| This is defined as the area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales and as such bracketing ranges are often required. This is often useful during the detailed assessment of a project in terms of further defining the determined. | | |
| 1 | Site | The impact will only affect the site |
| 2 | Local/district | Will affect the local area or district |
| 3 | Province/region | Will affect the entire province or region |
| 4 | International and National | Will affect the entire country |
| **PROBABILITY (P)** | | |
| This describes the chance of occurrence of an impact | | |
| 1 | Unlikely | The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence). |
| 2 | Possible | The impact may occur (Between a 25% to 50% chance of occurrence). |
| 3 | Probable | The impact will likely occur (Between a 50% to 75% chance of occurrence). |
| 4 | Definite | Impact will certainly occur (Greater than a 75% chance of occurrence). |
| **REVERSIBILITY (R)** | | |
| This describes the degree to which an impact on an environmental parameter can be successfully reversed upon completion of the proposed activity. | | |
| 1 | Completely reversible | The impact is reversible with implementation of minor mitigation measures |
| 2 | Partly reversible | The impact is partly reversible but more intense mitigation measures are required. |
| 3 | Barely reversible | The impact is unlikely to be reversed even with intense mitigation measures. |
| 4 | Irreversible | The impact is irreversible and no mitigation measures exist. |
| **IRREPLACEABLE LOSS OF RESOURCES (L)** | | |
| This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity. | | |
| 1 | No loss of resource. | The impact will not result in the loss of any resources. |
| 2 | Marginal loss of resource | The impact will result in marginal loss of resources. |
| 3 | Significant loss of resources | The impact will result in significant loss of resources. |
| 4 | Complete loss of resources | The impact is result in a complete loss of all resources. |
| **DURATION (D)** | | |
| This describes the duration of the impacts on the environmental parameter. Duration indicates the lifetime of the impact as a result of the proposed activity. | | |

| | | |
|---|---|---|
| 1 | Short term | The impact and its effects will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (0 – 1 years), or the impact and its effects will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years). |
| 2 | Medium term | The impact and its effects will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years). |
| 3 | Long term | The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 50 years). |
| 4 | Permanent | The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered transient (Indefinite). |
| **INTENSITY / MAGNITUDE (I / M)** | | |
| Describes the severity of an impact (i.e. whether the impact has the ability to alter the functionality or quality of a system permanently or temporarily). | | |
| 1 | Low | Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible. |
| 2 | Medium | Impact alters the quality, use and integrity of the system/component but system/ component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity). |
| 3 | High | Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation. |
| 4 | Very high | Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired (system collapse). Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation. |
| **SIGNIFICANCE (S)** | | |
| Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. This describes the significance of the impact on the environmental parameter. The calculation of the significance of an impact uses the following formula:<br><br>**Significance = (Extent + probability + reversibility + irreplaceability + duration) x magnitude/intensity.** | | |

The summation of the different criteria will produce a non-weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.

| Points | Impact Significance Rating | Description |
|---|---|---|
| | | |
| 5 to 23 | Negative Low impact | The anticipated impact will have negligible negative effects and will require little to no mitigation. |
| 5 to 23 | Positive Low impact | The anticipated impact will have minor positive effects. |
| 24 to 42 | Negative Medium impact | The anticipated impact will have moderate negative effects and will require moderate mitigation measures. |
| 24 to 42 | Positive Medium impact | The anticipated impact will have moderate positive effects. |
| 43 to 61 | Negative High impact | The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact. |
| 43 to 61 | Positive High impact | The anticipated impact will have significant positive effects. |
| 62 to 80 | Negative Very high impact | The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws". |
| 62 to 80 | Positive Very high impact | The anticipated impact will have highly significant positive effects. |

The table below is to be represented in the Impact Assessment section of the report. The excel spreadsheet template can be used to complete the Impact Assessment.

**Table 2:** Rating of impacts template and example

| ENVIRONMENTAL PARAMETER | ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE | ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION | | | | | | | | | RECOMMENDED MITIGATION MEASURES | ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | E | P | R | L | D | I / M | TOTAL | STATUS (+ OR -) | S | | E | P | R | L | D | I / M | TOTAL | STATUS (+ OR -) | S |
| **Construction Phase** | | | | | | | | | | | | | | | | | | | | |
| Vegetation and protected plant species | Vegetation clearing for access roads, turbines and their service areas and other infrastructure will impact on vegetation and protected plant species. | 2 | 4 | 2 | 2 | 3 | 3 | 39 | - | Medium | **Outline/explain the mitigation measures to be undertaken to ameliorate the impacts that are likely to arise from the proposed activity. These measures will be detailed in the EMPr.** | 2 | 4 | 2 | 1 | 3 | 2 | 24 | - | Low |
| | | | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operational Phase** | | | | | | | | | | | | | | | | | | | | |
| Fauna | Fauna will be negatively affected by the operation of the wind farm due to the human disturbance, the presence of vehicles on the site and possibly by noise generated by the wind turbines as well. | 2 | 3 | 2 | 1 | 4 | 3 | 36 | - | Medium | **Outline/explain the mitigation measures to be undertaken to ameliorate the impacts that are likely to arise from the proposed activity. These measures will be detailed in the EMPr.** | 2 | 2 | 2 | 1 | 4 | 2 | 22 | - | Low |
| | | | | | | | | | | | | | | | | | | | | |
| **Decommissioning Phase** | | | | | | | | | | | | | | | | | | | | |
| Fauna | Fauna will be negatively affected by the decommissioning of the wind farm due to the human disturbance, the presence and operation of vehicles and heavy machinery on the site and the noise generated. | 2 | 3 | 2 | 1 | 2 | 3 | 30 | - | Medium | **Outline/explain the mitigation measures to be undertaken to ameliorate the impacts that are likely to arise from the proposed activity. These measures will be detailed in the EMPr.** | 2 | 2 | 2 | 1 | 2 | 2 | 18 | - | Low |
| | | | | | | | | | | | | | | | | | | | | |

| Cumulative | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Broad-scale ecological processes | Transformation and presence of the facility will contribute to cumulative habitat loss and impacts on broad-scale ecological processes such as fragmentation. | 2 | 4 | 2 | 2 | 3 | 2 | 26 | - | Medium | **Outline/explain the mitigation measures to be undertaken to ameliorate the impacts that are likely to arise from the proposed activity. These measures will be detailed in the EMPr.** | 2 | 3 | 2 | 1 | 3 | 2 | 22 | - | Low |
| | | | | | | | | | | | | | | | | | | | |

# Appendix D. Impact Rating Tables

| PROPOSED CONSTRUCTION OF THE HEUWELTJIES WIND ENERGY FACILITY | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ENVIRONMENTAL PARAMETER | ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE | ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION | | | | | | | | | RECOMMENDED MITIGATION MEASURES | ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION | | | | | | | | | | |
| | | E | P | R | L | D | I / M | TOTAL | STATUS (+ OR -) | S | | E | P | R | L | D | I / M | TOTAL | STATUS (+ OR -) | S | | |
| **Construction Phase** | | | | | | | | | | | | | | | | | | | | | | |
| Disturbance/ displacement/ removal of soil and rock | Ground disturbance during access road construction, foundation earthworks, platform earthworks | 1 | 4 | 3 | 2 | 3 | 1 | 13 | - | Low | 1) Design access roads and turbine locations (including crane pads) to minimise earthworks and levelling based on high resolution ground contour information<br>2) Correct topsoil and spoil management<br>3) Materials utilisation to minimise opening of borrow pits or creation of spoil | 1 | 3 | 2 | 1 | 3 | 1 | 10 | - | Low | | |
| Soil Erosion | Increased erosion due to vegetation clearing, alteration of natural drainage | 1 | 3 | 3 | 2 | 2 | 1 | 11 | - | Low | 1) Avoid development in preferential drainage paths<br>2) Appropriate engineering design of road drainage and watercourse crossings<br>3) Temporary berms and drainage channels to divert surface runoff where needed<br>4) Landscape and rehabilitate disturbed areas timeously (e.g. revegetation)<br>5) Use designated access and laydown areas only to minimise disturbance to surrounding areas | 1 | 2 | 1 | 1 | 2 | 1 | 7 | - | Low | | |
| **Operational Phase** | | | | | | | | | | | | | | | | | | | | | | |
| Soil Erosion | Increased erosion due to alteration of natural drainage | 1 | 2 | 1 | 1 | 2 | 1 | 7 | - | Low | 1) Maintain drainage channels<br>2) Monitor for erosion and remediate and rehabilitate timeously | 1 | 1 | 1 | 1 | 2 | 1 | 6 | - | Low | | |
| **Decommissioning Phase** | | | | | | | | | | | | | | | | | | | | | | |

| ENVIRONMENTAL PARAMETER | ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE | ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION | | | | | | | | | RECOMMENDED MITIGATION MEASURES | ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | E | P | R | L | D | I / M | TOTAL | STATUS (+ OR -) | S | | E | P | R | L | D | I / M | TOTAL | STATUS (+ OR -) | S |
| Disturbance/ displacement/ removal of soil and rock | Ground disturbance during platform earthworks, road rehabilitation, removal of subsurface infrastructure | 1 | 4 | 2 | 2 | 2 | 1 | 11 | - | Low | 1) Restore natural site topography<br>2) Landscape and rehabilitate disturbed areas timeously (e.g. revegetation) | 1 | 4 | 2 | 1 | 2 | 1 | 10 | - | Low |
| Soil Erosion | Increased erosion due to ground disturbance during rehabilitation activities | 1 | 2 | 2 | 2 | 2 | 1 | 9 | - | Low | 1) Temporary berms and drainage channels to divert surface runoff where needed<br>2) Restore natural site topography<br>3) Use designated access and laydown areas only to minimise disturbance to surrounding areas | 1 | 1 | 1 | 1 | 2 | 1 | 6 | - | Low |
| **Cumulative** | | | | | | | | | | | | | | | | | | | | |
| Disturbance/ displacement/ removal of soil and rock | No cumulative effect | | | | | | | 0 | | | | | | | | | | 0 | | |
| Soil Erosion | | | | | | | | 0 | | | | | | | | | | 0 | | |

| HEUWELTJIES SOLAR WEF - SUBSTATION OPTION | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ENVIRONMENTAL PARAMETER | ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE | ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION | | | | | | | | | RECOMMENDED MITIGATION MEASURES | ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION | | | | | | | | |
| | | E | P | R | L | D | I / M | TOTAL | STATUS (+ OR -) | S | | E | P | R | L | D | I / M | TOTAL | STATUS (+ OR -) | S |
| **Construction Phase (Option 1)** | | | | | | | | | | | | | | | | | | | | |
| Disturbance/ displacement/ removal of soil and rock | Ground disturbance during access road construction, foundation earthworks, platform earthworks | 1 | 4 | 3 | 2 | 3 | 1 | 13 | - | Low | 1) Design access roads and pylon locations to minimise earthworks and levelling based on high resolution ground contour information<br>2) Correct topsoil and spoil management | 1 | 3 | 2 | 1 | 3 | 1 | 10 | - | Low |
| Soil Erosion | Increased erosion due to vegetation clearing, alteration of natural drainage | 1 | 3 | 3 | 2 | 2 | 1 | 11 | - | Low | 1) Avoid development in preferential drainage paths<br>2) Appropriate engineering design of road drainage and watercourse crossings<br>3) Temporary berms and drainage channels to divert surface runoff where needed<br>4) Landscape and rehabilitate disturbed areas timeously (e.g. revegetation)<br>5) Use designated access and laydown areas only to minimise disturbance to surrounding areas | 1 | 2 | 1 | 1 | 2 | 1 | 7 | - | Low |
| **Construction Phase (Option 2)** | | | | | | | | | | | | | | | | | | | | |
| Disturbance/ displacement/ removal of soil and rock | Ground disturbance during access road construction, foundation earthworks, platform earthworks | 1 | 4 | 3 | 2 | 3 | 1 | 13 | - | Low | 1) Design access roads and pylon locations to minimise earthworks and levelling based on high resolution ground contour information<br>2) Correct topsoil and spoil management | 1 | 3 | 2 | 1 | 3 | 1 | 10 | - | Low |
| Soil Erosion | Increased erosion due to vegetation clearing, alteration of natural drainage | 1 | 4 | 3 | 2 | 2 | 1 | 12 | - | Low | 1) Avoid development in preferential drainage paths<br>2) Appropriate engineering design of road drainage and watercourse crossings<br>3) Temporary berms and drainage channels to divert surface runoff where needed<br>4) Landscape and rehabilitate disturbed areas timeously (e.g. revegetation)<br>5) Use designated access and laydown areas only to minimise disturbance to surrounding areas | 1 | 3 | 1 | 1 | 2 | 1 | 8 | - | Low |

| ENVIRONMENTAL PARAMETER | ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE | ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION | | | | | | | | | RECOMMENDED MITIGATION MEASURES | ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | E | P | R | L | D | I / M | TOTAL | STATUS (+ OR -) | S | | E | P | R | L | D | I / M | TOTAL | STATUS (+ OR -) | S |
| **Operational Phase (Option 1)** | | | | | | | | | | | | | | | | | | | | |
| Soil Erosion | Increased erosion due to alteration of natural drainage | 1 | 2 | 1 | 1 | 2 | 1 | 7 | - | Low | 1) Maintain drainage channels<br>2) Monitor for erosion and remediate and rehabilitate timeously | 1 | 1 | 1 | 1 | 2 | 1 | 6 | - | Low |
| **Operational Phase (Option 2)** | | | | | | | | | | | | | | | | | | | | |
| Soil Erosion | Increased erosion due to alteration of natural drainage | 1 | 2 | 1 | 1 | 2 | 1 | 7 | - | Low | 1) Maintain drainage channels<br>2) Monitor for erosion and remediate and rehabilitate timeously | 1 | 1 | 1 | 1 | 2 | 1 | 6 | - | Low |
| **Decommissioning Phase (Option 1)** | | | | | | | | | | | | | | | | | | | | |
| Disturbance/ displacement/ removal of soil and rock | Ground disturbance during platform earthworks, road rehabilitation, removal of subsurface infrastructure | 1 | 4 | 2 | 2 | 2 | 1 | 11 | - | Low | 1) Restore natural site topography<br>2) Landscape and rehabilitate disturbed areas timeously (e.g. regrassing) | 1 | 4 | 2 | 1 | 2 | 1 | 10 | - | Low |
| Soil Erosion | Increased erosion due to ground disturbance during rehabilitation activities | 1 | 2 | 2 | 2 | 2 | 1 | 9 | - | Low | 1) Temporary berms and drainage channels to divert surface runoff where needed<br>2) Restore natural site topography<br>3) Use designated access and laydown areas only to minimise disturbance to surrounding areas | 1 | 1 | 1 | 1 | 2 | 1 | 6 | - | Low |
| **Decommissioning Phase (Option 2)** | | | | | | | | | | | | | | | | | | | | |
| Disturbance/ displacement/ removal of soil and rock | Ground disturbance during platform earthworks, road rehabilitation, removal of subsurface | 1 | 4 | 2 | 2 | 2 | 1 | 11 | - | Low | 1) Restore natural site topography | 1 | 4 | 2 | 1 | 2 | 1 | 10 | - | Low |

| ENVIRONMENTAL PARAMETER | ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE | ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION | | | | | | | | | RECOMMENDED MITIGATION MEASURES | ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | E | P | R | L | D | I / M | TOTAL | STATUS (+ OR -) | S | | E | P | R | L | D | I / M | TOTAL | STATUS (+ OR -) | S |
| rock | infrastructure | | | | | | | | | | 2) Landscape and rehabilitate disturbed areas timeously (e.g. revegetation) | | | | | | | | | |
| Soil Erosion | Increased erosion due to ground disturbance during rehabilitation activities | 1 | 2 | 2 | 2 | 2 | 1 | 9 | - | Low | 1) Temporary berms and drainage channels to divert surface runoff where needed<br>2) Restore natural site topography<br>3) Use designated access and laydown areas only to minimise disturbance to surrounding areas | 1 | 1 | 1 | 1 | 2 | 1 | 6 | - | Low |
| **Cumulative (Option 1)** | | | | | | | | | | | | | | | | | | | | |
| Disturbance/ displacement/ removal of soil and rock | No cumulative effect | | | | | | | 0 | | | | | | | | | | 0 | | |
| Soil Erosion | | | | | | | | 0 | | | | | | | | | | 0 | | |
| **Cumulative (Option 2)** | | | | | | | | | | | | | | | | | | | | |
| Disturbance/ displacement/ removal of soil and rock | No cumulative effect | | | | | | | 0 | | | | | | | | | | 0 | | |
| Soil Erosion | | | | | | | | 0 | | | | | | | | | | 0 | | |