Appendix 6
Specialist Studies

SiVEST

Appendix 6A

Agricultural and Soils Assessment

Johann Lanz
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AGRICULTURAL AND SOILS IMPACT ASSESSMENT FOR PROPOSED UMSOBOMVU SOLAR PV ENERGY FACILITIES NEAR NOUPOORT AND MIDDELBURG NORTHERN CAPE AND EASTERN CAPE PROVINCES

EIA REPORT

Report by
Johann Lanz

20 November 2019

Johann Lanz
Professional profile

Education

• M.Sc. (Environmental Geochemistry)	University of Cape Town	1996 - June 1997
• B.Sc. Agriculture (Soil Science, Chemistry)	University of Stellenbosch	1992 - 1995
• BA (English, Environmental & Geographical Science)	University of Cape Town	1989 - 1991
• Matric Exemption	Wynberg Boy's High School	1983

Professional work experience

I am registered as a Professional Natural Scientist (Pri.Sci.Nat.) in the field of soil science, registration number 400268/12, and am a member of the Soil Science Society of South Africa.

- **Soil Science Consultant** **Self employed** **2002 - present**
  I run a soil science consulting business, servicing clients in both the environmental and agricultural industries. Typical consulting projects involve:
- Soil specialist study inputs to EIA's, SEA's and EMPR's. These have focused on impact assessments and rehabilitation on agricultural land, rehabilitation and re-vegetation of mining and industrially disturbed and contaminated soils, as well as more general aspects of soil resource management. Recent clients include: CSIR; SRK Consulting; Aurecon; Mainstream Renewable Power; SiVEST; Savannah Environmental; Subsolar; Red Cap Investments; MBB Consulting Engineers; Enviroworks; Sharples Environmental Services; Haw & Inglis; BioTherm Energy; Tiptrans.
- Soil resource evaluations and mapping for agricultural land use planning and management. Recent clients include: Cederberg Wines; Unit for Technical Assistance - Western Cape Department of Agriculture; Wedderwill Estate; Goedgedacht Olives; Zewenwacht Wine Estate, Lourensford Fruit Company; Kaarsten Boerdery; Thelema Mountain Vineyards; Rudera Wines; Flagstone Wines; Solms Delta Wines; Dornier Wines.
- I have conducted several recent research projects focused on conservation farming, soil health and carbon sequestration.
- I have project managed the development of soil nutrition software for Farmsecure Agri Science.

- **Soil Science Consultant** **Agricultural Consultors International (Tinie du Preez)** **1998 - end 2001**
  Responsible for providing all aspects of a soil science technical consulting service directly to clients in the wine, fruit and environmental industries all over South Africa, and in Chile, South America.

- **Contracting Soil Scientist** **De Beers Namaqualand Mines** **July 1997 - Jan 1998**
  Completed a contract to make recommendations on soil rehabilitation and re-vegetation of mined areas.

Publications

- Lanz, J. 2012. Soil health: sustaining Stellenbosch's roots. In: M Swilling, B Sebitosi & R Loots (eds). *Sustainable Stellenbosch: opening dialogues*. Stellenbosch: SunMedia.
- Lanz, J. 2010. Soil health indicators: physical and chemical. *South African Fruit Journal*, April / May 2010 issue.
- Lanz, J. 2009. Soil health constraints. *South African Fruit Journal*, August / September 2009 issue.
- Lanz, J. 2009. Soil carbon research. *AgriProbe*, Department of Agriculture.
- Lanz, J. 2005. Special Report: Soils and wine quality. *Wineland Magazine.*

I am a reviewing scientist for the *South African Journal of Plant and Soil*.

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

Proposed Construction of the Mooi Plaats, Wonderheuvel and Paarde Valley Solar PV Energy Facilities and Associated Grid Connection Infrastructure, near Noupoort in the Northern and Eastern Cape Provinces.

Kindly note the following:

- 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.
- 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.
- A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
- 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.
- 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:	Johann Lanz – Soil Scientist			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	4	Percentage Procurement recognition	100%
Specialist name:	Johann Lanz			
Specialist Qualifications:	M.Sc. (Environmental Geochemistry)			
Professional affiliation/registration:	Registered Professional Natural Scientist Member of the Soil Science Society of South Africa			
Physical address:	1a Wolfe Street, Wynberg, Cape Town, 7800			
Postal address:	1a Wolfe Street, Wynberg, Cape Town, 7800			
Postal code:	7800	Cell:	082 927 9018	
Telephone:	082 927 9018	Fax:	Who still uses a fax?	
E-mail:	johann@johannlanz.co.za			

2. DECLARATION BY THE SPECIALIST

I, **Johann Lanz**, 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

Johann Lanz – Soil Scientist (sole proprietor)

Name of Company:

30/10/2019

Date

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, **Johann Lanz**, 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

Johann Lanz – Soil Scientist (sole proprietor)

Name of Company

30/10/2019

Date

7225358 CST
R MENDELN

Signature of the Commissioner of Oaths

2019 10.30.

Date

SUID-AFRIKAANSE POLISIEDIENS
STATION COMMANDER
WYNBERG KP
30 OCT 2019
STATION COMMANDER
WYNBERG CP
SOUTH AFRICAN POLICE SERVICE

EXECUTIVE SUMMARY

The key findings of this study are:

- The proposed project area is dominated by shallow, loamy sands on underlying rock or less commonly clay. Dominant soil forms are Swartland, Hutton, Mispah, and Valsrivier.
- The major limitations to agriculture are the limited climatic moisture availability (low rainfall), the rugged terrain and the shallow, rocky soils.
- As a result of these limitations, the agricultural use of the study area is limited to low intensity grazing only, except for some isolated patches of irrigation land.
- The proposed project area is classified with land capability evaluation values between 1 (very low) and 7 (low to moderate), with 6 being most predominant.
- The significance of all agricultural impacts is kept low by the limited agricultural potential of the land.
- The only parts of the study area that do not have low sensitivity are the small patches of irrigation. These are considered no-go areas for any footprint of development that will exclude cultivation.
- Two potential negative impacts of the development on agricultural resources and productivity were identified. These are:
    - Loss of agricultural land use; and
    - Soil erosion and degradation.
- One potential positive impact of the development on agricultural resources and productivity was identified as:
    - Increased financial security of farming operations through rental income
- Soil erosion and degradation was assessed as having medium significance before and after mitigation. The other two impacts were assessed as having low significance before and after mitigation.
- The recommended mitigation measures are for implementation of an effective system of storm water run-off control; maintenance of vegetation cover; and to strip, stockpile and re-spread topsoil.
- There is no material difference between the significance of impacts of any of the proposed project alternatives. All proposed alternatives have equal impact.
- Due to the low agricultural potential of the site, and the consequent low to medium, negative agricultural impact, there are no restrictions relating to agriculture which preclude authorisation of the proposed development (including all alternatives) and therefore, from an agricultural impact point of view, the development should be authorised.

Table of Contents

1 INTRODUCTION

Three Solar Photovoltaic (PV) Energy Facilities, with associated grid connection infrastructure, are proposed approximately 36 km north west of Middelburg in the Karoo.

The objectives of this study are to identify and assess all potential impacts of the proposed development on agricultural resources, including soils, and agricultural production potential and to provide recommended mitigation measures, monitoring requirements, and rehabilitation guidelines for all identified impacts.

2 PROJECT DESCRIPTION

It is proposed that three (3) Solar Photovoltaic (PV) Energy Facilities, with associated grid connection infrastructure, will be developed, these being:

Mooi Plaats Solar PV Facility, on an application site of approximately 5 303ha, comprising the following farm portions:

Portion 1 of Leuwe Kop No 120
Remainder of Mooi Plaats No 121

Wonderheuvel Solar PV Facility, on an application site of approximately 5 652ha, comprising the following farm portions:

Remainder of Mooi Plaats No 121
Portion 3 of Wonder Heuvel No 140
Portion 5 of Holle Fountain No 133

Paarde Valley Solar PV Facility, on an application site of approximately 3 695ha, comprising the following farm portion:

Portion 2 of Paarde Valley No 62: and
Portion 7 of the Farm Leeuw Hoek No. 61.

SOLAR PV COMPONENTS

Mooi Plaats Solar PV Energy Facility:

The proposed Mooi Plaats Solar PV Energy Facility will include the following components:

- Three (3) PV array areas, occupying a combined total area of approximately 777 hectares (ha).
- The proposed solar PV energy facility will have a maximum total generation capacity of approximately 400MW and will comprise approximately 1 142 857 PV modules. The final number of modules as well as their configuration will only be determined in the detailed design phase.
- PV modules will be either fixed tilt mounting or single axis tracking mounting, and the modules will be either crystalline silicon or thin film technology. Each module will be

approximately 2m wide and between 1m and 4m in height, depending on the mounting type.
- Internal roads, between 4m and 10m wide, will provide access to the PV arrays. Existing site roads will be used wherever possible, although new site roads will be constructed where necessary.
- Up to three (3) temporary construction laydown / staging areas of approximately 4ha each.
- Operation and maintenance (O&M) buildings will be provided for each PV array area, occupying a site of approximately 1ha each. Up to a maximum of three (3) O&M buildings will thus be constructed.
- Medium voltage cabling will link the solar PV energy facility to the grid connection infrastructure. These cables will be laid underground wherever technically feasible.

Wonderheuvel Solar PV Energy Facility:

The proposed Wonderheuvel Solar PV Energy Facility will include the following components:

- Six (6) PV array areas, occupying a combined total area of approximately 864ha.
- The proposed solar PV energy facility will have a maximum total generation capacity of approximately 480MW and will comprise approximately 1 371 429 PV modules. The final number of modules as well as their configuration will only be determined in the detailed design phase.
- PV modules will be either fixed tilt mounting or single axis tracking mounting, and the modules will be either crystalline silicon or thin film technology. Each module will be approximately 2m wide and between 1m and 4m in height, depending on the mounting type.
- Internal roads, between 4m and 10m wide, will provide access to the PV arrays. Existing site roads will be used wherever possible, although new site roads will be constructed where necessary.
- Up to a maximum of four (4) temporary construction laydown / staging areas of approximately 4ha each.
- Operation and maintenance (O&M) buildings will be provided for each PV array area, occupying a site of approximately 1ha each. However, certain PV array areas will share O&M buildings. Up to a maximum of four (4) O&M buildings will thus be constructed.
- Medium voltage cabling will link the solar PV energy facility to the grid connection infrastructure. These cables will be laid underground wherever technically feasible.

Paarde Valley Solar PV Energy Facility:

The proposed Paarde Valley Solar PV Energy Facility will include the following components:

- Five (5) PV array areas, occupying a combined total area of approximately 1 337ha.
- The proposed solar PV energy facility will have a maximum total generation capacity of approximately 700MW and will comprise approximately 2 000 000 PV modules. The final number of modules as well as their configuration will only be determined in the

detailed design phase.

- PV modules will be either fixed tilt mounting or single axis tracking mounting, and the modules will be either crystalline silicon or thin film technology. Each module will be approximately 2m wide and between 1m and 4m in height, depending on the mounting type.
- Internal roads, between 4m and 10m wide, will provide access to the PV arrays. Existing site roads will be used wherever possible, although new site roads will be constructed where necessary.
- Up to five (5) temporary construction laydown / staging areas of approximately 4ha each.
- Operation and maintenance (O&M) buildings will be provided for each PV array area, occupying a site of approximately 1ha each. Up to a maximum of five (5) O&M buildings will thus be constructed.
- Medium voltage cabling will link the solar PV energy facility to the grid connection infrastructure. These cables will be laid underground wherever technically feasible.

Grid Connection Infrastructure

The proposed grid connection infrastructure will include the following components:

- New on-site substations and collector substations to serve each solar PV energy facility, each occupying an area of up to approximately 4ha.
- A new 132kV overhead power line connecting the on-site substations and/or collector substations to either the Hydra D Main Transmission Substation (MTS) or the proposed Coleskop Wind Energy Facility (WEF) substation, from where the electricity will be fed into the national grid. The type of power line towers being considered at this stage to include both lattice and monopole towers which will be up to 25m in height.

Grid connection infrastructure alternatives have been provided for each PV project. These alternatives essentially provide for different route alignments with associated substations contained within an assessment corridor between approximately 400m and 900m wide. This is to allow for flexibility to route the power line on either side of the existing high voltage Eskom power lines.

Maps of the three projects are provided in Figures 1 to 3.

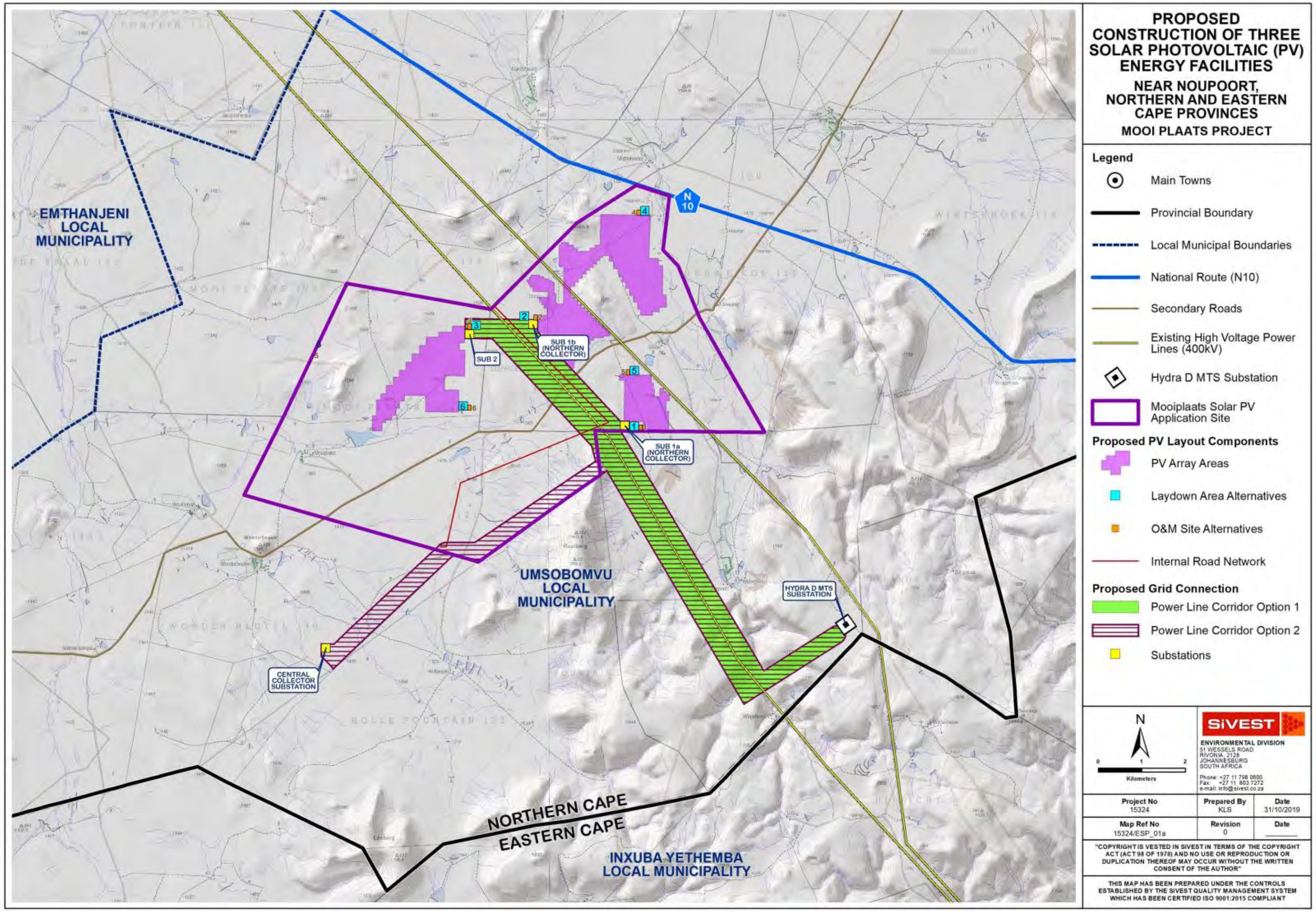

Figure 1. Map of Mooi Plaats project.

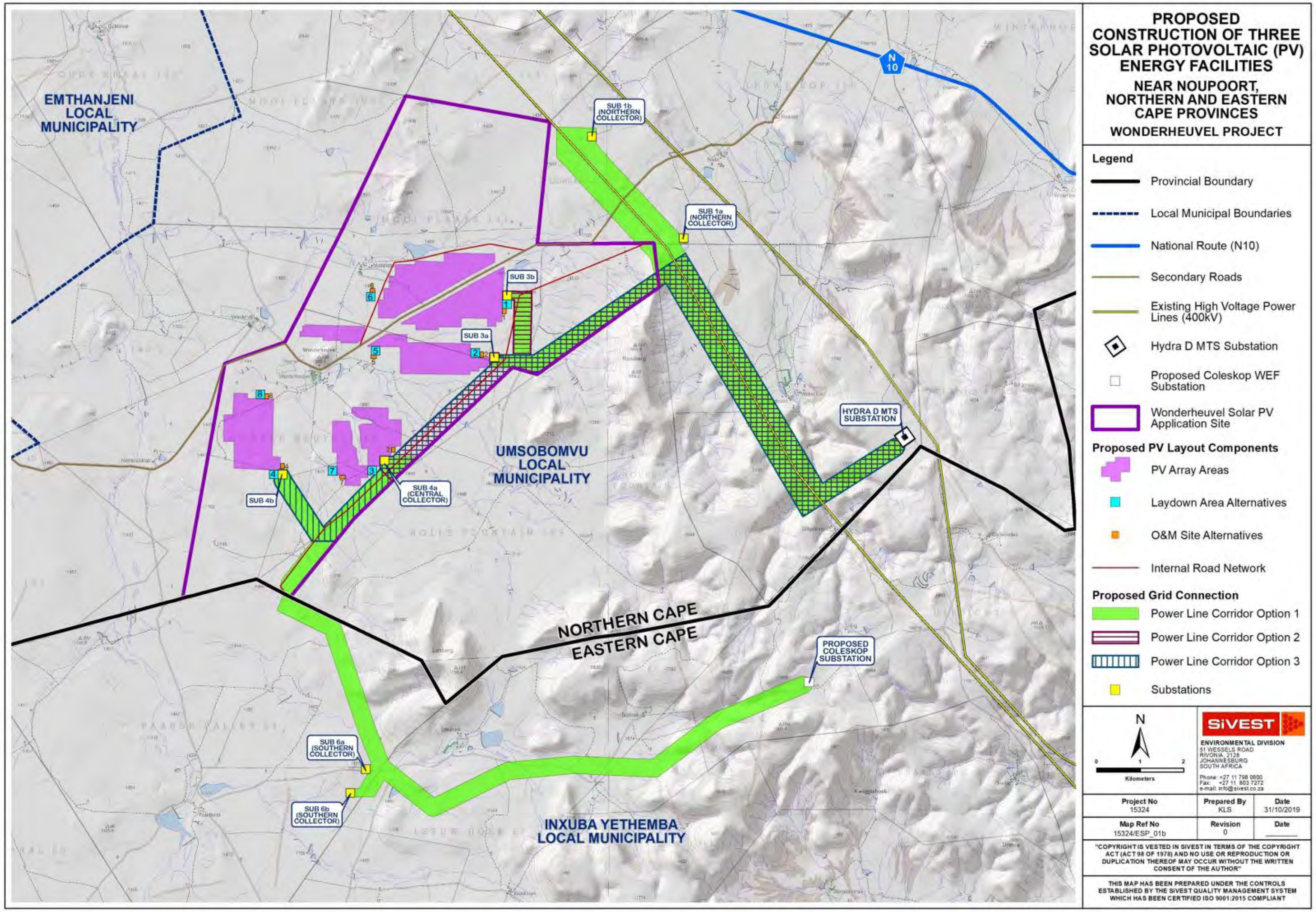

Figure 2. Map of Wonderheuvel project.

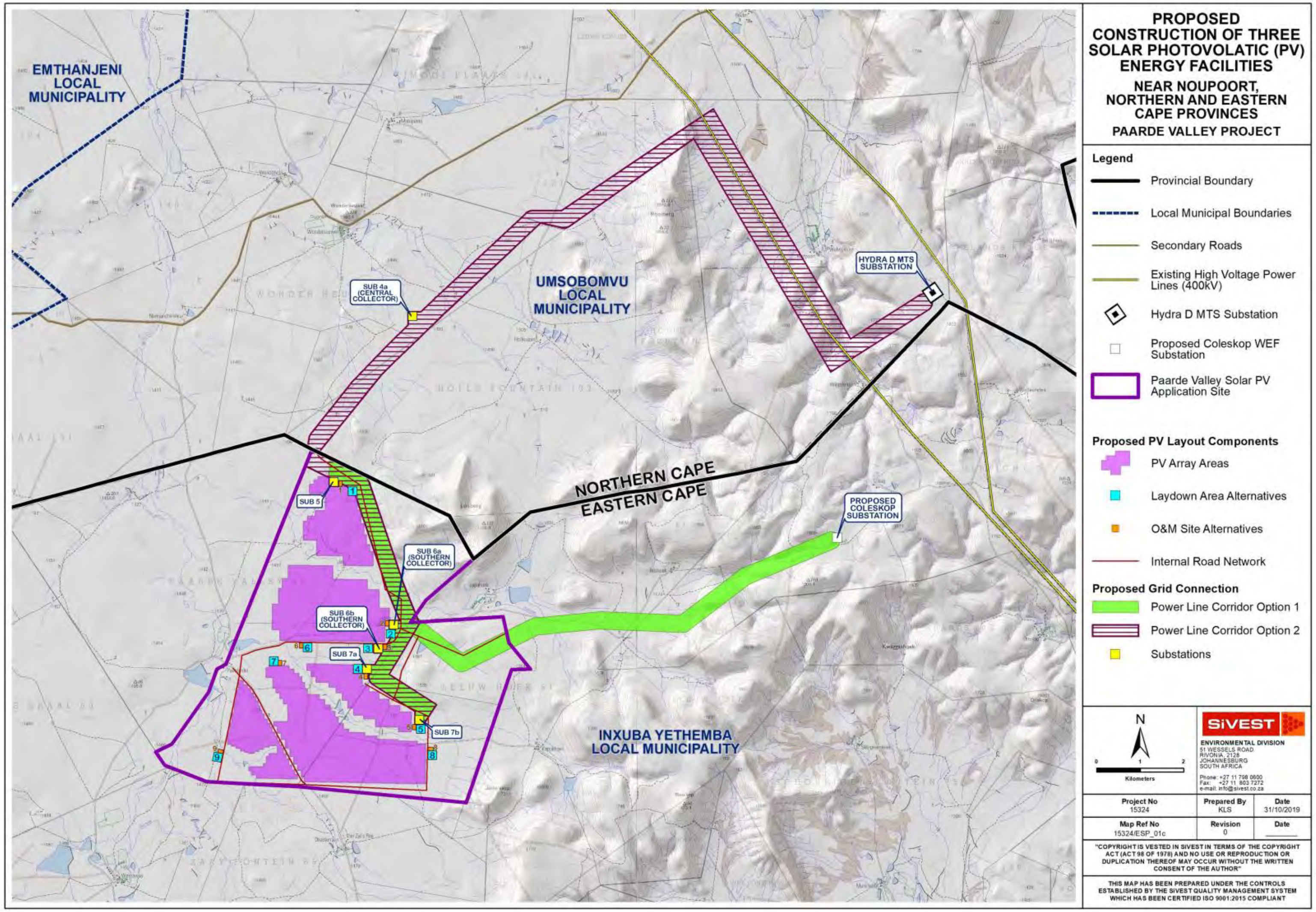

Figure 3. Map of Paarde Valley project.

3 TERMS OF REFERENCE

The following terms of reference apply to this study:

General requirements:

- Adherence to the content requirements for specialist reports in accordance with Appendix 6 of the EIA Regulations 2014, as amended (see Table 1);
- Adherence to all appropriate best practice guidelines, relevant legislation and authority requirements;
- Provide a thorough overview of all applicable legislation, guidelines
- Cumulative impact identification and assessment as a result of other renewable energy (RE) developments in the area (including; a cumulative environmental impact table(s) and statement, review of the specialist reports undertaken for other Renewable Energy developments and an indication of how the recommendations, mitigation measures and conclusion of the studies have been considered);
- Identification sensitive areas to be avoided (including providing shapefiles/kmls);
- Assessment of the significance of the proposed development during the Pre-construction, Construction, Operation, Decommissioning Phases and Cumulative impacts. Potential impacts should be rated in terms of the direct, indirect and cumulative:
    - Direct impacts are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity. These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable.
    - Indirect impacts of an activity are indirect or induced changes that may occur as a result of the activity. These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken, or which occur at a different place as a result of the activity.
    - Cumulative impacts are impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities. Cumulative impacts can occur from the collective impacts of individual minor actions over a period of time and can include both direct and indirect impacts.
- Comparative assessment of alternatives;
- Recommend mitigation measures in order to minimise the impact of the proposed development; and
- Implications of specialist findings for the proposed development (e.g. permits, licenses etc.).

Specific requirements:

- Describe the existing environment in terms of soils, geology, land-use and agricultural potential. Significant soils and agricultural features or disturbances should be identified, as well as sensitive features and receptors within the project area. The description must include surrounding agricultural land uses and activities, to convey the local agricultural context.
- Describe and map soil types (soil forms), soil characteristics (soil depth, soil colour, limiting factors, and clay content of the top and sub soil layers), and degradation and erodibility of soils etc. to the extent necessary to inform this assessment.

- Varying sensitivities of the soils and agricultural potential must be mapped and highlighted.
- The assessment is to be based on existing information, and professional experience and field work conducted by the specialist, as considered necessary and in accordance with relevant legislated requirements.
- Identify and assess the potential impacts of the proposed development on soils and agriculture, including impacts of associated infrastructure, such as the buildings, fencing etc. and provide relevant mitigation measures to include in the environmental management plan.
- Identify any protocols, legal and permit requirements relating to soil and agricultural potential impacts that are relevant to this project and the implications thereof.
- Map sensitivity of the site and clearly show no-go areas i.e. existing irrigated fields/ cultivated lands
- The report needs to fulfill the terms of reference for an agricultural study as set out in the National Department of Agriculture's document, Regulations for the evaluation and review of applications pertaining to renewable energy on agricultural land, dated September 2011, with an appropriate level of detail for the agricultural suitability and soil variation on site (which may therefore be less than the standardised level of detail stipulated in the above regulations).

Table 1: Compliance with the Appendix 6 of the 2014 EIA Regulations (as Amended)

Requirements of Appendix 6 – GN R326 EIA Regulations 7 April 2017	**Addressed in the Specialist Report**
(1) A specialist report prepared in terms of these Regulations must contain- (α) details of- ι. the specialist who prepared the report; and ιι. the expertise of that specialist to compile a specialist report including a curriculum vitae;	page ii
(β) a declaration that the specialist is independent in a form as may be specified by the competent authority;	page iv
(c) an indication of the scope of, and the purpose for which, the report was prepared;	Sections 1 & 3
(cA)an indication of the quality and age of base data used for the specialist report;	Section 4.1
(cB)a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Sections 7.5 & 8.3
(δ) the date, duration and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 4.1
(ε) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 4
(φ) 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;	Section 7.7 & Figure 2
(γ) an identification of any areas to be avoided, including buffers;	Section 7.7

(η) 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;	Figure 2
(ι) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5
(φ) a description of the findings and potential implications of such findings on the impact of the proposed activity <u>or activities;</u>	Section 8
(κ) any mitigation measures for inclusion in the EMPr;	Section 8
(λ) any conditions for inclusion in the environmental authorisation;	Section 9
(μ) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Not applicable
(ν) a reasoned opinion- (ι) whether the proposed activity, <u>activities</u> or portions thereof should be authorised; <u>(iA) regarding the acceptability of the proposed activity or activities and</u> (ii) if the opinion is that the proposed activity, <u>activities</u> 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;	 Section 9 Section 9 Section 8
(ο) a description of any consultation process that was undertaken during the course of preparing the specialist report;	Not applicable
(π) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Not applicable
(θ) any other information requested by the competent authority.	Not applicable
(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

4 METHODOLOGY OF STUDY

4.1 Methodology for assessing soils and agricultural potential

The soil investigation applied an appropriate level of detail for the agricultural suitability on site and for the level of impact of the proposed development on agricultural land. A detailed soil survey, as per the requirement in the above DAFF document (see Section 2), is only appropriate for a significant footprint of impact on arable land. It has little relevance to an assessment of agricultural potential in this environment, where the agricultural limitations are overwhelmingly climatic, terrain is rugged, soil conditions are generally poor, and cultivation potential is non-existent. In such an environment, even where soils suitable for cultivation may occur, they cannot be cultivated because of the aridity and terrain constraints. Conducting a soil assessment at the stipulated level of detail would be very time consuming and add no value to the assessment. A field investigation was therefore not considered necessary. The assessment was based on a desktop analysis of existing soil and agricultural potential data and other data for the site, which is considered entirely adequate for a thorough assessment of all the agricultural impacts of the proposed development.

The following sources of information were used:

- Soil data was sourced from the land type data set, of the Department of Agriculture, Forestry and Fisheries. This data set originates from the land type survey that was conducted from the 1970's until 2002. It is the most reliable and comprehensive national database of soil information in South Africa and although the data was collected some time ago, it is still entirely relevant as the soil characteristics included in the land type data do not change within time scales of hundreds of years.
- Land capability data was sourced from the 2017 National land capability evaluation raster data layer produced by the Department of Agriculture, Forestry and Fisheries, Pretoria.
- Rainfall and temperature data was sourced from The World Bank Climate Change Knowledge Portal, dated 2015.
- Grazing capacity data was sourced from Cape Farm Mapper.
- Satellite imagery of the site and surrounds was sourced from Google Earth.

The potential impacts identified in this specialist study were assessed based on the criteria and methodology common to the whole impact assessment. The ratings of impacts were based on the specialist's knowledge and experience of the field conditions of the environment in which the proposed development is located, and of the impact of disturbances on that agricultural environment.

5 ASSUMPTIONS, CONSTRAINTS AND LIMITATIONS OF STUDY

The assessment rating of impacts is not an absolute measure. It is based on the subjective considerations and experience of the specialist, but is done with due regard and as accurately as possible within these constraints.

The study makes the assumption that water for irrigation is very limited across the site. This is based on the assumption that a long history of farming experience in an area will result in the exploitation of viable water sources if they exist, and only very limited irrigation water has been exploited in this area.

Cumulative impacts are assessed by adding expected impacts from this proposed development to existing and proposed developments with similar impacts in a 50 km radius. The existing and proposed developments that were taken into consideration for cumulative impacts are listed in Appendix B. SiVEST undertook every effort to obtain the information (including specialist studies, BA / EIA / Scoping and EMPr Reports) for the surrounding developments. However, many of the documents are not currently publicly available to download, and could therefore not be reviewed during this assessment.

There are no other specific constraints, uncertainties and gaps in knowledge for this study.

6 APPLICABLE LEGISLATION AND PERMIT REQUIREMENTS

The Subdivision of Agricultural Land Act (Act 70 of 1970) (SALA), requires that an application for the PV development be approved by the Department of Agriculture, Forestry and Fisheries (DAFF). Despite the name of the Act, it does not apply only to subdivision, and its purpose is to ensure productive use of agriculturally zoned land. Therefore, even if land is not being subdivided or leased, SALA approval is required to develop agriculturally zoned land for non-agricultural purposes.

The power lines require the registration of a servitude for each farm portion crossed. In terms of SALA, the registration of a power line servitude requires written consent of the Minister if the following two conditions apply:

1. if the servitude width exceeds 15 metres; and
2. if Eskom is not the applicant for the servitude.

If one or both of these conditions do not apply, then no agricultural consent is required. Eskom is currently exempt from agricultural consent for power line servitudes.

The Act 70 of 1970 consent is separate from the EIA and needs to be applied for and obtained after the EIA.

Rehabilitation after disturbance to agricultural land is managed by the Conservation of Agricultural Resources Act (Act 43 of 1983) (CARA). No application is required in terms of CARA. The EIA process covers the required aspects of this.

7 BASELINE ASSESSMENT OF THE SOILS AND AGRICULTURAL CAPABILITY OF THE AFFECTED ENVIRONMENT

This section is organised in sub headings based on DEA's requirements for an agricultural study.

7.1 Climate and water availability

Rainfall for the site is given as a low 378 mm per annum (The World Bank Climate Change Knowledge Portal, 2015). The average monthly distribution of rainfall is shown in Figure 4. Rainfall and resultant moisture availability are insufficient to support viable, rainfed cultivation of crops and also limit the grazing capacity of the veld.

There are some small farm dams across the project area, and limited groundwater exploitation which support small, isolated patches of cultivation.

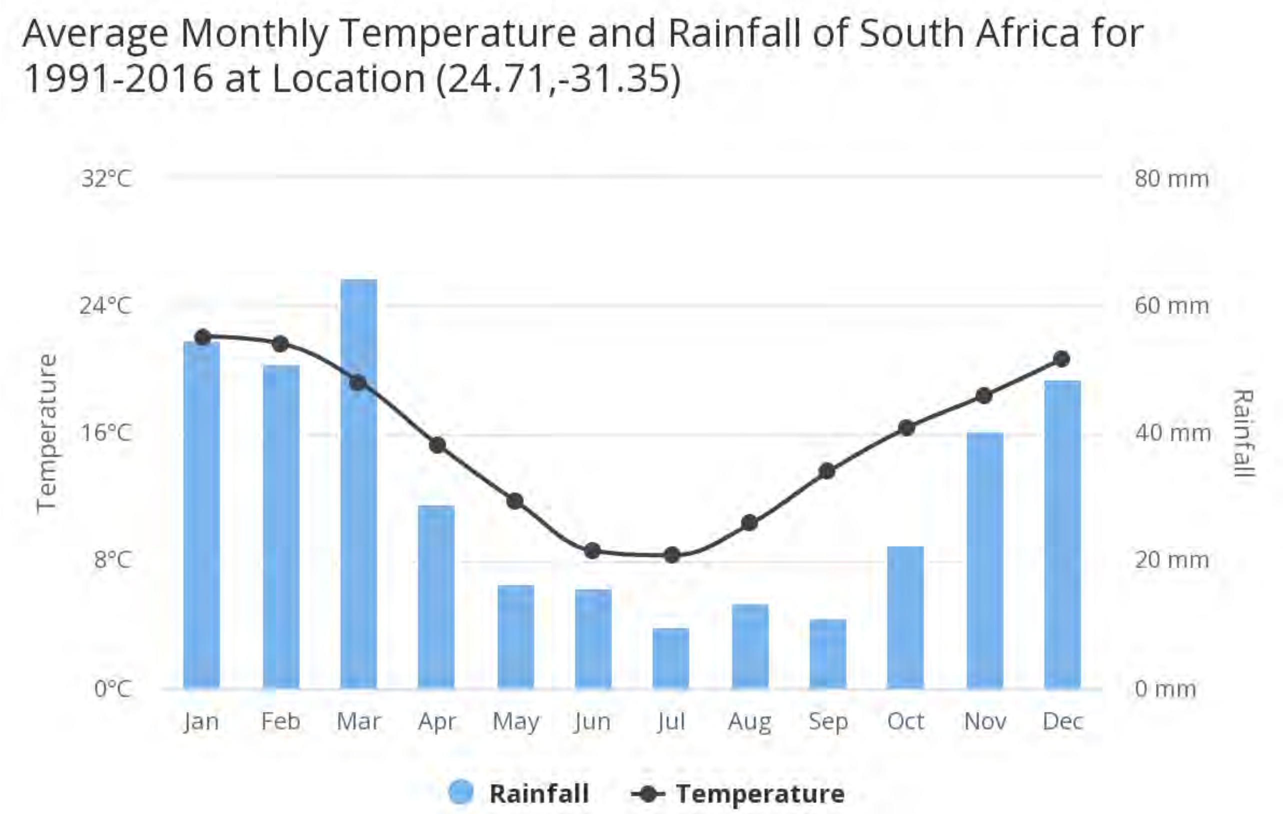

Figure 4. *Average monthly temperature and rainfall for a position approximately in the centre of the development (The World Bank Climate Change Knowledge Portal, 2015).*

7.2 Terrain, topography and drainage

The proposed development is located on plains and broken terrain with small mountains on the escarpment plateau. Altitude varies between approximately 1,440 and 1,700 metres. There is a wide range of slopes across the broken terrain of the project area. There are several non-perennial water courses, typical of arid areas, that drain the project area.

The underlying geology is shale, mudstone and sandstone of the Beaufort Group of the Karoo Supergroup. Dolerite intrusions are common.

7.3 Soils

The land type classification is a nationwide survey that groups areas of similar soil, terrain and climatic conditions into different land types. The proposed development is located on predominantly two similar land types, namely Da6 and Da77. Only a small proportion of the proposed power line routes crosses another two land types, Ib316 and Fb373, in the mountainous terrain. Soils on these land types are fairly similar and are predominantly shallow, loamy sands on underlying rock or less commonly clay. Dominant soil forms are Swartland, Hutton, Mispah, and Valsrivier. The soils would fall into the Duplex and Lithic soil groups according to the classification of Fey (2010). A summary detailing soil data for the land types is provided in Appendix 1, Table A1.

7.4 Agricultural capability

Land capability is defined as the combination of soil, climate and terrain suitability factors for supporting rainfed agricultural production. It is an indication of what level and type of agricultural production can sustainably be achieved on any land. The higher land capability classes are suitable as arable land for the production of cultivated crops, while the lower suitability classes are only suitable as non-arable grazing land, or at the lowest extreme, not even suitable for grazing. In 2017 DAFF released updated and refined land capability mapping across the whole of South Africa. This has greatly improved the accuracy of the land capability rating for any particular piece of land anywhere in the country. The new land capability mapping divides land capability into 15 different categories with 1 being the lowest and 15 being the highest. Values of below 8 are generally not suitable for production of cultivated crops. Detail of this land capability scale is shown in Table 2.

The project area is classified with land capability evaluation values that range from 1 to 7, with 6 being the predominant land capability. The land capability is limited by the very low climatic moisture availability, the rugged terrain, and the shallow, rocky soils.

Table 2: Details of the 2017 Land Capability classification for South Africa.

Land capability evaluation value	Description
1	Very Low
2	
3	Very Low to Low
4	
5	Low
6	Low to Moderate
7	
8	Moderate
9	Moderate to High
10	

11	High
12	High to Very High
13	
14	Very High
15	

Due to the land capability constraints, agricultural land use is restricted to grazing only. The natural grazing capacity is given on Cape Farm Mapper as reasonable, at 16 to 17 hectares per large stock unit.

7.5 Land use and development on and surrounding the site

The area is a sheep farming area. The climate does not support any cultivation, except for small patches of irrigation associated with farm dams. Low intensity natural grazing is the dominant agricultural activity. There are several farmsteads (that is a residential and administrative node of buildings and infrastructure from which a farm is managed) within the study area. There is often agricultural infrastructure, including some irrigation in the proximity of the farmsteads. The only agricultural infrastructure away from the small patches of cultivation, are wind pumps, stock watering points and fencing surrounding grazing camps.

7.6 Possible land use options for the site

The low climatic moisture availability means that natural grazing is the only viable agricultural land use for most of the area, except for the small patches of irrigation.

7.7 Agricultural sensitivity

Agricultural sensitivity is directly related to the capability of the land for agricultural production. This is because a negative impact on land of higher agricultural capability is more detrimental to agriculture than the same impact on land of low agricultural capability. A general assessment of agricultural sensitivity, in terms of loss of agricultural land in South Africa, considers arable land that can support viable production of cultivated crops, to have high sensitivity. This is because there is a scarcity of such land in South Africa, in terms of how much is required for food security. However, there is not a scarcity in the country of land that is only suitable as grazing land and such land is therefore not considered to have high agricultural sensitivity.

Agricultural sensitivity of a particular development is also a function of the severity of the impact which that type of development poses to agriculture. In the case of PV, fairly large areas of land are excluded from agricultural use, so in terms of that aspect, there is sensitivity. In the case of power lines, the impact is negligible because almost all agricultural activities can continue undisturbed beneath power lines.

The majority of the study area has low agricultural potential and therefore low agricultural sensitivity to development and consequent loss of agricultural land use. The only exception are the small patches of irrigation. These have a higher sensitivity, because of their agricultural value, and should be considered no-go areas for any footprint of development that will exclude cultivation. For power lines, the no-go only applies to centre-pivot irrigated lands. This is because there is a danger of shorting between power lines (at standard height) and the centre pivot irrigation structures. Power lines can however cross centre pivot irrigated lands if the height of the power line is raised. No-go areas require no buffers. No-go areas are shown in Figure 5.

Apart from the cultivated no-go areas, agricultural potential and conditions are very uniform across the rest of the study area and the choice of placement of facility infrastructure therefore has minimal influence on the significance of agricultural impacts.

8 IDENTIFICATION AND ASSESSMENT OF IMPACTS ON AGRICULTURE

The focus and defining question of an agricultural impact assessment is to determine to what extent a proposed development will compromise (negative impacts) or enhance (positive impacts) current and/or future agricultural production. The significance of an impact is therefore a direct function of the degree to which that impact will affect current or future agricultural production. If there will be no impact on production, then there is no agricultural impact. Impacts that degrade the agricultural resource base pose a threat to production and therefore are within the scope of an agricultural impact assessment. Lifestyle impacts on the resident farming community, for example visual impacts, do not necessarily impact agricultural production and, if they do not, are not relevant to and within the scope of an agricultural impact assessment. Such impacts are better addressed within the impact assessments of other disciplines included in the EIA process.

For agricultural impacts, the exact nature of the different infrastructure within the facility has very little bearing on the significance of impacts. What is of most relevance is simply the occupation of the land, and whether it is being occupied by a solar array, a road, a building or a substation makes no difference. What is of most relevance therefore is simply the total footprint of the facility.

The ways in which the project can impact on soils, agricultural resources and productivity are:

- Occupation of the land by the total physical footprint of the proposed project including all PV panels, roads and electrical infrastructure.
- Disturbance and changes to the land surface characteristics and soil profile from constructional activities such as levelling and excavations as well as the establishment of hard surfaces. These may lead to erosion and land degradation.

The significance of all potential agricultural impacts is kept low by the low agricultural potential of the land and the consequent low agricultural sensitivity to the loss of this land for agriculture.

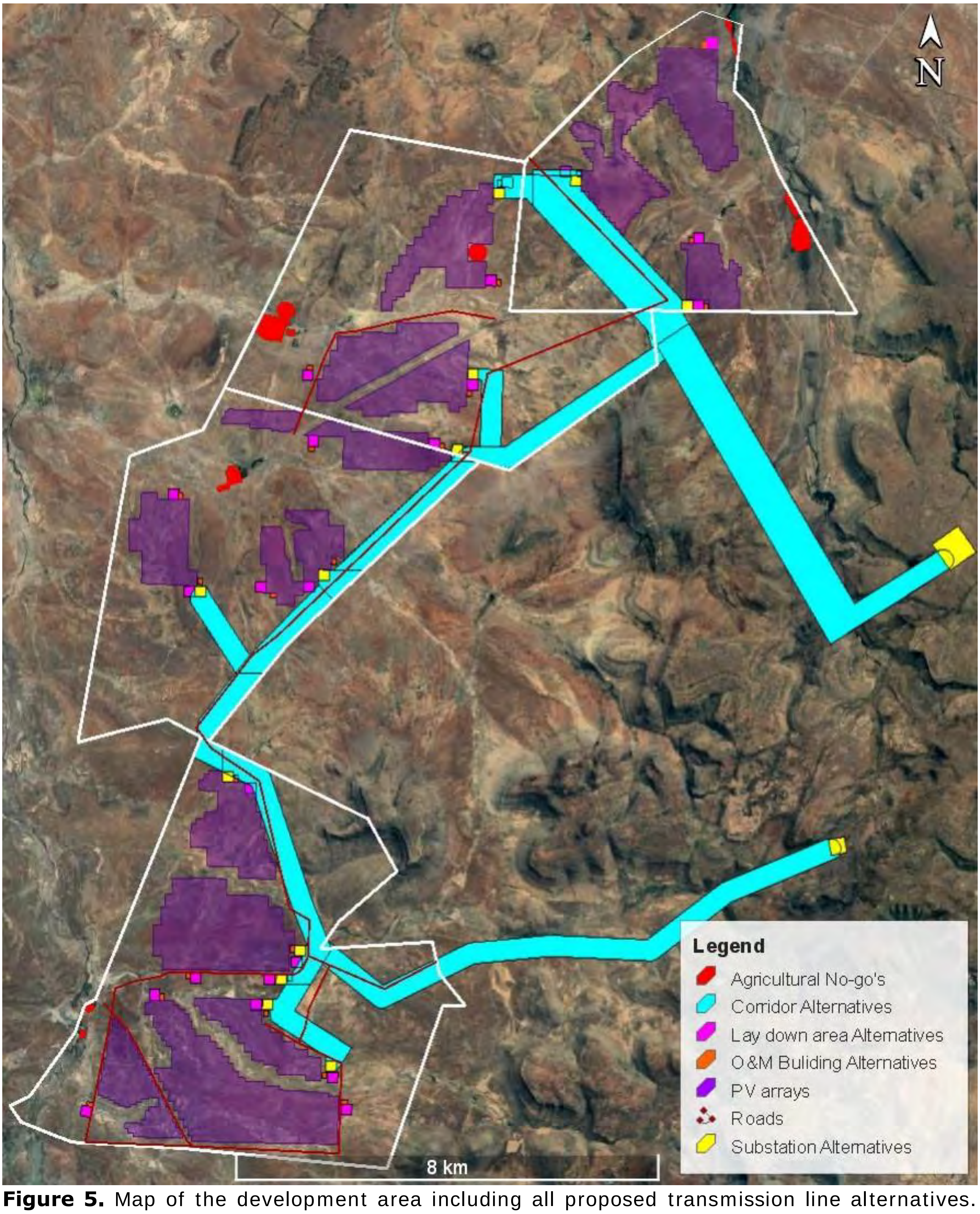

Figure 5. Map of the development area including all proposed transmission line alternatives. Agricultural no-go areas are shown with red outlines.

8.1 Impacts of the solar PV facilities

Because of the similarity of the agricultural environment across all three of the proposed project areas, the impacts are identical for all three solar PV facilities, and are therefore only presented here once.

Three potential agricultural impacts have been identified. Two of these are direct, negative impacts and apply to all three phases of the development (construction, operational and decommissioning). They are:

- Loss of agricultural land use
  Agricultural grazing land directly occupied by the development infrastructure will become unavailable for agricultural use.
- Soil degradation
  Soil degradation can result from erosion and topsoil loss. Erosion can occur as a result of the alteration of the land surface run-off characteristics, which can be caused by construction related land surface disturbance, vegetation removal, and the establishment of hard surface areas including roads. Loss of topsoil can result from poor topsoil management during construction related soil profile disturbance. Soil degradation will reduce the ability of the soil to support vegetation growth.

The third impact is a positive, indirect impact and only applies to the operational phase:

- Increased financial security for farming operations
  Reliable income will be generated by the farming enterprises through the lease of the land to the energy facility. This is likely to increase their cash flow and financial security and thereby improve farming operations.

An assessment of these impacts is presented in ***Table 3***, below.

8.2 Impacts of the grid connection infrastructure

Because of the similarity of the agricultural environment across all three of the proposed project areas, the impacts are identical for all three grid connection infrastructures, and are therefore only presented here once.

Grid connection infrastructure has negligible impact on agriculture because all viable agricultural activities in this environment can continue undisturbed below transmission lines and the remaining footprint of the infrastructure (substations etc) occupies an insignificantly small proportion of the available land. Only one agricultural impact has been identified. It is a direct, negative impact that applies to two of the phases of the development (construction and decommissioning):

- Soil degradation
  Soil degradation can result from erosion and topsoil loss. Erosion can occur as a result of the alteration of the land surface run-off characteristics, which can be caused by

construction related land surface disturbance, vegetation removal, and the establishment of hard surface areas including roads. Loss of topsoil can result from poor topsoil management during construction related soil profile disturbance. Soil degradation will reduce the ability of the soil to support vegetation growth.

An assessment of this impact is presented in **Table 4**, below.

8.3 Cumulative impact of the solar PV facilities

The cumulative impact of a development is the impact that development will have when its impact is added to the incremental impacts of other past, present or reasonably foreseeable future activities that will affect the same environment. The most important concept related to a cumulative impact is that of an acceptable level of change to an environment. A cumulative impact only becomes relevant when the impact of the proposed development will lead directly to the sum of impacts of all developments causing an acceptable level of change to be exceeded in the surrounding area. If the impact of the development being assessed does not cause that level to be exceeded, then the cumulative impact associated with that development is not significant.

The potential cumulative agricultural impact of importance is a regional loss or degradation of agricultural land. The defining question for assessing the cumulative agricultural impact is this:

> What level of loss of agricultural land use is acceptable in the area, and will the loss associated with the Umsombovu PV development, cause that level in the area to be exceeded?

DEA requires compliance with a specified methodology for the assessment of cumulative impacts. This is positive in that it ensures engagement with the important issue of cumulative impacts. However, the required compliance has some limitations and can, in my opinion, result in an over-focus on methodological compliance, while missing the more important task of answering the above defining question more broadly.

The first limitation with DEA's required methodology is that it restricts the cumulative impacts to similar developments, so in this case to renewable energy developments. In order to accurately answer the defining question above, all developments, regardless of their type and similarity, should be taken into account, because all will contribute to exceeding the acceptable level of change.

The second problem with the requirement, is that it restricts surrounding developments to those within an absolutely defined distance, in this case 35km. Again this does not allow for accurately answering the defining question. To achieve this, the distance used for cumulative impact assessment should be discipline dependent. A different distance is likely to apply for agricultural impact than for economic impact or botanical impact. And a different distance should be used in different environments, for example in high potential agricultural environments versus very low potential agricultural environments.

Given the above, this assessment focuses less on methodological compliance and more on effectively addressing the defining question above by considering the cumulative impacts more broadly than is required by DEA compliance. This includes considering a wider area than the 35 km radius, and considering the likelihood of pressure from other types of developments as well.

There are 17 renewable energy projects, with their associated transmission lines, within 35km of the proposed site (that need to be considered in terms of the DEA requirements). These are listed and mapped in Appendix 2.

All of these projects have the same agricultural impacts in a very similar agricultural environment, and in all cases the agricultural impact is assessed as low

Of all the mitigation measures proposed for all of these projects the following have not been included in this report for the reasons given. All others have been included.

Keeping disturbed soil covered by straw, mulch, or erosion control mats. This is not considered viable in the arid environment. Straw would blow away, and there is unlikely to be any viable source of mulch. Vegetation establishment, taking into account any recommendations by the vegetation study, would be the most viable form of soil stabilisation.

In quantifying the cumulative impact, the area of land taken out of agricultural grazing as a result of all of the projects above will amount to a total of approximately 1,700 hectares. This is calculated using the industry standards of 2.5 and 0.3 hectares per megawatt for solar and wind energy generation respectively, as per DEA (2015). As a proportion of the area within a 35km radius (approximately 385,000 ha), this amounts to only 0.44% of the surface area. That is well within an acceptable limit in terms of loss of low potential agricultural land, of which there is no scarcity in the country. This is particularly so when considered within the context of the following point:

- In order for South Africa to achieve its renewable energy generation goals, agriculturally zoned land will need to be used for renewable energy generation. It is far more preferable to incur a cumulative loss of agricultural land in a region such as the one being assessed, which has no cultivation potential, and low grazing capacity, than to lose agricultural land that has a higher potential, and that is much scarcer, to renewable energy development elsewhere in the country. The limits of acceptable agricultural land loss are therefore far higher in this region than in regions with higher agricultural potential.

It should also be noted that there are few land uses, other than renewable energy, that are competing for agricultural land use in this area. The cumulative impact from developments, other than renewable energy, is therefore low.

Due to all of the considerations discussed above, the cumulative impact of loss of agricultural land use is assessed as having low significance. In terms of cumulative impact, therefore, the development can be authorised.

8.4 Cumulative impact of the grid connection infrastructures

The discussion of cumulative impacts above applies to the grid connection infrastructure as well. However, because the agricultural impacts of grid connection infrastructure are negligible, the cumulative impacts are even lower than those for the solar PV facilities. This environment could accommodate many more overhead power lines than currently exist or than are proposed, before acceptable levels of land loss and degradation as a result of transmission lines have any likelihood of being exceeded. Acceptable levels of change in terms of other areas of impact, such as visual impact, would be exceeded long before agricultural levels of change came anywhere near to being exceeded.

Table 3: Impact assessment summary for all three solar PV facilities. Because of the similarity of the agricultural environment across all three of the proposed project areas, the impacts are identical for all three solar PV facilities, and are therefore only presented here once.

3 UMSOMBOVU SOLAR PV FACILITIES																					
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																					
Agricultural land	Loss of agricultural land use due to direct occupation	1	4	2	2	3	2	24	-	Medium	None	1	4	2	2	3	2	24	-	Medium	
Soil	Soil degradation and erosion	1	2	2	2	2	2	18	-	Low	Control run-off; maintain vegetation cover; strip, stockpile and re-spread topsoil	1	1	2	2	2	2	16	-	Low	

Operational Phase																				
Agricultural land	Loss of agricultural land use due to direct occupation	1	4	2	2	3	2	24	-	Medium	None	1	4	2	2	3	2	24	-	Medium
Soil	Soil degradation and erosion	1	2	2	2	2	2	18	-	Low	Control run-off; maintain vegetation cover; strip, stockpile and re-spread topsoil	1	1	2	2	2	2	16	-	Low
Financial security of farming operations	Increased financial security through rental income	1	4	1	1	3	2	20	+	Low	None	1	4	1	1	3	2	20	+	Low
Decommissioning Phase																				
Agricultural land	Loss of agricultural land use due to direct occupation	1	4	2	2	3	2	24	-	Medium	None	1	4	2	2	3	2	24	-	Medium
Soil	Soil degradation and erosion	1	2	2	2	2	2	18	-	Low	Control run-off; maintain vegetation cover; strip, stockpile and re-spread topsoil	1	1	2	2	2	2	16	-	Low
Cumulative Agricultural land	Regional loss of agricultural land and productivity	2	1	2	2	3	2	20	-	Low	Control run-off; maintain vegetation cover; strip, stockpile and re-spread topsoil	2	1	2	2	3	2	20	-	Low

Table 4: Impact assessment summary for all three grid connection infrastructures.

3 UMSOMBOVU GRID CONNECTON INFRASTRUCTURES																				
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																				
Soil	Soil degradation and erosion	1	1	2	2	2	1	8	-	Low	Control run-off; maintain vegetation cover; strip, stockpile and re-spread topsoil	1	1	2	2	2	1	8	-	Low
Operational Phase																				
N/A	N/A									N/A	N/A									N/A
Decommissioning Phase																				
Soil	Soil degradation and erosion	1	1	2	2	2	1	8	-	Low	Control run-off; maintain vegetation cover; strip, stockpile and re-spread topsoil	1	1	2	2	2	1	8	-	Low
Cumulative																				
Soil	Soil degradation and	2	1	2	2	2	1	9	-	Low	Control run-off; maintain	2	1	2	2	2	1	9	-	Low

	erosion										vegetation cover; strip, stockpile and re-spread topsoil									

8.5 Assessment of project alternatives

No site location alternatives are considered because these have already been considered in a high-level screening of potential environmental and socio-economic issues, as well as 'fatal flaws' to determine suitable areas for project development.

The following project alternatives have been comparatively assessed (see alternatives table below):

- Laydown Areas and Operation & Maintenance (O&M) Building Site Alternatives. The Applicant wants to construct one (1) Laydown Area and O&M Building per PV array area; and
- Grid Connection Infrastructure Alternatives for each solar PV project.

It should be noted that the locations of the on-site / collector substations will depend on the Grid Connection Infrastructure Alternatives which are chosen as 'preferred' for each project. Grid connection alternatives are described below.

Mooi Plaats Solar PV Grid Connection:

The alternatives essentially provide for two (2) different route alignments with associated substations contained within an assessment corridor between approximately 400m and 900m wide. The alternatives are as follows:

OPTION 1:

- **Corridor Option 1a** - links Substation 2 and Substation 1a to the Hydra D MTS.
- **Corridor Option 1b** - links Substation 2 and Substation 1b to the Hydra D MTS.

OPTION 2:

- **Corridor Option 2a** - links Substation 2 and Substation 1a to the Hydra D MTS via the proposed Central Collector substation located on the Wonderheuvel PV project application site.
- **Corridor Option 2b** - links Substation 2 and Substation 1b to the Hydra D MTS via the proposed Central Collector substation located on the Wonderheuvel PV project application site.

Wonderheuvel Solar PV Grid Connection:

The alternatives essentially provide for three (3) different route alignments with associated substations contained within an assessment corridor between approximately 400m and 900m wide. The alternatives are as follows:

<u>OPTION 1:</u>

- **Corridor Option 1a** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links the Proposed Substation 3a to the Hydra D MTS via the proposed Northern Collector Substation located on the Mooi Plaats PV project application site.
  ii. The *southern connection* links the proposed Substation 4a to the Coleskop WEF Substation via the proposed Southern Collector Substation located on the Paarde Valley PV Project application site.

- **Corridor Option 1b** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern* connection links the Proposed Substation 3a to the Hydra D MTS via the proposed Northern Collector Substation located on the Mooi Plaats PV project application site.
  ii. The *southern connection* links the proposed Substation 4b to the Coleskop WEF Substation via the proposed Southern Collector Substation located on the Paarde Valley PV Project application site.

- **Corridor Option 1c** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern* connection links the Proposed Substation 3b to the Hydra D MTS via the proposed Northern Collector Substation located on the Mooi Plaats PV project application site.
  ii. The *southern connection* links the proposed Substation 4a to the Coleskop WEF Substation via the proposed Southern Collector Substation located on the Paarde Valley PV Project application site.

- **Corridor Option 1d** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links the Proposed Substation 3b to Hydra D MTS via the proposed Northern Collector Substation located on the Mooi Plaats PV project application site.
  ii. The *southern connection* links the proposed Substation 4b to the Coleskop WEF Substation via the proposed Southern Collector Substation located on the Paarde Valley PV Project application site.

<u>OPTION 2:</u>

- **Corridor Option 2a** - links Substation 3a to the Hydra D MTS via the proposed Central Collector Substation.

- **Corridor Option 2b** - Option 2b links Substation 3b to Hydra D MTS via the proposed Central Collector Substation.

<u>OPTION 3:</u>

- **Corridor Option 3** links Substation 4b to Hydra D MTS via the proposed Central

Collector Substation.

Paarde Valley Solar PV Grid Connection:

The alternatives essentially provide for two (2) different route alignments with associated substations contained within an assessment corridor between approximately 400m and 900m wide. The alternatives are as follows:

OPTION 1:

- Corridor **Option 1a** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  1. The *northern connection* links Substation 5 to Coleskop Substation via the proposed Southern Collector Sub (Substation 6a will act as Central Collector for this option).
  2. The *southern connection* links Substation 7a to the Coleskop Substation via the proposed Southern Collector Substation (Substation 6a will act as Southern Collector for this option).

- Corridor **Option 1b** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  1. The *northern connection* links Substation 5 to Coleskop Substation via the proposed Southern Collector Sub (Substation 6b will act as Southern Collector for this option).
  2. The *southern connection* links Substation 7a to the Coleskop Substation via the proposed Southern Collector Substation (Substation 6b will act as Southern Collector for this option).

- Corridor **Option 1c** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  1. The *northern connection* links Substation 5 to Coleskop Substation via the proposed Southern Collector Sub (Substation 6a will act as Southern Collector for this option).
  2. The *southern connection* links Substation 7b to the Coleskop Substation via the proposed Southern Collector Substation (Substation 6a will act as Southern Collector for this option).

- Corridor **Option 1d** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  1. The *northern connection* links Substation 5 to Coleskop Substation via the proposed Southern Collector Sub (Substation 6b will act as Southern Collector for this option).
  2. The *southern connection* links Substation 7b to the Coleskop Substation via the proposed Southern Collector Substation (Substation 6b will act as Southern Collector for this option).

OPTION 2:

- Corridor **Option 2a** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links Substation 5 to Hydra D MTS via the proposed Central Collector Sub located on the Wonderveuvel PV Project application site.
  ii. The *southern connection* links Substation 6a and 7a to the Hydra D MTS via the proposed Central Collector Substation located on the Wonderheuvel PV Project application site.

- Corridor **Option 2b** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links Substation 5 to Hydra D MTS via the proposed Central Collector Sub located on the Wonderheuvel PV Project application site.
  ii. The *southern connection* links Substation 6b and 7b to the Hydra D MTS via the proposed Central Collector Substation located on the Wonderheuvel PV Project application site.

- Corridor **Option 2c** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links Substation 5 to Hydra D MTS via the proposed Central Collector Sub located on the Wonderheuvel PV Project application site.
  ii. The *southern connection* links Substation 6a and 7b to the Hydra D MTS via the proposed Central Collector Substation located on the Wonderheuvel PV Project application site.

- Corridor **Option 2d** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links Substation 5 to Hydra D MTS via the proposed Central Collector Sub located on the Wonderheuvel PV Project application site.
  ii. The *southern connection* links Substation 6b and 7a to the Hydra D MTS via the proposed Central Collector Substation located on the Wonderheuvel PV Project application site.

Although it is possible to propose theoretical differences between the significance of the impacts of the above alternatives, there is practically no material difference of any significance between them. Therefore, from an agricultural impact perspective, there are no preferred alternatives, and all the proposed alternatives are acceptable.

Key

PREFERRED	The alternative will result in a low impact / reduce the impact / result in a positive impact
FAVOURABLE	The impact will be relatively insignificant
LEAST PREFERRED	The alternative will result in a high impact / increase the impact
NO PREFERENCE	The alternative will result in equal impacts

PV INFRASTRUCTURE ALTERNATIVES (LAYDOWN AREAS AND O&M BUILDINGS)	Preference	Reasons (incl. potential issues)
MOOI PLAATS SOLAR PV FACILITY:		
Laydown Area and O&M Building Site Option 1	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Laydown Area and O&M Building Site Option 2	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Laydown Area and O&M Building Site Option 3	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Laydown Area and O&M Building Site Option 4	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Laydown Area and O&M Building Site Option 5	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Laydown Area and O&M Building Site Option 6	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
WONDERHEUVEL SOLAR PV FACILITY:		
Laydown Area and O&M Building Site Option 1	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Laydown Area and O&M Building Site Option 2	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Laydown Area and O&M Building Site Option 3	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Laydown Area and O&M Building Site Option 4	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Laydown Area and O&M Building Site Option 5	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Laydown Area and O&M Building Site Option 6	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Laydown Area and O&M Building Site Option 7	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Laydown Area and O&M Building Site Option 8	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
PAARDE VALLEY SOLAR PV FACILITY:		
Laydown Area and O&M Building Site Option 1	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Laydown Area and O&M Building Site Option 2	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Laydown Area and O&M Building Site Option 3	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Laydown Area and O&M Building Site Option 4	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Laydown Area and O&M Building Site Option 5	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Laydown Area and O&M Building Site	No Preference	Low agricultural impacts and the

PV INFRASTRUCTURE ALTERNATIVES (LAYDOWN AREAS AND O&M BUILDINGS)	Preference	Reasons (incl. potential issues)
Option 6		agricultural uniformity of the site.
Laydown Area and O&M Building Site Option 7	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Laydown Area and O&M Building Site Option 8	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Laydown Area and O&M Building Site Option 9	No Preference	Low agricultural impacts and the agricultural uniformity of the site.

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS AND ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
MOOI PLAATS SOLAR PV FACILITY:		
Grid Connection Option 1a	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Grid Connection Option 1b	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Grid Connection Option 2a	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Grid Connection Option 2a	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
WONDERHEUVEL SOLAR PV FACILITY:		
Grid Connection Option 1a	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Grid Connection Option 1b	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Grid Connection Option 1c	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Grid Connection Option 1d	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Grid Connection Option 2a	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Grid Connection Option 2b	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Grid Connection Option 3	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
PAARDE VALLEY SOLAR PV FACILITY:		
Grid Connection Option 1a	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Grid Connection Option 1b	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Grid Connection Option 1c	No Preference	Low agricultural impacts and the agricultural uniformity of the site.

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS AND ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
Grid Connection Option 1d	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Grid Connection Option 2a	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Grid Connection Option 2b	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Grid Connection Option 2c	No Preference	Low agricultural impacts and the agricultural uniformity of the site.
Grid Connection Option 2d	No Preference	Low agricultural impacts and the agricultural uniformity of the site.

9 CONCLUSIONS

South Africa has very limited arable land and it is therefore critical to ensure that development does not lead to an inappropriate loss of potentially arable land. The assessment has found that the proposed development will only impact agricultural land which is of low agricultural potential and only suitable for low intensity grazing.

Agricultural impacts of the proposed development are assessed as being of low to medium significance. The significance of agricultural impacts is limited by the limited agricultural potential of the proposed development site, which is a function of the climate, terrain and shallow soils. The majority of the study area has low agricultural potential and therefore low agricultural sensitivity to development and consequent loss of agricultural land use. The only exception are small patches of irrigation. These were considered no-go areas for any footprint of development that will exclude cultivation, and have been avoided by the development layout.

This agricultural impact assessment is considered to be comprehensive and no further study is required for agricultural impact.

Due to the low agricultural potential of the site, and the consequent low agricultural impact, there are no restrictions relating to agriculture which preclude authorisation of the proposed development and therefore, from an agricultural impact point of view, the development should be authorised. There is no preference in terms of the proposed power line route alternatives and all alternatives are supported.

There are no conditions resulting from this assessment that need to be included in the Environmental Authorisation, apart from the mitigation measures proposed above.

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APPENDIX 1: SOIL DATA

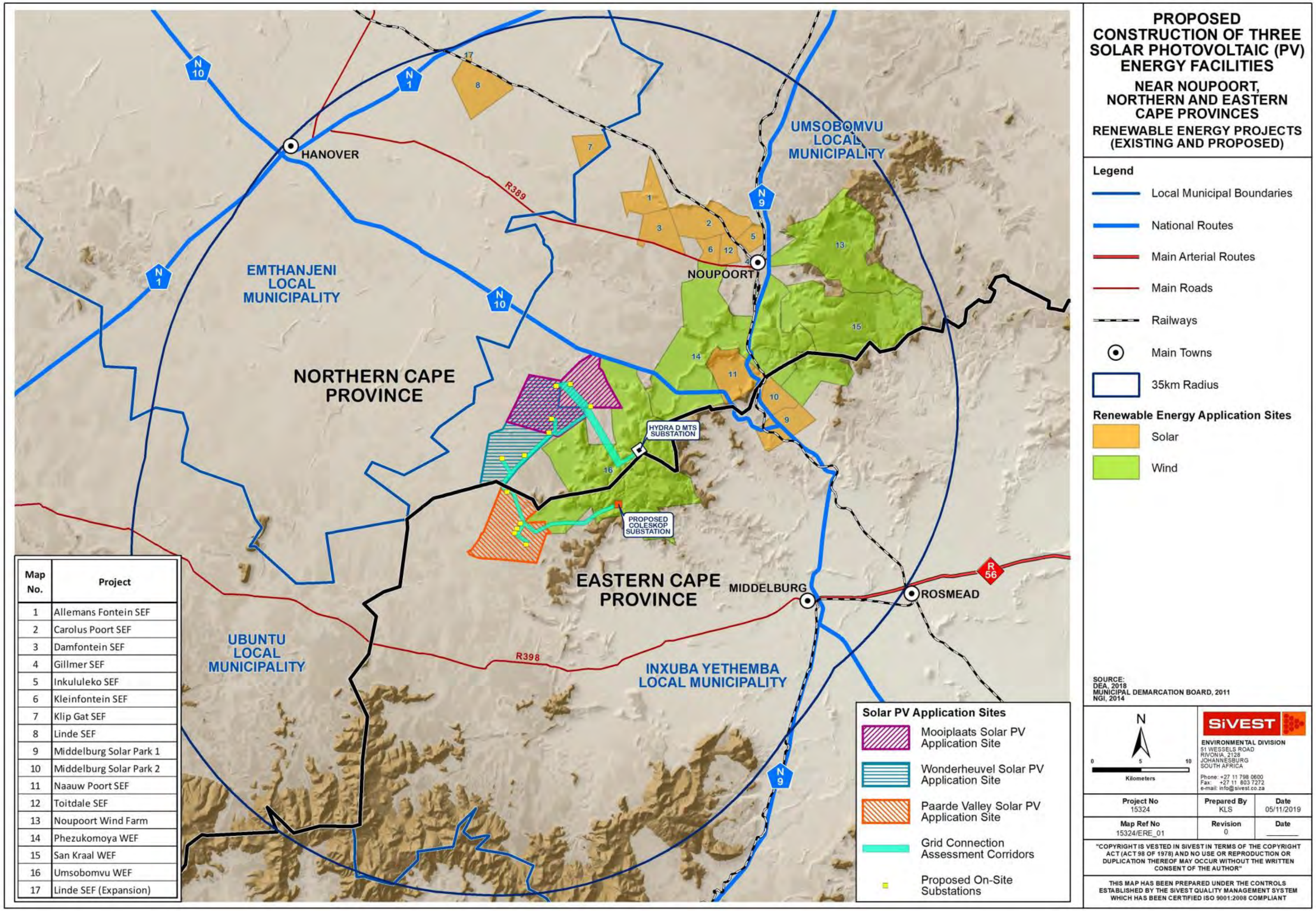
Table A1. Land type soil data for the study area.

Land type	Soil series (forms)	Depth (mm)			Clay % A horizon			Clay % B horizon			Depth limiting layer	% of land type
Da6	Swartland	30	-	300	15	-	30	30	-	45	so	54.2
	Rock outcrop											10.8
	Hutton	100	-	600	10	-	25	10	-	30	R	9.5
	Mispah	50	-	100	10	-	25				R	9.3
	Valsrivier	60	-	400	15	-	30	35	-	45	vr,vp	6.0
	Glenrosa	100	-	200	10	-	25				R	4.0
	Oakleaf	600	>	1200	15	-	25	35	-	40	ne	3.0
	Oakleaf	600	>	1200	15	-	25	15	-	30	ne	3.0
Da77	Swartland	200	-	500	5	-	25	25	-	35	so	18.3
	Hutton	50	-	450	6	-	25	6	-	25	R	17.0
	Swartland	200	-	300	15	-	25	35	-	45	so	16.3
	Valsrivier	200	-	400	15	-	25	35	-	45	vr,vp	12.0
	Mispah	20	-	100	10	-	20				R	11.0
	Oakleaf	400	-	700	15	-	25	15	-	30	ne	5.9
	Rock outcrop											5.8
	Oakleaf	300	-	800	15	-	30	35	-	45	ne	5.3
	Glenrosa	50	-	150	10	-	20	10	-	25	R	5.0
	Sterkspruit	100	-	300	15	-	30	35	-	45	pr	2.3
	Dundee	300	-	800	10	-	30	10	-	30	ne	0.6
	Inhoek	500	-	1200	25	-	35	35	-	45	ne	0.4
	Estcourt	300	-	600	10	-	25	15	-	25	pr	0.4

Depth limiting layers: R = hard rock; so = partially weathered bedrock; lo = partially weathered bedrock (softer); ca = soft carbonate; ka = hardpan carbonate; db = dorbank hardpan; hp = cemented hardpan plinthite (laterite); sp = soft plinthic horizon; pr = dense, prismatic clay layer; vp = dense, structured clay layer; vr = dense, red, structured clay layer; gc = dense clay horizon that is frequently saturated; pd = podzol horizon; U = alluvium.

APPENDIX 2: PROJECTS CONSIDERED IN CUMULATIVE ASSESSMENT

Project	DEA Reference No	Technology	Capacity	Status of Application / Development
Allemans Fontein SEF	14/12/16/3/3/1/730	Solar	20MW	Approved
Carolus Poort SEF	14/12/16/3/3/1/729	Solar	20MW	Approved
Damfontein SEF	14/12/16/3/3/1/728	Solar	20MW	Approved
Gillmer SEF	14/12/16/3/3/1/735	Solar	20MW	Approved
Inkululeko SEF	14/12/16/3/3/1/553	Solar	20MW	Approved
Kleinfontein SEF	12/12/20/2654	Solar	20MW	Approved
Klip Gat SEF	14/12/16/3/3/2/354	Solar	75M	Approved
Linde SEF	12/12/20/2258	Solar	40MW	In Operation
Linde SEF (Expansion)	14/12/16/3/3/1/1122	Solar	75MW	Approved
Middelburg Solar Park 1	12/12/20/2465/2	Solar	75MW	Approved
Middelburg Solar Park 2	12/12/20/2465/1	Solar	75MW	Approved
Naauw Poort SEF	14/12/16/3/3/2/355	Solar	75MW	Approved
Toitdale SEF	12/12/20/2653	Solar	20MW	Approved
Noupoort Wind Farm	12/12/20/2319	Wind	188MW	In Operation
Phezukomoya WEF	14/12/16/3/3/1/1028	Wind	315MW	EIA in Process
San Kraal WEF	14/12/16/3/3/1/1069	Wind	390MW	EIA in Process
Umsobomvu WEF	14/12/16/3/3/2/730	Wind	140MW	Approved



PROPOSED CONSTRUCTION OF THREE SOLAR PHOTOVOLTAIC (PV) ENERGY FACILITIES
NEAR NOUPOORT, NORTHERN AND EASTERN CAPE PROVINCES
RENEWABLE ENERGY PROJECTS (EXISTING AND PROPOSED)
Legend
Local Municipal Boundaries
National Routes
Main Arterial Routes
Main Roads
Railways
Main Towns
35km Radius
Renewable Energy Application Sites
Solar
Wind
Solar PV Application Sites
Mooiplaats Solar PV Application Site
Wonderheuvel Solar PV Application Site
Paarde Valley Solar PV Application Site
Grid Connection Assessment Corridors
Proposed On-Site Substations
HANOVER
NOUPOORT
MIDDELBURG
ROSMEAD
R389
R398
R56
N1
N9
N10
NORTHERN CAPE PROVINCE
EASTERN CAPE PROVINCE
EMTHANJENI LOCAL MUNICIPALITY
UMSOBOMVU LOCAL MUNICIPALITY
UBUNTU LOCAL MUNICIPALITY
INXUBA YETHEMBA LOCAL MUNICIPALITY
HYDRA D MTS SUBSTATION
PROPOSED COLESKOP SUBSTATION
Map No. | Project
1 Allemans Fontein SEF
2 Carolus Poort SEF
3 Damfontein SEF
4 Gillmer SEF
5 Inkululeko SEF
6 Kleinfontein SEF
7 Klip Gat SEF
8 Linde SEF
9 Middelburg Solar Park 1
10 Middelburg Solar Park 2
11 Naauw Poort SEF
12 Toitdale SEF
13 Noupoort Wind Farm
14 Phezukomoya WEF
15 San Kraal WEF
16 Umsobomvu WEF
17 Linde SEF (Expansion)
SOURCE:
DEA, 2018
MUNICIPAL DEMARCATION BOARD, 2011
NGI, 2014
N
0 5 10
Kilometers
SiVEST
ENVIRONMENTAL DIVISION
51 WESSELS ROAD
RIVONIA, 2128
JOHANNESBURG
SOUTH AFRICA
Phone: +27 11 798 0600
Fax: +27 11 803 7272
e-mail: info@sivest.co.za
Project No 15324
Prepared By KLS
Date 05/11/2019
Map Ref No 15324/ERE_01
Revision 0
Date
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SiVEST

Appendix 6B

Avifauna

AVIFAUNAL SPECIALIST STUDY

PROPOSED UMSOBOMVU SOLAR PV ENERGY FACILITIES AND ASSOCIATED INFRASTRUCTURE IN THE NORTHERN AND EASTERN CAPE PROVINCES

November 2019

AFRIMAGE Photography (Pty) Ltd t/a

Chris van Rooyen Consulting

VAT#: 4580238113

email: vanrooyen.chris@gmail.com

Tel: +27 (0)82 4549570 cell

EXECUTIVE SUMMARY

SiVEST has been appointed by Mooi Plaats Solar Power (Pty) Ltd, Wonderheuvel Solar Power (Pty) Ltd and Paarde Valley (Pty) Ltd to conduct an Environmental Authorisation Application for the proposed Umsobomvu PV Solar Energy Facility (SEF) and associated grid connection, near Middelburg and Noupoort in the Eastern and Northern Cape. Chris van Rooyen Consulting was in turn appointed by SiVEST to conduct an avifaunal impact study to assess the impact of the proposed SEF on avifauna.

The proposed Umsobomvu PV facilities will have some pre-mitigation impacts on avifauna at a site and local level which will range from **Medium to Low**.

The impact of displacement due to disturbance during the construction phase is rated as **Medium** and will remain at a **Medium** level after mitigation. The impact of displacement of priority species due to habitat transformation associated with the operation of the plant and associated infrastructure is rated as **Medium**. This impact can be partially reversed through mitigation, but it will remain at a **Medium** level, after mitigation. The envisaged impacts in the operational phase, i.e. mortalities due to collisions with the solar panels and entrapment in perimeter fences are both rated as **Low** pre-mitigation and could be further reduced with appropriate mitigation. The impact of displacement due to disturbance during the decommissioning phase is rated as **Medium**, and it will remain at a **Medium** level after mitigation. The cumulative impact of the proposed PV facilities within a 35km radius is rated as **Low**, both per- and post mitigation.

The impact of displacement due to disturbance associated with the construction of the proposed 132kV grid connection and substations, is assessed to be **Medium** and can be mitigated to a **Low** level. The potential for displacement due to habitat destruction associated with the construction of the substations is rated as **Low** and could be further reduced with appropriate mitigation. The impact of bird collisions with the 132kV grid connection is rated as **High** and could be reduced to **Medium** with the application of mitigation measures. The potential impact of electrocutions is assessed to be **Medium**, but it can be reduced to **Low** with appropriate mitigation. The impact of displacement due to disturbance associated with the de-commissioning of the proposed 132kV grid connection and substations, is assessed to be **Medium** and can be mitigated to a **Low** level. The cumulative impact of the proposed grid connections within a 35km radius is rated as **Medium**, but it can be reduced to **Low** with the application of appropriate mitigation.

IMPACT STATEMENT

From an avifaunal impact perspective, there is no objection to the proposed development of the Umsobomvu PV facilities and associated grid connections, provided the proposed mitigation measures are strictly implemented. No further monitoring will be required during the operational phase.

National Environmental Management Act, 1998 (Act No. 107 of 1998) and Environmental Impact Regulations 2014 (as amended) Requirements for Specialist Reports (Appendix 6)

Section in EIA Regulations 2014 (as amended)		Clause	Section in Report
Appendix 6	(1)	A specialist report prepared in terms of these Regulations must contain —	
	(a)	details of –	
		(i) the specialist who prepared the report; and	Pg. 6
		(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae.	Pg. 10 - 15
	(b)	A declaration that the person is independent in a form as may be specified by the competent authority;	Pg. 7 - 9
	(c)	An indication of the scope of, and the purpose for which, the report was prepared;	Section 2
	(cA)	An indication of the quality and age of base data used for the specialist report;	Section 3
	(cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Sections 6 and 7
	(d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 3 and Appendix 1
	(e)	A description of the methodology adopted in preparing the report or carrying out the specialised process; inclusive of equipment and modelling used;	Appendix 1
	(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;	Section 7
	(g)	An indication of any areas to be avoided, including buffers;	Section 8
	(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;	Section 8
	(i)	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 4
	(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;	Sections 9 and 10
	(k)	Any mitigation measures for inclusion in the EMPr;	Section 7

	(l)	Any conditions for inclusion in the environmental authorization;	Section 7
	(m)	Any monitoring requirements for inclusion in the EMPr or environmental authorization;	N/A
	(n)	A reasoned opinion –	
		(i) as to whether the proposed activity, activities or portions thereof should be authorized;	Section 10
		(iA) regarding the acceptability of the proposed activity or activities; and	Section 10
		(ii) if the opinion is that the proposed activity, activities or portions thereof should be authorized, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 7
	(o)	A description of any consultation process that was undertaken during the course of preparing the specialist report;	Section 3
	(p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A
	(q)	Any other information requested by the authority.	N/A
	(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.	N/A

TABLE OF CONTENTS

DETAILS OF THE SPECIALIST AND EXPERTISE TO COMPILE A SPECIALIST REPORT

Chris van Rooyen

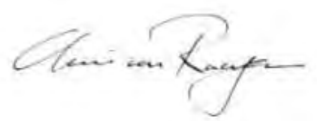
Chris has 21 years' experience in the management of wildlife interactions with electricity infrastructure. He was head of the Eskom-Endangered Wildlife Trust (EWT) Strategic Partnership from 1996 to 2007, which has received international acclaim as a model of co-operative management between industry and natural resource conservation. He is an acknowledged global expert in this field and has worked in South Africa, Namibia, Botswana, Lesotho, New Zealand, Texas, New Mexico and Florida. Chris also has extensive project management experience and has received several management awards from Eskom for his work in the Eskom-EWT Strategic Partnership. He is the author of 15 academic papers (some with co-authors), co-author of two book chapters and several research reports. He has been involved as ornithological consultant in numerous power line and wind generation projects. Chris is also co-author of the Best Practice for Avian Monitoring and Impact Mitigation at Wind Development Sites in Southern Africa, which is the industry standard. Chris also works outside the electricity industry and had done a wide range of bird impact assessment studies associated with various residential and industrial developments.

Albert Froneman

Albert has an M. Sc. in Conservation Biology from the University of Cape Town and started his career in the natural sciences as a Geographic Information Systems (GIS) specialist at Council for Scientific and Industrial Research (CSIR). In 1998, he joined the Endangered Wildlife Trust where he headed up the Airports Company South Africa – EWT Strategic Partnership, a position he held until he resigned in 2008 to work as a private ornithological consultant. Albert's specialist field is the management of wildlife, especially bird related hazards at airports. His expertise is recognized internationally; in 2005 he was elected as Vice Chairman of the International Bird Strike Committee. Since 2010, Albert has worked closely with Chris van Rooyen in developing a protocol for pre-construction monitoring at wind energy facilities, and he is currently jointly coordinating pre-construction monitoring programmes at several wind farm facilities. Albert also works outside the electricity industry and had done a wide range of bird impact assessment studies associated with various residential and industrial developments.

SPECIALIST DECLARATION

I, Chris van Rooyen as duly authorised representative of Chris van Rooyen Consulting, and working under the supervision of and in association with Albert Froneman (SACNASP Zoological Science Registration number 400177/09) as stipulated by the Natural Scientific Professions Act 27 of 2003, hereby confirm my independence (as well as that of Chris van Rooyen Consulting) as a specialist and declare that neither I nor Chris van Rooyen Consulting have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which SiVEST was appointed as environmental assessment practitioner in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for worked performed, specifically in connection with the Environmental Impact Assessment for the proposed Umsobomvu Solar Project.



Full Name: Chris van Rooyen

Position: Director

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

Proposed Construction of the Mooi Plaats, Wonderheuvel and Paarde Valley Solar PV Energy Facilities and Associated Grid Connection Infrastructure, near Noupoort in the Northern and Eastern Cape Provinces.

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:	Afrimage Photography (Pty) Ltd t/a Chris van Rooyen Consulting			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	Contribution level (indicate 1 to 8 or non-compliant)	Contribution level (indicate 1 to 8 or non-compliant)	Contribution level (indicate 1 to 8 or non-compliant)
Specialist name:	Chris van Rooyen			
Specialist Qualifications:	BA LLB			
Professional affiliation/registration:	I work under the supervision of and in association with Albert Froneman (MSc Conservation Biology) (SACNASP Zoological Science Registration number 400177/09) as stipulated by the Natural Scientific Professions Act 27 of 2003.			
Physical address:	30 Roosevelt Street, Robindale, Randburg			
Postal address:	30 Roosevelt Street, Robindale, Randburg			
Postal code:	2194			
Telephone:	0824549570			
E-mail:	Vanrooyen.chris@gmail.com			

2. DECLARATION BY THE SPECIALIST

I, Chris van Rooyen, 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

Chris van Rooyen Consulting

Name of Company:

6 May 2019

Date

3. **UNDERTAKING UNDER OATH/ AFFIRMATION**

I, Chris van Rooyen, 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

Chris van Rooyen Consulting

Name of Company

6 May 2019

Date

Signature of the Commissioner of Oaths

6 May 2019

Date

SOUTH AFRICAN POLICE SERVICE
COMMUNITY SERVICE CENTRE
2019 -05- 06
C.S.C
LINDEN
SUID-AFRIKAANSE POLISIEDIENS

Details of Specialist, Declaration and Undertaking Under Oath

Page 3 of 3

Curriculum vitae: Chris van Rooyen

Profession/Specialisation	:	Avifaunal Specialist
Highest Qualification	:	BA LLB
Nationality	:	South African
Years of experience	:	22 years

Key Experience

Chris van Rooyen has twenty-two years' experience in the assessment of avifaunal interactions with industrial infrastructure. He was employed by the Endangered Wildlife Trust as head of the Eskom-EWT Strategic Partnership from 1996 to 2007, which has received international acclaim as a model of co-operative management between industry and natural resource conservation. He is an acknowledged global expert in this field and has consulted in South Africa, Namibia, Botswana, Lesotho, New Zealand, Texas, New Mexico and Florida. He also has extensive project management experience and he has received several management awards from Eskom for his work in the Eskom-EWT Strategic Partnership. He is the author and/or co-author of 17 conference papers, co-author of two book chapters, several research reports and the current best practice guidelines for avifaunal monitoring at wind farm sites. He has completed around 130 power line assessments; and has to date been employed as specialist avifaunal consultant on more than 50 renewable energy generation projects. He has also conducted numerous risk assessments on existing power lines infrastructure. He also works outside the electricity industry and he has done a wide range of bird impact assessment studies associated with various residential and industrial developments. He serves on the Birds and Wind Energy Specialist Group which was formed in 2011 to serve as a liaison body between the ornithological community and the wind industry.

Key Project Experience

Bird Impact Assessment Studies and avifaunal monitoring for wind-powered generation facilities:

1. Eskom Klipheuwel Experimental Wind Power Facility, Western Cape
2. Mainstream Wind Facility Jeffreys Bay, Eastern Cape (EIA and monitoring)
3. Biotherm, Swellendam, (Excelsior), Western Cape (EIA and monitoring)
4. Biotherm, Napier, (Matjieskloof), Western Cape (pre-feasibility)
5. Windcurrent SA, Jeffreys Bay, Eastern Cape (2 sites) (EIA and monitoring)
6. Caledon Wind, Caledon, Western Cape (EIA)
7. Innowind (4 sites), Western Cape (EIA)
8. Renewable Energy Systems (RES) Oyster Bay, Eastern Cape (EIA and monitoring)
9. Oelsner Group (Kerriefontein), Western Cape (EIA)
10. Oelsner Group (Langefontein), Western Cape (EIA)
11. InCa Energy, Vredendal Wind Energy Facility Western Cape (EIA)
12. Mainstream Loeriesfontein Wind Energy Facility (EIA and monitoring)
13. Mainstream Noupoort Wind Energy Facility (EIA and monitoring)
14. Biotherm Port Nolloth Wind Energy Facility (Monitoring)
15. Biotherm Laingsburg Wind Energy Facility (EIA and monitoring)
16. Langhoogte Wind Energy Facility (EIA)
17. Vleesbaai Wind Energy Facility (EIA and monitoring)
18. St. Helena Bay Wind Energy Facility (EIA and monitoring)
19. Electrawind, St Helena Bay Wind Energy Facility (EIA and monitoring)
20. Electrawind, Vredendal Wind Energy Facility (EIA)
21. SAGIT, Langhoogte and Wolseley Wind Energy facilities
22. Renosterberg Wind Energy Project – 12-month preconstruction avifaunal monitoring project
23. De Aar – North (Mulilo) Wind Energy Project – 12-month preconstruction avifaunal monitoring project
24. De Aar – South (Mulilo) Wind Energy Project – 12-month bird monitoring
25. Namies – Aggenys Wind Energy Project – 12-month bird monitoring
26. Pofadder - Wind Energy Project – 12-month bird monitoring
27. Dwarsrug Loeriesfontein - Wind Energy Project – 12-month bird monitoring
28. Waaihoek – Utrecht Wind Energy Project – 12-month bird monitoring
29. Amathole – Butterworth Utrecht Wind Energy Project – 12-month bird monitoring & EIA specialist
30. Phezukomoya and San Kraal Wind Energy Projects 12-month bird monitoring & EIA specialist study (Innowind)
31. Beaufort West Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mainstream)
32. Leeuwdraai Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mainstream)
33. Sutherland Wind Energy Facility 12-month bird monitoring (Mainstream)
34. Maralla Wind Energy Facility 12-month bird monitoring & EIA specialist study (Biotherm)
35. Esizayo Wind Energy Facility 12-month bird monitoring & EIA specialist study (Biotherm)
36. Humansdorp Wind Energy Facility 12-month bird monitoring & EIA specialist study (Cennergi)
37. Aletta Wind Energy Facility 12-month bird monitoring & EIA specialist study (Biotherm)
38. Eureka Wind Energy Facility 12-month bird monitoring & EIA specialist study (Biotherm)
39. Makambako Wind Energy Faclity (Tanzania) 12-month bird monitoring & EIA specialist study (Windlab)
40. R355 Wind Energy Facility 12-month bird monitoring (Mainstream)
41. Groenekloof Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mulilo)
42. Tsitsikamma Wind Energy Facility 24-months post-construction monitoring (Cennergi)
43. Noupoort Wind Energy Facility 24-months post-construction monitoring (Mainstream)
44. Kokerboom Wind Energy Facility 12-month bird monitoring & EIA specialist study (Business Venture Investments)
45. Kuruman Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mulilo)
46. Dassieklip Wind Energy Facility 3 years post-construction monitoring (Biotherm)
47. Loeriesfontein 2 Wind Energy Facility 2 years post-construction monitoring (Mainstream)
48. Khobab Wind Energy Facility 2 years post-construction monitoring (Mainstream)
49. Excelsior Wind Energy Facility 18 months construction phase monitoring (Biotherm)
50. Boesmansberg Wind Energy Facility 12-months pre-construction bird monitoring (juwi)
51. Mañhica Wind Energy Facility, Mozambique, 12-months pre-construction monitoring (Windlab)

Bird Impact Assessment Studies for Solar Energy Plants:

1. Concentrated Solar Power Plant, Upington, Northern Cape.
2. Globeleq De Aar and Droogfontein Solar PV Pre- and Post-construction avifaunal monitoring
3. JUWI Kronos PV project, Copperton, Northern Cape
4. Sand Draai CSP project, Groblershoop, Northern Cape
5. Biotherm Helena PV Project, Copperton, Northern Cape
6. Biotherm Letsiao CSP Project, Aggeneys, Northern Cape
7. Biotherm Enamandla PV Project, Aggeneys, Northern Cape
8. Biotherm Sendawo PV Project, Vryburg, North-West
9. Biotherm Tlisitseng PV Project, Lichtenburg, North-West
10. JUWI Hotazel Solar Park Project, Hotazel, Northern Cape
11. Veld Solar One Project, Aggeneys, Northern Cape
12. Brypaal Solar Power Project, Kakamas, Northern Cape
13. ABO Vryburg 1,2,3 Solar PV Project, Vryburg, North-West
14. NamPower CSP Facility near Arandis, Namibia

Bird Impact Assessment Studies for the following overhead line projects:

1. Chobe 33kV Distribution line
2. Athene - Umfolozi 400kV
3. Beta-Delphi 400kV
4. Cape Strengthening Scheme 765kV
5. Flurian-Louis-Trichardt 132kV
6. Ghanzi 132kV (Botswana)
7. Ikaros 400kV
8. Matimba-Witkop 400kV
9. Naboomspruit 132kV
10. Tabor-Flurian 132kV
11. Windhoek - Walvisbaai 220 kV (Namibia)
12. Witkop-Overyssel 132kV
13. Breyten 88kV
14. Adis-Phoebus 400kV
15. Dhuva-Janus 400kV
16. Perseus-Mercury 400kV
17. Gravelotte 132kV
18. Ikaros 400 kV
19. Khanye 132kV (Botswana)
20. Moropule – Thamaga 220 kV (Botswana)
21. Parys 132kV
22. Simplon –Everest 132kV
23. Tutuka-Alpha 400kV
24. Simplon-Der Brochen 132kV
25. Big Tree 132kV
26. Mercury-Ferrum-Garona 400kV
27. Zeus-Perseus 765kV
28. Matimba B Integration Project
29. Caprivi 350kV DC (Namibia)
30. Gerus-Mururani Gate 350kV DC (Namibia)
31. Mmamabula 220kV (Botswana)
32. Steenberg-Der Brochen 132kV
33. Venetia-Paradise T 132kV
34. Burgersfort 132kV
35. Majuba-Umfolozi 765kV
36. Delta 765kV Substation
37. Braamhoek 22kV
38. Steelpoort Merensky 400kV
39. Mmamabula Delta 400kV
40. Delta Epsilon 765kV
41. Gerus-Zambezi 350kV DC Interconnector: Review of proposed avian mitigation measures for the Okavango and Kwando River crossings
42. Giyani 22kV Distribution line
43. Liqhobong-Kao 132/11kV distribution power line, Lesotho
44. 132kV Leslie – Wildebeest distribution line
45. A proposed new 50 kV Spoornet feeder line between Sishen and Saldanha
46. Cairns 132kv substation extension and associated power lines
47. Pimlico 132kv substation extension and associated power lines
48. Gyani 22kV
49. Matafin 132kV
50. Nkomazi_Fig Tree 132kV
51. Pebble Rock 132kV
52. Reddersburg 132kV
53. Thaba Combine 132kV
54. Nkomati 132kV
55. Louis Trichardt – Musina 132kV

56. Endicot 44kV
57. Apollo Lepini 400kV
58. Tarlton-Spring Farms 132kV
59. Kuschke 132kV substation
60. Bendstore 66kV Substation and associated lines
61. Kuiseb 400kV (Namibia)
62. Gyani-Malamulele 132kV
63. Watershed 132kV
64. Bakone 132kV substation
65. Eerstegoud 132kV LILO lines
66. Kumba Iron Ore: SWEP - Relocation of Infrastructure
67. Kudu Gas Power Station: Associated power lines
68. Steenberg Booysendal 132kV
69. Toulon Pumps 33kV
70. Thabatshipi 132kV
71. Witkop-Silica 132kV
72. Bakubung 132kV
73. Nelsriver 132kV
74. Rethabiseng 132kV
75. Tilburg 132kV
76. GaKgapane 66kV
77. Knobel Gilead 132kV
78. Bochum Knobel 132kV
79. Madibeng 132kV
80. Witbank Railway Line and associated infrastructure
81. Spencer NDP phase 2 (5 lines)
82. Akanani 132kV
83. Hermes-Dominion Reefs 132kV
84. Cape Pensinsula Strengthening Project 400kV
85. Magalakwena 132kV
86. Benficosa 132kV
87. Dithabaneng 132kV
88. Taunus Diepkloof 132kV
89. Taunus Doornkop 132kV
90. Tweedracht 132kV
91. Jane Furse 132kV
92. Majeje Sub 132kV
93. Tabor Louis Trichardt 132kV
94. Riversong 88kV
95. Mamatsekele 132kV
96. Kabokweni 132kV
97. MDPP 400kV Botswana
98. Marble Hall NDP 132kV
99. Bokmakiere 132kV Substation and LILO lines
100. Styldrift 132kV
101. Taunus – Diepkloof 132kV
102. Bighorn NDP 132kV
103. Waterkloof 88kV
104. Camden – Theta 765kV
105. Dhuva – Minerva 400kV Diversion
106. Lesedi –Grootpan 132kV
107. Waterberg NDP
108. Bulgerivier – Dorset 132kV
109. Bulgerivier – Toulon 132kV
110. Nokeng-Fluorspar 132kV
111. Mantsole 132kV
112. Tshilamba 132kV
113. Thabamoopo - Tshebela – Nhlovuko 132kV
114. Arthurseat 132kV
115. Borutho 132kV MTS
116. Volspruit - Potgietersrus 132kV
117. Neotel Optic Fibre Cable Installation Project: Western Cape
117. Matla-Glockner 400kV
118. Delmas North 44kV
119. Houwhoek 11kV Refurbishment
120. Clau-Clau 132kV
121. Ngwedi-Silwerkrans 134kV
122. Nieuwehoop 400kV walk-through
123. Booysendal 132kV Switching Station
124. Tarlton 132kV
125. Medupi - Witkop 400kV walk-through
126. Germiston Industries Substation
127. Sekgame 132kV
128. Botswana – South Africa 400kV Transfrontier Interconnector
129. Syferkuil – Rampheri 132kV
130. Queens Substation and associated 132kV powerlines
131. Oranjemond 400kV Transmission line

132. Aries – Helios – Juno walk-down
133. Kuruman Phase 1 and 2 Wind Energy facilities 132kV Grid connection
134. Transnet

Bird Impact Assessment Studies for the following residential and industrial developments:

1. Lizard Point Golf Estate
2. Lever Creek Estates
3. Leloko Lifestyle Estates
4. Vaaloewers Residential Development
5. Clearwater Estates Grass Owl Impact Study
6. Sommerset Ext. Grass Owl Study
7. Proposed Three Diamonds Trading Mining Project (Portion 9 and 15 of the Farm Blesbokfontein)
8. N17 Section: Springs To Leandra –"Borrow Pit 12 And Access Road On (Section 9, 6 And 28 Of The Farm Winterhoek 314 Ir)
9. South African Police Services Gauteng Radio Communication System: Portion 136 Of The Farm 528 Jq, Lindley.
10. Report for the proposed upgrade and extension of the Zeekoegat Wastewater Treatment Works, Gauteng.
11. Bird Impact Assessment for Portion 265 (a portion of Portion 163) of the farm Rietfontein 189-JR, Gauteng.
12. Bird Impact Assessment Study for Portions 54 and 55 of the Farm Zwartkop 525 JQ, Gauteng.
13. Bird Impact Assessment Study Portions 8 and 36 of the Farm Nooitgedacht 534 JQ, Gauteng.
14. Shumba's Rest Bird Impact Assessment Study
15. Randfontein Golf Estate Bird Impact Assessment Study
16. Zilkaatsnek Wildlife Estate
17. Regenstein Communications Tower (Namibia)
18. Avifaunal Input into Richards Bay Comparative Risk Assessment Study
19. Maquasa West Open Cast Coal Mine
20. Glen Erasmia Residential Development, Kempton Park, Gauteng
21. Bird Impact Assessment Study, Weltevreden Mine, Mpumalanga
22. Bird Impact Assessment Study, Olifantsvlei Cemetery, Johannesburg
23. Camden Ash Disposal Facility, Mpumalanga
24. Lindley Estate, Lanseria, Gauteng
25. Proposed open cast iron ore mine on the farm Lylyveld 545, Northern Cape
26. Avifaunal monitoring for the Sishen Mine in the Northern Cape as part of the EMPr requirements
27. Steelpoort CNC Bird Impact Assessment Study

Professional affiliations

I work under the supervision of and in association with Albert Froneman (MSc Conservation Biology) (SACNASP Zoological Science Registration number 400177/09) as stipulated by the Natural Scientific Professions Act 27 of 2003.

Chris van Rooyen
06 May 2019

Curriculum vitae: Albert Froneman

Profession/Specialisation	:	Avifaunal Specialist
Highest Qualification	:	MSc (Conservation Biology)
Nationality	:	South African
Years of experience	:	18 years

Key Qualifications

Albert Froneman **(**Pr.Sci.Nat) has more than 18 years' experience in the management of avifaunal interactions with industrial infrastructure. He holds a M.Sc. degree in Conservation Biology from the University of Cape Town. He managed the Airports Company South Africa (ACSA) – Endangered Wildlife Trust Strategic Partnership from 1999 to 2008 which has been internationally recognized for its achievements in addressing airport wildlife hazards in an environmentally sensitive manner at ACSA's airports across South Africa. Albert is recognized worldwide as an expert in the field of bird hazard management on airports and has worked in South Africa, Swaziland, Botswana, Namibia, Kenya, Israel, and the USA. He has served as the vice chairman of the International Bird Strike Committee and has presented various papers at international conferences and workshops. At present he is consulting to ACSA with wildlife hazard management on all their airports. He also an accomplished specialist ornithological consultant outside the aviation industry and has completed a wide range of bird impact assessment studies. He has co-authored many avifaunal specialist studies and pre-construction monitoring reports for proposed renewable energy developments across South Africa. He also has vast experience in using Geographic Information Systems to analyse and interpret avifaunal data spatially and derive meaningful conclusions. Since 2009 Albert has been a registered Professional Natural Scientist (reg. nr 400177/09) with The South African Council for Natural Scientific Professions, specialising in Zoological Science.

Key Project Experience

Renewable Energy Facilities –avifaunal monitoring projects in association with Chris van Rooyen Consulting

1. Jeffrey's Bay Wind Farm – 12-months preconstruction avifaunal monitoring project
2. Oysterbay Wind Energy Project – 12-months preconstruction avifaunal monitoring project
3. Ubuntu Wind Energy Project near Jeffrey's Bay – 12-months preconstruction avifaunal monitoring project
4. Bana-ba-Pifu Wind Energy Project near Humansdorp – 12-months preconstruction avifaunal monitoring project
5. Excelsior Wind Energy Project near Caledon – 12-months preconstruction avifaunal monitoring project
6. Laingsburg Spitskopvlakte Wind Energy Project – 12-months preconstruction avifaunal monitoring project
7. Loeriesfontein Wind Energy Project Phase 1, 2 & 3 – 12-months preconstruction avifaunal monitoring project
8. Noupoort Wind Energy Project – 12-months preconstruction avifaunal monitoring project
9. Vleesbaai Wind Energy Project – 12-months preconstruction avifaunal monitoring project
10. Port Nolloth Wind Energy Project – 12-months preconstruction avifaunal monitoring project
11. Langhoogte Caledon Wind Energy Project – 12-months preconstruction avifaunal monitoring project
12. Lunsklip – Stilbaai Wind Energy Project – 12-months preconstruction avifaunal monitoring project
13. Indwe Wind Energy Project – 12-months preconstruction avifaunal monitoring project
14. Zeeland St Helena bay Wind Energy Project – 12-months preconstruction avifaunal monitoring project
15. Wolseley Wind Energy Project – 12-months preconstruction avifaunal monitoring project
16. Renosterberg Wind Energy Project – 12-months preconstruction avifaunal monitoring project
17. De Aar – North (Mulilo) Wind Energy Project – 12-months preconstruction avifaunal monitoring project (2014)
18. De Aar – South (Mulilo) Wind Energy Project – 12-months bird monitoring
19. Namies – Aggenys Wind Energy Project – 12-months bird monitoring
20. Pofadder - Wind Energy Project – 12-months bird monitoring
21. Dwarsrug Loeriesfontein - Wind Energy Project – 12-months bird monitoring
22. Waaihoek – Utrecht Wind Energy Project – 12-months bird monitoring
23. Amathole – Butterworth Utrecht Wind Energy Project – 12-months bird monitoring & EIA specialist study
24. De Aar and Droogfontein Solar PV Pre- and Post-construction avifaunal monitoring
25. Makambako Wind Energy Faclity (Tanzania) 12-month bird monitoring & EIA specialist study (Windlab)
26. R355 Wind Energy Facility 12-month bird monitoring (Mainstream)
27. Groenekloof Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mulilo)
28. Tsitsikamma Wind Energy Facility 24-months post-construction monitoring (Cennergi)
29. Noupoort Wind Energy Facility 24-months post-construction monitoring (Mainstream)
30. Kokerboom Wind Energy Facility 12-month bird monitoring & EIA specialist study (Business Venture Investments)
31. Kuruman Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mulilo)
32. Mañhica Wind Energy Facility 12-month bird monitoring & EIA specialist study (Windlab)

Bird Impact Assessment studies and / or GIS analysis:

1. Aviation Bird Hazard Assessment Study for the proposed Madiba Bay Leisure Park adjacent to Port Elizabeth Airport.
2. Extension of Runway and Provision of Parallel Taxiway at Sir Seretse Khama Airport, Botswana Bird / Wildlife Hazard Management Specialist Study
3. Maun Airport Improvements Bird / Wildlife Hazard Management Specialist Study
4. Bird Impact Assesment Study - Bird Helicopter Interaction – The Bitou River, Western Cape Province South Africa
5. Proposed La Mercy Airport – Bird Aircraft interaction specialists study using bird detection radar to assess swallow flocking behaviour
6. KwaZulu Natal Power Line Vulture Mitigation Project – GIS analysis
7. Perseus-Zeus Powerline EIA – GIS Analysis
8. Southern Region Pro-active GIS Blue Crane Collision Project.
9. Specialist advisor ~ Implementation of a bird detection radar system and development of an airport wildlife hazard management and operational environmental management plan for the King Shaka International Airport
10. Matsapha International Airport – bird hazard assessment study with management recommendations
11. Evaluation of aviation bird strike risk at candidate solid waste disposal sites in the Ekurhuleni Metropolitan Municipality

12. Gateway Airport Authority Limited – Gateway International Airport, Polokwane: Bird hazard assessment; Compile a bird hazard management plan for the airport
13. Bird Specialist Study - Evaluation of aviation bird strike risk at the Mwakirunge Landfill site near Mombasa Kenya
14. Bird Impact Assessment Study - Proposed Weltevreden Open Cast Coal Mine Belfast, Mpumalanga
15. Avian biodiversity assessment for the Mafube Colliery Coal mine near Middelburg Mpumalanga
16. Avifaunal Specialist Study - SRVM Volspruit Mining project – Mokopane Limpopo Province
17. Avifaunal Impact Assessment Study (with specific reference to African Grass Owls and other Red List species) Stone Rivers Arch
18. Airport bird and wildlife hazard management plan and training to Swaziland Civil Aviation Authority (SWACAA) for Matsapha and Sikhupe International Airports
19. Avifaunal Impact Scoping & EIA Study - Renosterberg Wind Farm and Solar PV site
20. Bird Impact Assessment Study - Proposed 60 year Ash Disposal Facility near to the Kusile Power Station
21. Avifaunal pre-feasibility assessment for the proposed Montrose dam, Mpumalanga
22. Bird Impact Assessment Study – Proposed ESKOM Phantom Substation near Knysna, Western Cape
23. Habitat sensitivity map for Denham's Bustard, Blue Crane and White-bellied Korhaan in the Kouga Municipal area of the Eastern Cape Province
24. Swaziland Civil Aviation Authority – Sikhuphe International Airport – Bird hazard management assessment
25. Avifaunal monitoring – extension of Specialist Study - SRVM Volspruit Mining project – Mokopane Limpopo Province
26. Avifaunal Specialist Study – Rooikat Hydro Electric Dam – Hope Town, Northern Cape
27. The Stewards Pan Reclamation Project – Bird Impact Assessment study
28. Airports Company South Africa – Avifaunal Specialist Consultant – Airport Bird and Wildlife Hazard Mitigation

Geographic Information System analysis & maps

1. ESKOM Power line Makgalakwena EIA – GIS specialist & map production
2. ESKOM Power line Benficosa EIA – GIS specialist & map production
3. ESKOM Power line Riversong EIA – GIS specialist & map production
4. ESKOM Power line Waterberg NDP EIA – GIS specialist & map production
5. ESKOM Power line Bulge Toulon EIA – GIS specialist & map production
6. ESKOM Power line Bulge DORSET EIA – GIS specialist & map production
7. ESKOM Power lines Marblehall EIA – GIS specialist & map production
8. ESKOM Power line Grootpan Lesedi EIA – GIS specialist & map production
9. ESKOM Power line Tanga EIA – GIS specialist & map production
10. ESKOM Power line Bokmakierie EIA – GIS specialist & map production
11. ESKOM Power line Rietfontein EIA – GIS specialist & map production
12. Power line Anglo Coal EIA – GIS specialist & map production
13. ESKOM Power line Camcoll Jericho EIA – GIS specialist & map production
14. Hartbeespoort Residential Development – GIS specialist & map production
15. ESKOM Power line Mantsole EIA – GIS specialist & map production
16. ESKOM Power line Nokeng Flourspar EIA – GIS specialist & map production
17. ESKOM Power line Greenview EIA – GIS specialist & map production
18. Derdepoort Residential Development – GIS specialist & map production
19. ESKOM Power line Boynton EIA – GIS specialist & map production
20. ESKOM Power line United EIA – GIS specialist & map production
21. ESKOM Power line Gutshwa & Malelane EIA – GIS specialist & map production
22. ESKOM Power line Origstad EIA – GIS specialist & map production
23. Zilkaatsnek Development Public Participation –map production
24. Belfast – Paarde Power line - GIS specialist & map production
25. Solar Park Solar Park Integration Project Bird Impact Assessment Study – avifaunal GIS analysis.
26. Kappa-Omega-Aurora 765kV Bird Impact Assessment Report – Avifaunal GIS analysis.
27. Gamma – Kappa 2nd 765kV – Bird Impact Assessment Report – Avifaunal GIS analysis.
28. ESKOM Power line Kudu-Dorstfontein Amendment EIA – GIS specialist & map production.
29. Proposed Heilbron filling station EIA – GIS specialist & map production
30. ESKOM Lebatlhane EIA – GIS specialist & map production
31. ESKOM Pienaars River CNC EIA – GIS specialist & map production
32. ESKOM Lemara Phiring Ohrigstad EIA – GIS specialist & map production
33. ESKOM Pelly-Warmbad EIA – GIS specialist & map production
34. ESKOM Rosco-Bracken EIA – GIS specialist & map production
35. ESKOM Ermelo-Uitkoms EIA – GIS specialist & map production
36. ESKOM Wisani bridge EIA – GIS specialist & map production
37. City of Tswane – New bulkfeeder pipeline projects x3 Map production
38. ESKOM Lebohang Substation and 132kV Distribution Power Line Project Amendment GIS specialist & map production
39. ESKOM Geluk Rural Powerline GIS & Mapping
40. Eskom Kimberley Strengthening Phase 4 Project GIS & Mapping
41. ESKOM Kwaggafontein - Amandla Amendment Project GIS & Mapping
42. ESKOM Lephalale CNC – GIS Specialist & Mapping
43. ESKOM Marken CNC – GIS Specialist & Mapping
44. ESKOM Lethabong substation and powerlines – GIS Specialist & Mapping
45. ESKOM Magopela- Pitsong 132kV line and new substation – GIS Specialist & Mapping

Professional affiliations

South African Council for Natural Scientific Professions (SACNASP) registered Professional Natural Scientist (reg. nr 400177/09) – specialist field: Zoological Science. Registered since 2009.

1 BACKGROUND

SiVEST has been appointed by Mooi Plaats Solar Power (Pty) Ltd, Wonderheuvel Solar Power (Pty) Ltd and Paarde Valley (Pty) Ltd to conduct an Environmental Authorisation Application for the proposed Umsobomvu PV Solar Energy Facility (SEF) and associated grid connection, near Middelburg and Noupoort in the Eastern and Northern Cape. Chris van Rooyen Consulting was in turn appointed by SiVEST to conduct an avifaunal impact study to assess the impact of the proposed SEF on avifauna.

It is proposed that three (3) Solar Photovoltaic (PV) Energy Facilities, with associated grid connection infrastructure, will be developed, these being:

- ***Mooi Plaats Solar PV Facility***, on an application site of approximately 5 303ha, comprising the following farm portions:
  - Portion 1 of Leuwe Kop No 120
  - Remainder of Mooi Plaats No 121

- ***Wonderheuvel Solar PV Facility***, on an application site of approximately 5 652ha, comprising the following farm portions:
  - Remainder of Mooi Plaats No 121
  - Portion 3 of Wonder Heuvel No 140
  - Portion 5 of Holle Fountain No 133

- ***Paarde Valley Solar PV Facility***, on an application site of approximately 3 695ha, comprising the following farm portion:
  - Portion 2 of Paarde Valley No 62: and
  - Portion 7 of the Farm Leeuw Hoek No. 61.

1.1 SOLAR PV COMPONENTS

Mooi Plaats Solar PV Energy Facility:

The proposed Mooi Plaats Solar PV Energy Facility will include the following components:

- Three (3) PV array areas, occupying a combined total area of approximately 777 hectares (ha).
- The proposed solar PV energy facility will have a maximum total generation capacity of approximately **400MW** and will comprise approximately **1 142 857** PV modules. The final number of modules as well as their configuration will only be determined in the detailed design phase.
- PV modules will be either fixed tilt mounting or single axis tracking mounting, and the modules will be either crystalline silicon or thin film technology. Each module will be approximately 2m wide and between 1m and 4m in height, depending on the mounting type.
- Internal roads, between 4m and 10m wide, will provide access to the PV arrays. Existing site roads will be used wherever possible, although new site roads will be constructed where necessary.
- Up to three (3) temporary construction laydown / staging areas of approximately 4ha each.
- Operation and maintenance (O&M) buildings will be provided for each PV array area, occupying a site of approximately 1ha each. Up to a maximum of three (3) O&M buildings will thus be constructed.
- Medium voltage cabling will link the solar PV energy facility to the grid connection infrastructure. These cables will be laid underground wherever technically feasible.

Wonderheuvel Solar PV Energy Facility:

The proposed Wonderheuvel Solar PV Energy Facility will include the following components:

- Six (6) PV array areas, occupying a combined total area of approximately 864ha.
- The proposed solar PV energy facility will have a maximum total generation capacity of approximately **480MW** and will comprise approximately **1 371 429** PV modules. The final number of modules as well as their configuration will only be determined in the detailed design phase.
- PV modules will be either fixed tilt mounting or single axis tracking mounting, and the modules will be either crystalline silicon or thin film technology. Each module will be approximately 2m wide and between 1m and 4m in height, depending on the mounting type.
- Internal roads, between 4m and 10m wide, will provide access to the PV arrays. Existing site roads will be used wherever possible, although new site roads will be constructed where necessary.
- Up to a maximum of four (4) temporary construction laydown / staging areas of approximately 4ha each.
- Operation and maintenance (O&M) buildings will be provided for each PV array area, occupying a site of approximately 1ha each. However, certain PV array areas will share O&M buildings. Up to a maximum of four (4) O&M buildings will thus be constructed.
- Medium voltage cabling will link the solar PV energy facility to the grid connection infrastructure. These cables will be laid underground wherever technically feasible.

Paarde Valley Solar PV Energy Facility:

The proposed Paarde Valley Solar PV Energy Facility will include the following components:

- Five (5) PV array areas, occupying a combined total area of approximately 1 337ha.
- The proposed solar PV energy facility will have a maximum total generation capacity of approximately **700MW** and will comprise approximately **2 000 000** PV modules. The final number of modules as well as their configuration will only be determined in the detailed design phase.
- PV modules will be either fixed tilt mounting or single axis tracking mounting, and the modules will be either crystalline silicon or thin film technology. Each module will be approximately 2m wide and between 1m and 4m in height, depending on the mounting type.
- Internal roads, between 4m and 10m wide, will provide access to the PV arrays. Existing site roads will be used wherever possible, although new site roads will be constructed where necessary.
- Up to five (5) temporary construction laydown / staging areas of approximately 4ha each.
- Operation and maintenance (O&M) buildings will be provided for each PV array area, occupying a site of approximately 1ha each. Up to a maximum of five (5) O&M buildings will thus be constructed.
- Medium voltage cabling will link the solar PV energy facility to the grid connection infrastructure. These cables will be laid underground wherever technically feasible.

1.2 Grid Connection Infrastructure

The proposed grid connection infrastructure will include the following components:

- New on-site substations and collector substations to serve each solar PV energy facility, each occupying an area of up to approximately 4ha.
- A new 132kV overhead power line connecting the on-site substations and/or collector substations to either the Hydra D Main Transmission Substation (MTS) or the proposed

Coleskop Wind Energy Facility (WEF) substation, from where the electricity will be fed into the national grid. The type of power line towers being considered at this stage to include both lattice and monopole towers which will be up to 25m in height.

Grid connection infrastructure alternatives have been provided for each PV project. These alternatives essentially provide for different route alignments with associated substations contained within an assessment corridor between approximately 400m and 900m wide. This is to allow for flexibility to route the power line on either side of the existing high voltage Eskom power lines. The respective alternatives are as follows:

Mooi Plaats Solar PV Grid Connection:

The alternatives essentially provide for two (2) different route alignments with associated substations contained within an assessment corridor between approximately 400m and 900m wide. The alternatives are as follows:

OPTION 1:

- **Corridor Option 1a** - links Substation 2 and Substation 1a to the Hydra D MTS.
- **Corridor Option 1b** - links Substation 2 and Substation 1b to the Hydra D MTS.

OPTION 2:

- **Corridor Option 2a** - links Substation 2 and Substation 1a to the Hydra D MTS via the proposed Central Collector substation located on the Wonderheuvel PV project application site.
- **Corridor Option 2b** - links Substation 2 and Substation 1b to the Hydra D MTS via the proposed Central Collector substation located on the Wonderheuvel PV project application site.

Wonderheuvel Solar PV Grid Connection:

The alternatives essentially provide for three (3) different route alignments with associated substations contained within an assessment corridor between approximately 400m and 900m wide. The alternatives are as follows:

OPTION 1:

- **Corridor Option 1a** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
    a. The *northern connection* links the Proposed Substation 3a to the Hydra D MTS via the proposed Northern Collector Substation located on the Mooi Plaats PV project application site.
    b. The *southern connection* links the proposed Substation 4a to the Coleskop WEF Substation via the proposed Southern Collector Substation located on the Paarde Valley PV Project application site.

- **Corridor Option 1b** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
    a. The *northern* connection links the Proposed Substation 3a to the Hydra D MTS via the proposed Northern Collector Substation located on the Mooi Plaats PV project application site.
    b. The *southern connection* links the proposed Substation 4b to the Coleskop WEF Substation via the proposed Southern Collector Substation located on the Paarde Valley PV Project application site.

- **Corridor Option 1c** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  a. The *northern* connection links the Proposed Substation 3b to the Hydra D MTS via the proposed Northern Collector Substation located on the Mooi Plaats PV project application site.
  b. The *southern connection* links the proposed Substation 4a to the Coleskop WEF Substation via the proposed Southern Collector Substation located on the Paarde Valley PV Project application site.

- **Corridor Option 1d** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  a. The *northern connection* links the Proposed Substation 3b to Hydra D MTS via the proposed Northern Collector Substation located on the Mooi Plaats PV project application site.
  b. The *southern connection* links the proposed Substation 4b to the Coleskop WEF Substation via the proposed Southern Collector Substation located on the Paarde Valley PV Project application site.

OPTION 2:

- **Corridor Option 2a** - links Substation 3a to the Hydra D MTS via the proposed Central Collector Substation.
- **Corridor Option 2b** - Option 2b links Substation 3b to Hydra D MTS via the proposed Central Collector Substation.

OPTION 3:

- **Corridor Option 3** links Substation 4b to Hydra D MTS via the proposed Central Collector Substation.

Paarde Valley Solar PV Grid Connection:

The alternatives essentially provide for two (2) different route alignments with associated substations contained within an assessment corridor between approximately 400m and 900m wide. The alternatives are as follows:

OPTION 1:

- Corridor **Option 1a** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links Substation 5 to Coleskop Substation via the proposed Southern Collector Sub (Substation 6a will act as Central Collector for this option).
  ii. The *southern connection* links Substation 7a to the Coleskop Substation via the proposed Southern Collector Substation (Substation 6a will act as Southern Collector for this option).

- Corridor **Option 1b** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links Substation 5 to Coleskop Substation via the proposed Southern Collector Sub (Substation 6b will act as Southern Collector for this option).
  ii. The *southern connection* links Substation 7a to the Coleskop Substation via the proposed Southern Collector Substation (Substation 6b will act as Southern Collector for this option).

- Corridor **Option 1c** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links Substation 5 to Coleskop Substation via the proposed Southern Collector Sub (Substation 6a will act as Southern Collector for this option).

ii. The *southern connection* links Substation 7b to the Coleskop Substation via the proposed Southern Collector Substation (Substation 6a will act as Southern Collector for this option).

- Corridor **Option 1d** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links Substation 5 to Coleskop Substation via the proposed Southern Collector Sub (Substation 6b will act as Southern Collector for this option).
  ii. The *southern connection* links Substation 7b to the Coleskop Substation via the proposed Southern Collector Substation (Substation 6b will act as Southern Collector for this option).

OPTION 2:

- Corridor **Option 2a** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links Substation 5 to Hydra D MTS via the proposed Central Collector Sub located on the Wonderveuvel PV Project application site.
  ii. The *southern connection* links Substation 6a and 7a to the Hydra D MTS via the proposed Central Collector Substation located on the Wonderheuvel PV Project application site.

- Corridor **Option 2b** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links Substation 5 to Hydra D MTS via the proposed Central Collector Sub located on the Wonderheuvel PV Project application site.
  ii. The *southern connection* links Substation 6b and 7b to the Hydra D MTS via the proposed Central Collector Substation located on the Wonderheuvel PV Project application site.

- Corridor **Option 2c** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links Substation 5 to Hydra D MTS via the proposed Central Collector Sub located on the Wonderheuvel PV Project application site.
  ii. The *southern connection* links Substation 6a and 7b to the Hydra D MTS via the proposed Central Collector Substation located on the Wonderheuvel PV Project application site.

- Corridor **Option 2d** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links Substation 5 to Hydra D MTS via the proposed Central Collector Sub located on the Wonderheuvel PV Project application site.
  ii. The *southern connection* links Substation 6b and 7a to the Hydra D MTS via the proposed Central Collector Substation located on the Wonderheuvel PV Project application site.

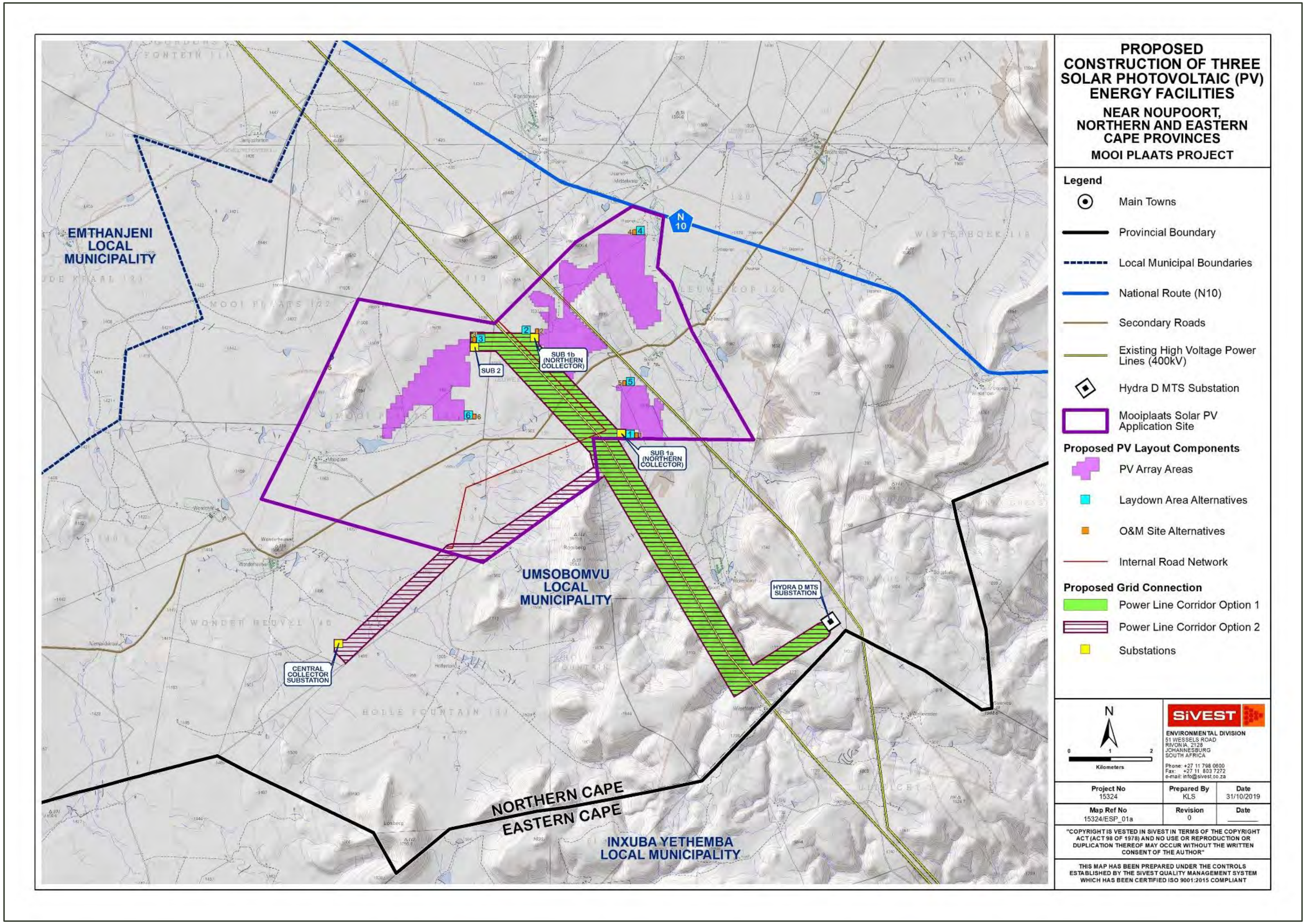


Figure 1: Mooi Plaats Solar PV Facility

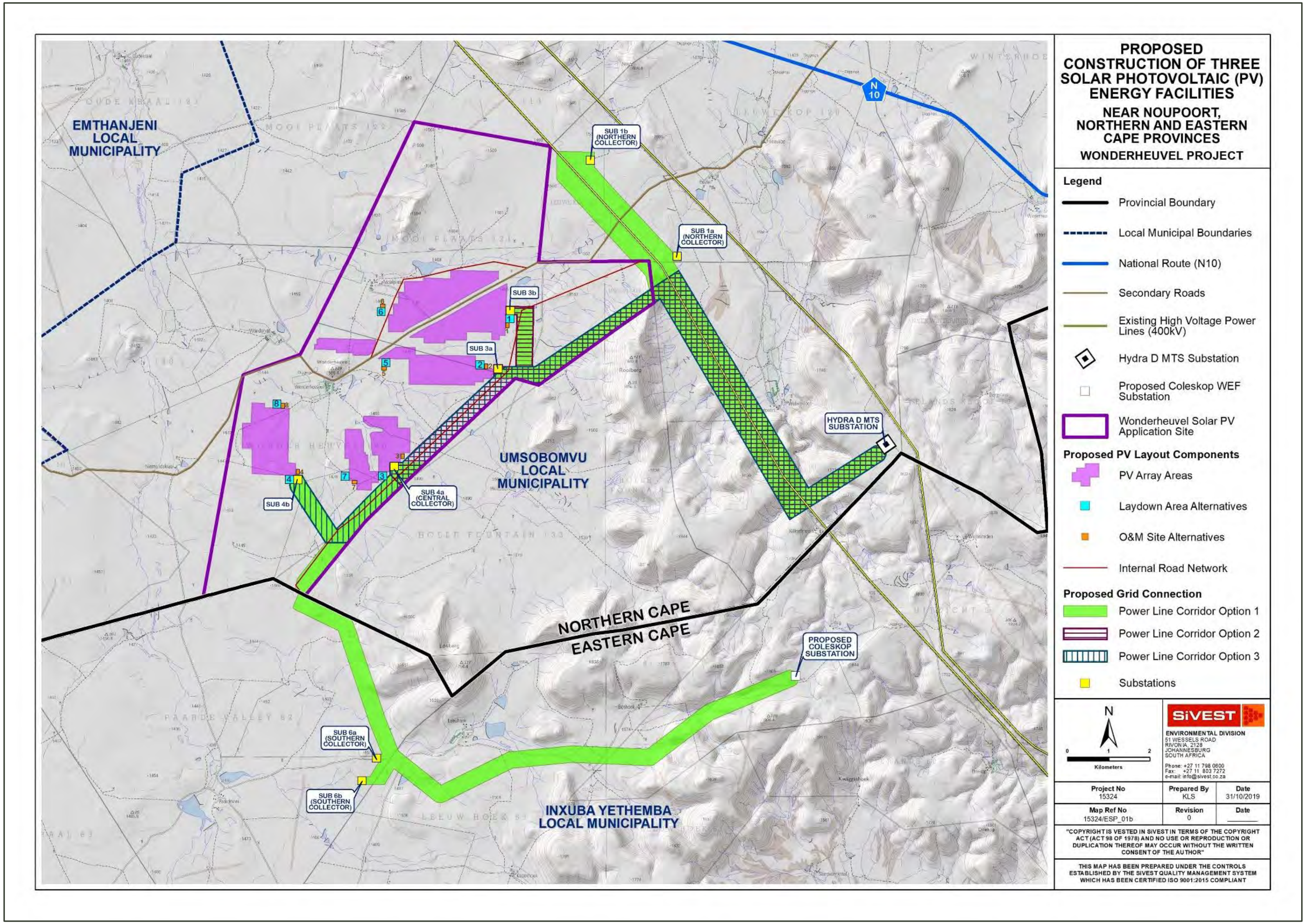


Figure 2: Wonderheuvel Solar PV Facility

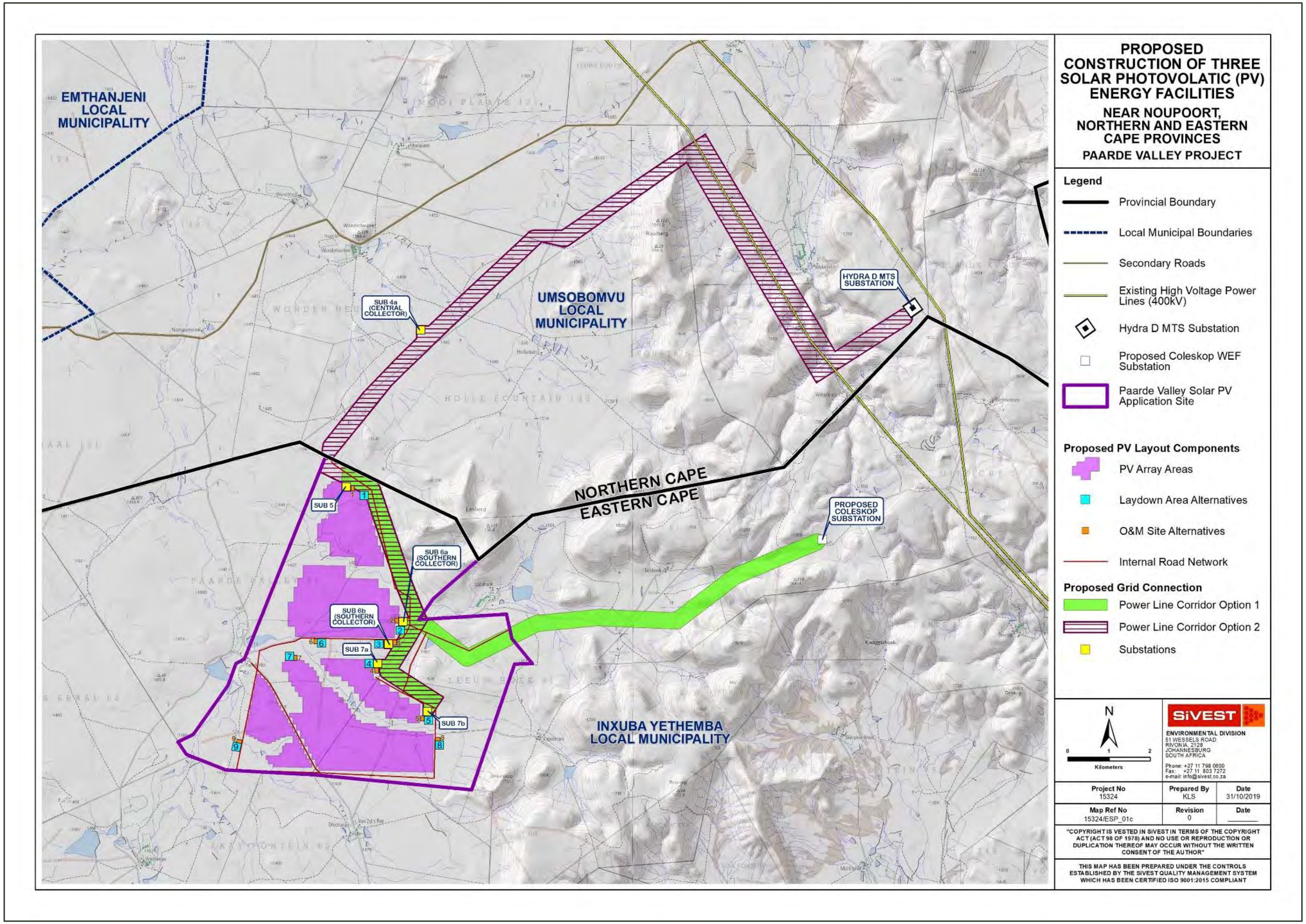


Figure 3: Paarde Valley Solar PV Energy Facility

2 PROJECT SCOPE

The terms of reference for this assessment report are as follows:

- Describe the affected environment from an avifaunal perspective;
- Discuss gaps in baseline data and other limitations;
- List and describe the expected impacts associated with the solar facilities and associated infrastructure;
- Assess the potential impacts;
- Recommend mitigation measures to reduce the impact of the expected impacts.

3 OUTLINE OF METHODOLOGY AND INFORMATION REVIEWED

The following information sources were consulted in order to conduct this study:

- Bird distribution data from the Southern African Bird Atlas Project 2 (SABAP 2) was obtained (http://sabap2.adu.org.za/), in order to ascertain which species occur in the pentads where the proposed development areas are located. A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km. In order to get a more representative impression of the birdlife, a consolidated data set was obtained for a total of 9 pentads some of which intersect and others that are in the vicinity of the development, henceforth called the broader area. The SABAP2 data covers the period 2007 to 2019. The relevant pentads are 3115_2435, 3115_2440, 3110_2445, 3120_2435, 3120_2440, 3115_2445, 3125_2435, 3125_2440, 3125_2445.
- A classification of the vegetation types in the development area was obtained from the Atlas of Southern African Birds 1 (SABAP1) and the National Vegetation Map compiled by the South African National Biodiversity Institute (Mucina & Rutherford 2006).
- The national threatened status of all priority species was determined with the use of the most recent edition of the Red Data Book of Birds of South Africa, Lesotho and Swaziland (Taylor *et al*. 2015), and the latest authoritative summary of southern African bird biology (Hockey *et al.* 2005).
- The global threatened status of all priority species was determined by consulting the latest (2019.1) IUCN Red List of Threatened Species).
- The Important Bird and Biodiversity Areas of South Africa (Marnewick *et al.* 2015) was consulted for information on potentially relevant Important Bird Areas (IBAs).
- Satellite imagery was used in order to view the broader area on a landscape level and to help identify bird habitat on the ground.
- A desktop investigation was conducted to source information on the impacts of solar facilities on avifauna.
- A visit to the site and general area was conducted on 15 and 16 January 2019, followed up by on-site surveys from 17 - 19 January and 9 - 12 May 2019. Surveys were conducted according to the best practice guidelines for avifaunal impact studies at solar developments, compiled by BirdLife South Africa (BLSA) in 2017 (Jenkins *et al*. 2017). Please see Appendix 1 for the methodology used in the surveys.

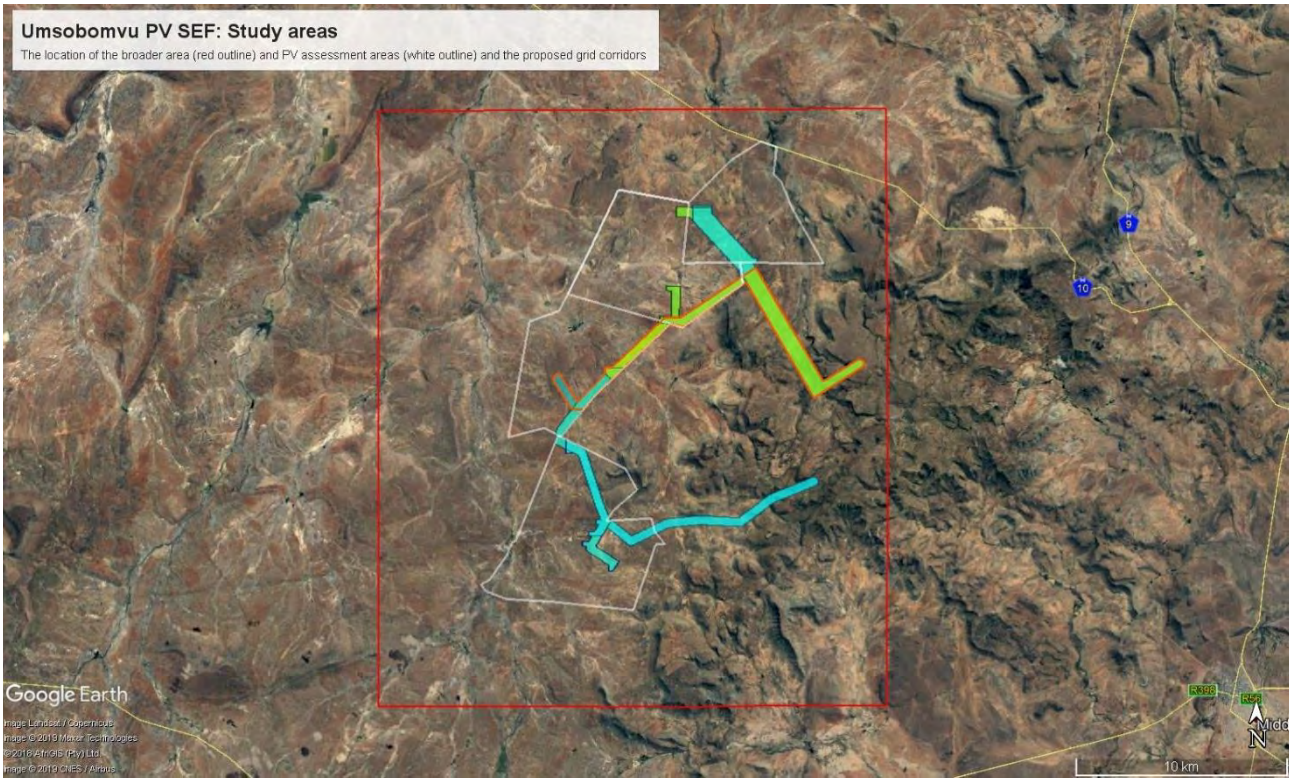


Figure 4: Area covered by the nine SABAP 2 pentads (red outline), the PV assessment areas (white outline) and the proposed powerline corridors.

4 ASSUMPTIONS AND LIMITATIONS

This study assumed that the sources of information used in this report are reliable. In this respect, the following must be noted:

- A total of 40 SABAP2 full protocol lists had been completed for the broader area where the proposed project is located (i.e. bird listing surveys lasting a minimum of two hours each). In addition,12 ad hoc protocol lists (i.e. bird listing surveys lasting less than two hours but still giving useful data) and 684 incidental sightings were also recorded. The SABAP2 data was therefore regarded as a good indicator of the avifauna which could occur at the proposed development area, and it was further supplemented by data collected during the on-site surveys.
- The focus of the study is primarily on the potential impacts on priority solar and powerline species.
- Priority solar species were defined as follows:
    - South African Red Data species;
    - South African endemics and near-endemics;
    - Raptors
    - Waterbirds
- Priority powerline species were defined as those species which could potentially be impacted by powerline collisions or electrocutions, based on morphology and/or behaviour.
- The impact of solar installations on avifauna is a new field of study, with only one published scientific study on the impact of PV facilities on avifauna in South Africa (Visser *et al*. 2019). Strong reliance was therefore placed on expert opinion and data from existing monitoring programmes at solar facilities in the USA where monitoring has been ongoing since 2013. The pre-cautionary principle was applied throughout as the full extent of impacts on avifauna at solar facilities is not presently known.
- The assessment of impacts is based on the baseline environment as it currently exists at the proposed development area.

- Cumulative impacts include all proposed and existing renewable energy projects within a 35km radius around the proposed development areas[1].
- Conclusions in this study are based on experience of these and similar species in different parts of South Africa. Bird behaviour can never be entirely reduced to formulas that will be valid under all circumstances.
- The **broader area** is defined as the area encompassed by the 9 pentads where the project is located (see Figure 4). The **study area** is defined as the combined area of the Mooi Plaats, Wonderheuvel, and Paarde Valley PV assessment areas, and the powerline corridors (see Figure 4). The **PV development footprint** is defined as the combined area covered by the solar fields, internal roads, lay-down areas and O&M buildings.

5 LEGISLATIVE CONTEXT

There is no specific legislation pertaining specifically to the impact of solar facilities on avifauna. Guidelines for assessing and monitoring the impact of solar power generating facilities on birds in southern Africa (Jenkins *et al.* 2017), compiled by BirdLife South Africa, was followed in the compilation of this report.

5.1 AGREEMENTS AND CONVENTIONS

Table 1 below lists agreements and conventions which South Africa is party to and which is relevant to the conservation of avifauna (BirdLife International 2019).

Table 1: Agreements and conventions which South Africa is party to and which is relevant to the conservation of avifauna.

Convention name	Description	Geographic scope
African-Eurasian Waterbird Agreement (AEWA)	The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) is an intergovernmental treaty dedicated to the conservation of migratory waterbirds and their habitats across Africa, Europe, the Middle East, Central Asia, Greenland and the Canadian Archipelago. Developed under the framework of the Convention on Migratory Species (CMS) and administered by the United Nations Environment Programme (UNEP), AEWA brings together countries and the wider international conservation community in an effort to establish coordinated conservation and management of migratory waterbirds throughout their entire migratory range.	Regional
Convention on Biological Diversity (CBD), Nairobi, 1992	The Convention on Biological Diversity (CBD) entered into force on 29 December 1993. It has 3 main objectives: The conservation of biological diversity The sustainable use of the components of biological diversity The fair and equitable sharing of the benefits arising out of the utilization of genetic resources.	Global
Convention on the Conservation of Migratory Species of Wild Animals, (CMS), Bonn, 1979	As an environmental treaty under the aegis of the United Nations Environment Programme, CMS provides a global platform for the conservation and sustainable use of migratory animals and their habitats. CMS brings together the States through which migratory animals pass, the Range States, and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range.	Global
Convention on the International Trade in Endangered Species of Wild Flora and Fauna, (CITES), Washington DC, 1973	CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.	Global

[1] The list of projects was provided by SiVEST.

Ramsar Convention on Wetlands of International Importance, Ramsar, 1971	The Convention on Wetlands, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.	Global
Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia	The Signatories will aim to take co-ordinated measures to achieve and maintain the favourable conservation status of birds of prey throughout their range and to reverse their decline when and where appropriate.	Regional

5.2 NATIONAL LEGISLATION

5.2.1 Constitution of the Republic of South Africa, 1996

The Constitution of the Republic of South Africa provides in the Bill of Rights that: Everyone has the right –

(a) to an environment that is not harmful to their health or well-being; and

(b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that –

- (i) prevent pollution and ecological degradation;
- (ii) promote conservation; and
- (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

5.2.2 The National Environmental Management Act 107 of 1998 (NEMA)

The National Environmental Management Act 107 of 1998 (NEMA) creates the legislative framework for environmental protection in South Africa and is aimed at giving effect to the environmental right in the Constitution. It sets out a number of guiding principles that apply to the actions of all organs of state that may significantly affect the environment. Sustainable development (socially, environmentally and economically) is one of the key principles, and internationally accepted principles of environmental management, such as the precautionary principle and the polluter pays principle, are also incorporated.

NEMA also provides that a wide variety of listed developmental activities, which may significantly affect the environment, may be performed only after an environmental impact assessment has been done and authorization has been obtained from the relevant authority. Many of these listed activities can potentially have negative impacts on bird populations in a variety of ways. The clearance of natural vegetation, for instance, can lead to a loss of habitat and may depress prey populations, while erecting structures needed for generating and distributing energy, communication, and so forth can cause mortalities by collision or electrocution.

5.2.3 The National Environmental Management: Biodiversity Act 10 of 2004 (NEMBA) and the Threatened or Protected Species Regulations, February 2007 (TOPS Regulations)

The most prominent statute containing provisions directly aimed at the conservation of birds is the National Environmental Management: Biodiversity Act 10 of 2004 read with the Threatened or Protected Species Regulations, February 2007 (TOPS Regulations). Chapter 1 sets out the objectives of the Act, and they are aligned with the objectives of the Convention on Biological Diversity, which are the conservation of biodiversity, the sustainable use of its components, and the fair and equitable sharing of the benefits of the use of genetic resources. The Act also gives effect to CITES, the Ramsar Convention, and the Bonn Convention on Migratory Species of Wild Animals. The State is endowed with the trusteeship of biodiversity and has the responsibility to manage, conserve and sustain the biodiversity of South Africa.

6 BASELINE ASSESSMENT

6.1 IMPORTANT BIRD AREAS

The Platberg-Karoo Conservancy Important Bird Area (IBA) SA037 is located approximately 3 - 4km north-west of the PV study area and proposed powerline corridors (see Figure 5). The Platberg–Karoo Conservancy IBA covers the entire districts of De Aar, Philipstown and Hanover, including suburban towns. The landscape consists of extensive flat to gently undulating plains that are broken by dolerite hills and flat-topped inselbergs. The ephemeral Brak River flows in an arc from south-east to north-west, eventually feeding into the Orange River basin. Other ephemeral rivers include the Hondeblaf, Seekoei, Elandsfontein and Ongers rivers with a network of tributaries. Vanderkloof Dam is on the north-eastern boundary (Marnewick *et al.* 2015).

This IBA is in the Nama Karoo and Grassland Biomes. The eastern Nama Karoo has the highest rainfall of all the Nama Karoo vegetation types and is thus ecotonal to grassland, with a complex mix of grass- and shrub-dominated vegetation types. Eight broad vegetation types are present; seven are Least Threatened and the Upper Gariep Alluvial Vegetation type is classified as Vulnerable (Marnewick *et al*. 2015).

The land is used primarily for grazing and agriculture. Commercial livestock farming is mostly extensive wool and mutton production, with some cattle and game farming. Less than 5% of this IBA is cultivated under dry-land or irrigated conditions, and includes lucerne and prickly pear *Opuntia ficus-indica* orchards (Marnewick *et al.* 2015).

This IBA contributes significantly to the conservation of large terrestrial birds and raptors. These include Blue Crane *Anthropoides paradiseus*, Ludwig's Bustard *Neotis ludwigii*, Kori Bustard *Ardeotis kori*, Blue Korhaan *Eupodotis caerulescens*, Black Stork *Ciconia nigra*, Secretarybird *Sagittarius serpentarius*, Martial Eagle *Polemaetus bellicosus*, Verreauxs' Eagle *Aquila verreauxii* and Tawny Eagle *A. rapax* (Marnewick *et al.* 2015).

In summer, close to 10% of the global population of Lesser Kestrels *Falco naumanni* roost in this IBA. Amur Falcons *F. amurensis* are also abundant and forage and roost with Lesser Kestrels. This IBA is seasonally important for White Stork *Ciconia ciconia*, with high numbers of this species recorded during outbreaks of brown locusts *Locustana pardalina* and armoured ground crickets *Acanthoplus discoidalis* (Marnewick *et al.* 2015).

IBA trigger species are the globally threatened Blue Crane, Ludwig's Bustard, Kori Bustard, Secretarybird, Martial Eagle, Blue Korhaan, Black Harrier *Circus maurus* and Denham's Bustard *Neotis denhami*. Regionally threatened species are Black Stork, Lanner Falcon *Falco biarmicus*, Tawny Eagle, Karoo Korhaan and Verreaux's' Eagle (Marnewick *et al*. 2015).

Biome-restricted species include Karoo Lark *Calendulauda albescens*, Karoo Long-billed Lark *Certhilauda subcoronata*, Karoo Chat *Cercomela schlegelii*, Tractrac Chat *C. tractrac*, Sickle-winged Chat *C. sinuata*, Namaqua Warbler *Phragmacia substriata*, Layard's Tit-Babbler *Sylvia layardi*, Pale-winged Starling *Onychognathus nabouroup* and Black-headed Canary *Serinus alario*. Congregatory species include Lesser Kestrel and Amur Falcon.

Due to the proximity of the IBA to the study area, it is possible that the proposed project could impact on some of the trigger species in the IBA. Far ranging birds that move in and out of the IBA could be impacted, namely powerline sensitive species such as Blue Crane, Ludwig's Bustard, Kori Bustard, Black Stork, Secretarybird, Martial Eagle, Verreaux's Eagle and Tawny Eagle, which could be at risk of electrocutions on and/or collisions with the proposed 132kV grid connection.

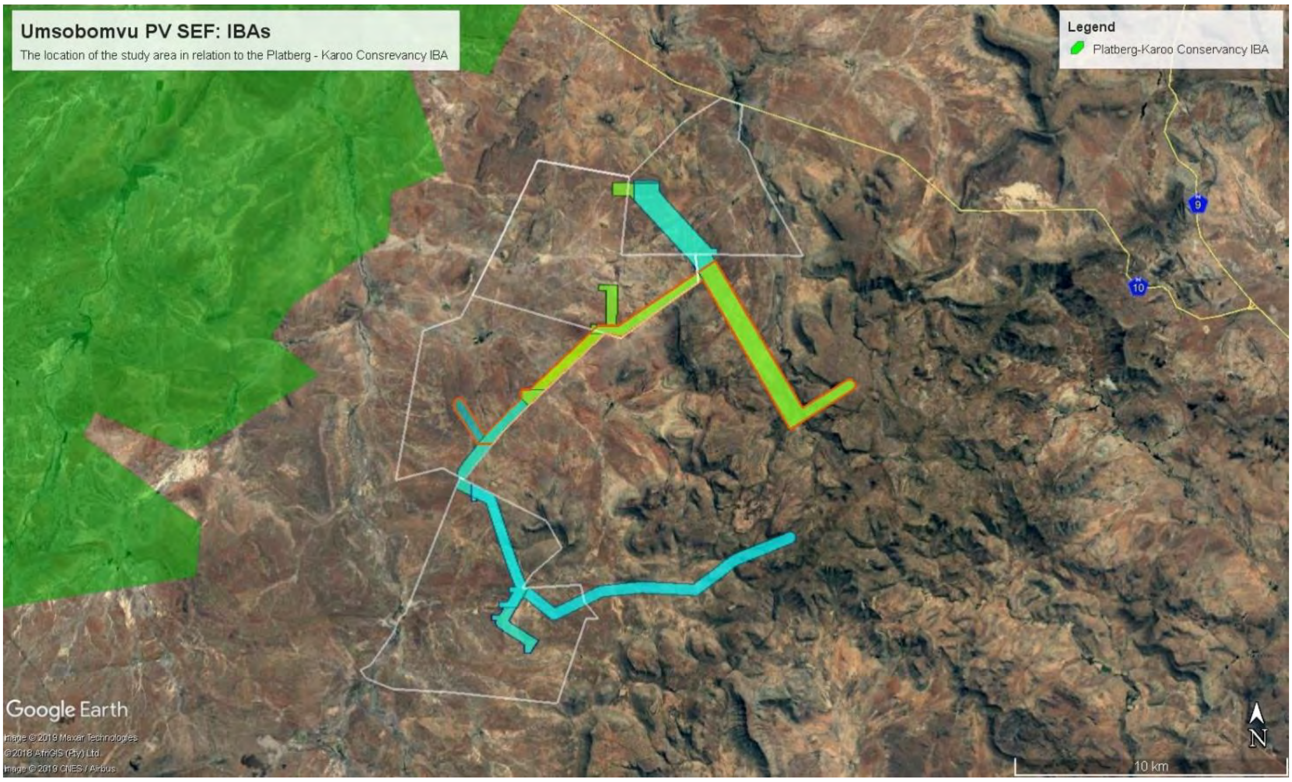


Figure 5: The location of the Platberg – Karoo Conservancy IBA relative to the study area.

6.2 HABITAT CLASSES

Vegetation structure, rather than the actual plant species, is more significant for bird species distribution and abundance (Harrison *et al.* 1997). The description of the vegetation types occurring in the study area largely follows the classification system presented in the Atlas of southern African birds (SABAP1) (Harrison *et al*. 1997). The criteria used to amalgamate botanically defined vegetation units, or to keep them separate were (1) the existence of clear differences in vegetation structure, likely to be relevant to birds, and (2) the results of published community studies on bird/vegetation associations. It is important to note that no new vegetation unit boundaries were created, with use being made only of previously published data. The description of vegetation presented in this study therefore concentrates on factors relevant to the bird species present and is not an exhaustive list of plant species present.

Whilst the distribution and abundance of the priority bird species in the study area are closely tied to natural features e.g. vegetation structure and topography/relief, it is also necessary to examine external modifications to the environment that might have relevance for priority species. Anthropogenic avifaunal-relevant habitat modifications which could potentially influence the avifaunal community that were recorded in or close to the study area are dams and water reservoirs, high voltage transmission lines, agriculture, fences and alien trees. The habitat classes are discussed in more detail below.

The solar and powerline priority species associated with each habitat class are listed in Tables 2 and 3.

6.2.1 Grassy Karoo

The study area lies at the intersection between Nama Karoo and Grassland biomes (Mucina & Rutherford 2006), described by Harrison et al. (1997) as Grassy Karoo. The dominant vegetation type in the study area is Eastern Upper Karoo, which occurs on the plains where all of the PV assessment areas are located, and is dominated by dwarf microphyllous shrubs, with 'white' grasses of the genera Aristida and Eragrostis (these become prominent especially in the early autumn months after good summer rains). Rainfall occurs mainly in autumn and summer, peaking in March. The mean annual precipitation ranges from about 180 mm to 430 mm. Incidence of frost is relatively high. Mean maximum and minimum monthly temperatures in Middelburg (Grootfontein) are 36.1°C and –7.2°C for January and July, respectively (Mucina & Rutherford, 2006). Small sections of some of the proposed powerline corridors are located in Besemkaree Koppies Shrubland, which occurs on slopes of koppies, butts and tafelbergs covered by two-layered karroid shrubland. The lower (closed-canopy) layer is dominated by dwarf small-leaved shrubs and, especially in precipitation-rich years, also by abundant grasses, while the upper (loose canopy) layer is dominated by tall shrubs (Mucina & Rutherford, 2006).

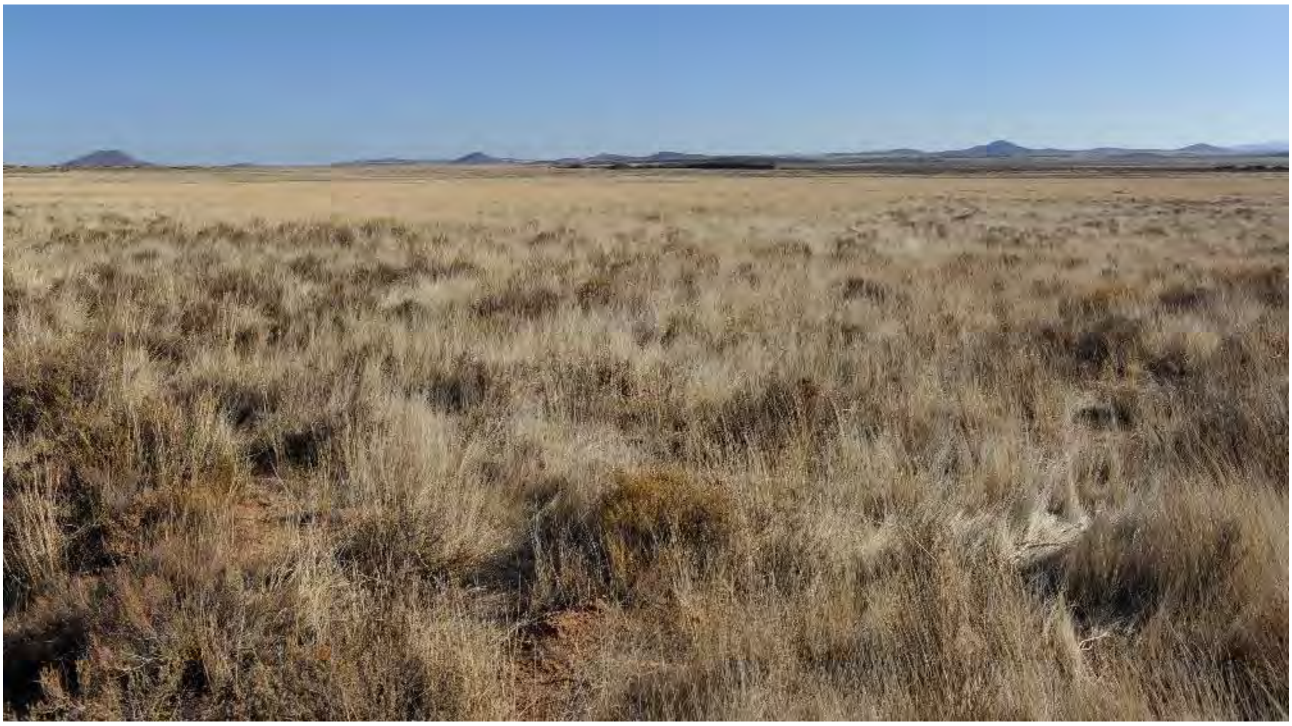


Figure 6: An example of Eastern Upper Karoo (Grassy Karoo) occurring on the plains where the proposed PV areas are located.

Figure 7: An example of Besemkaree Koppies Shrubland which occurs on the slopes.

6.2.2 Surface water

Surface water is of specific importance to avifauna in this semi-arid environment. The study area contains many boreholes with open water troughs that provide drinking water to livestock. Open water troughs are important sources of surface water and could potentially be used extensively by various bird species, including large raptors, to drink and bath. There are also a number of dams and natural waterbodies in the study area, which are located in drainage lines (see Figure 8). The dams and waterbodies were mostly dry when the surveys were conducted, but it could hold water after good rains, when it could be attractive to various bird species, including large raptors, to drink and bath. It could also serve as an attraction to waterbirds when it contains water.

Figure 8: A dam in the study area

6.2.3 Cliffs

The south-eastern part of the broader area contains several cliffs which is utilised by a number of cliff-nesting raptors for breeding, including Booted Eagle, Verreaux's Eagle (see Figure 9) and possibly Jackal Buzzard. Figure 10 below shows the location of known nests in the study area.

Figure 9: A Verreaux's Eagle nest on a cliff in the study area

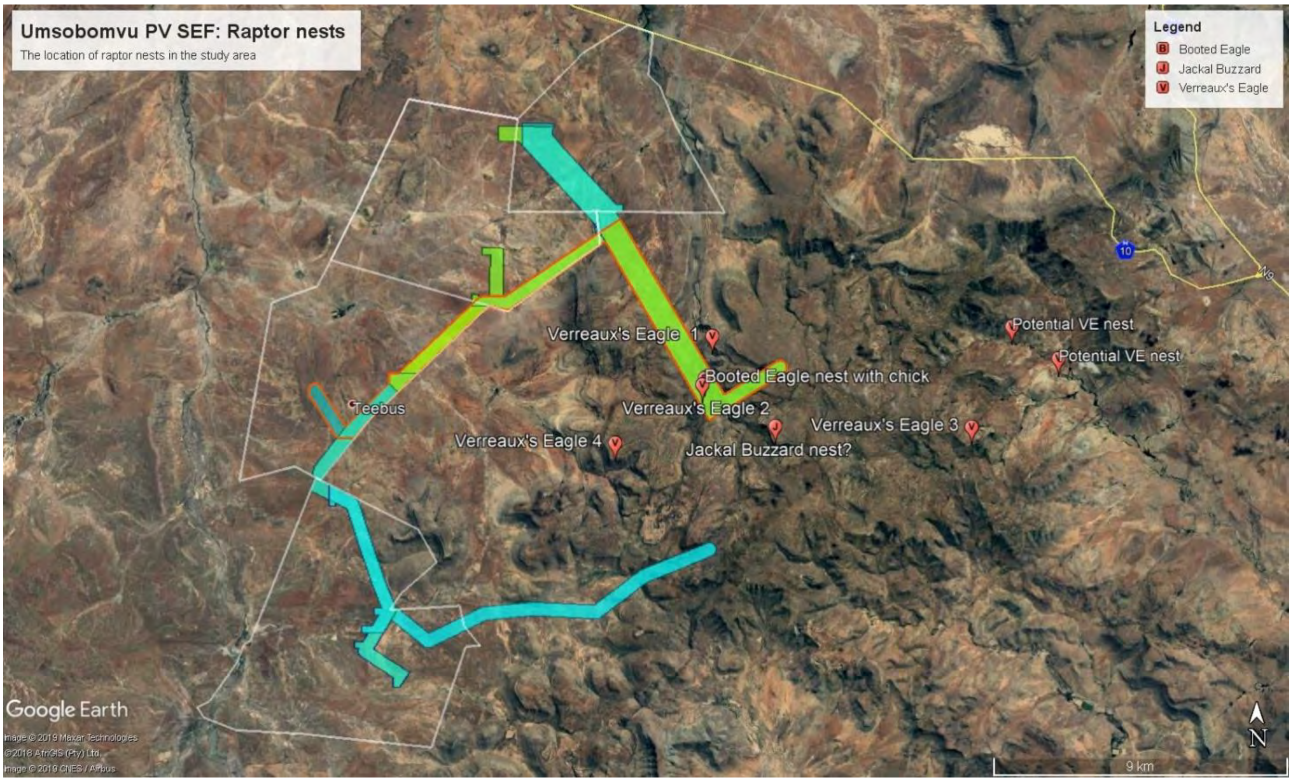


Figure 10: The location of raptor nests in the study area.

6.2.4 High voltage lines

High voltage lines are an important roosting and breeding substrate for large raptors in the tree-less Karoo habitat (Jenkins *et al.* 2006). There are two 400kV transmission lines running through the study area, namely the Hydra-Poseidon 400kV 1 and 2 (see Figure 11 below). No raptor nests were recorded on the transmission lines.


Figure 11: The Hydra-Poseidon 400kV 1 high voltage line running through the site.

6.2.5 Fences

The study area is fenced off into grazing camps (see Figure 12). Farm fences provide important perching substrate for a wide range of birds in this treeless environment where natural perches are scarce, as a staging post for territorial displays by small birds and also for perch hunting for raptors such as Greater Kestrel, Rock Kestrel, Black-winged Kite and Southern pale Chanting Goshawk.

Figure 12: The study area contains many fences.

6.2.6 Agriculture

The study area contains a number of agricultural clearings and irrigated pivots (see Figure 13). These areas may attract several solar and powerline priority species, including Ludwig's Bustard, Blue Crane, Spurwing Goose, Egyptian Goose, Helmeted Guineafowl, White Stork and Blue Korhaan.

Figure 13: Irrigated fields in the study area.

6.2.7 Alien trees

Large indigenous trees are rare in the Karoo, therefore alien trees of the genus *Pinus*, *Populus* and *Eucalyptus* have been introduced in many areas, often around homesteads, but also at boreholes (see Figure 14). In some places, these alien species have become an invasive threat in drainage lines. Many solar and powerline priority species use alien trees for nesting and roosting.

Figure 14: Alien trees in the study area

6.3 AVIFAUNA

6.3.1 Southern African Bird Atlas 2

The SABAP2 data indicate that a total of 185 bird species could potentially occur in the broader area – Appendix 2 provides a comprehensive list of all the species, including those recorded during the pre-construction monitoring. Of these, 78 species are classified as priority solar species, and 50 as powerline priority species (see Section 4 for the definition of a priority species). The probability of a priority species occurring in the study area is indicated in Tables 2 and 3.

Table 2 below lists all the solar priority species and the possible impact on the respective species by the proposed solar energy infrastructure. Table 3 does the same for powerline sensitive species and powerline infrastructure. The following abbreviations and acronyms are used:

- EN = Endangered
- VU = Vulnerable
- NT = Near-threatened

6.3.2 Pre-construction surveys

A visit to the study area was conducted on 15 and 16 January 2019, followed up by on-site surveys from 17 - 19 January and 9 – 12 May 2019. Surveys were conducted according to the best practice guidelines for avifaunal impact studies at solar developments, compiled by BirdLife South Africa (BLSA) in 2017 (Jenkins *et al.* 2017). Please see Appendix 1 for the methodology used in the surveys.

6.3.2.1 Priority species abundance

The abundance of solar priority species (birds/km) recorded during the two seasonal surveys are displayed in Figure 15 below.

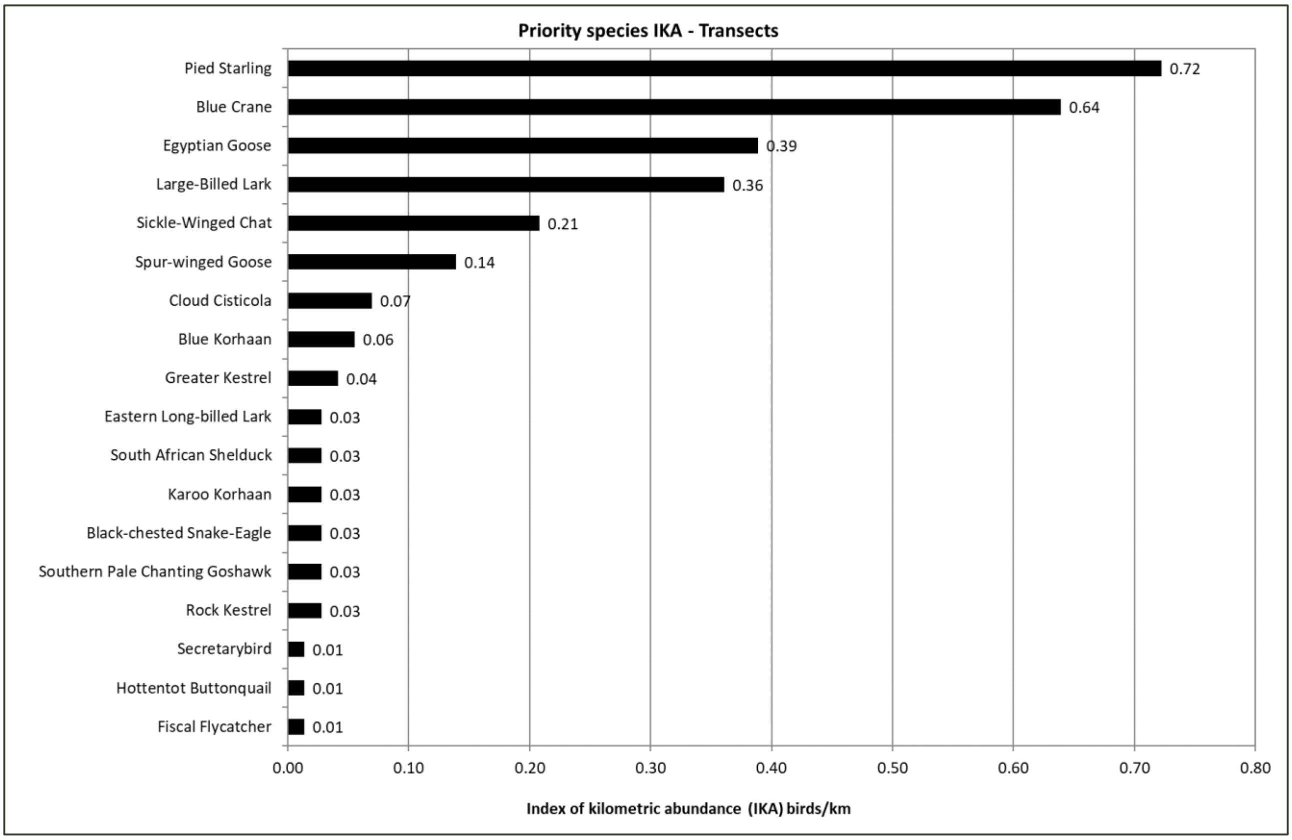


Figure 15: The abundance of solar priority species recorded during the two rounds of seasonal surveys

Table 2: Solar priority species potentially occurring at the site, conservation status, priority criteria, SABAP reporting rates, probability of occurrence, habitat use and potential impacts.

Species	Taxonomic name	Solar priority species	SABAP2 Average reporting rate: full protocol	Red Data status: International	Red Data status: Regional	Endemic - South Africa	Endemic - Southern Africa	Possibility of occurrence	Recorded during surveys	Grassy Karoo	Surface water	Alien trees	Cliffs	Powerlines	Agriculture	Fences	PV panel collisions	Displacement - disturbance	Displacement - habitat loss	Entrapment in fences
Avocet, Pied	*Recurvirostra avosetta*	*x*	15.48					Low			x						x			
Bustard, Ludwig's	*Neotis ludwigii*	*x*	25.67	EN	EN		Near-endemic	High	x	x					x			x	x	x
Buzzard, Jackal	*Buteo rufofuscus*	*x*	22.22			Near endemic	Endemic	High	x	x	x	x	x	x	x	x	x	x		
Canary, Black-headed	*Serinus alario*	*x*	14.56			Near endemic	Endemic	Low		x	x					x	x	x		
Chat, Sickle-winged	*Cercomela sinuata*	*x*	48.81			Near endemic	Endemic	High	x	x						x	x	x		
Cisticola, Cloud	*Cisticola textrix*	*x*	0.00			Near endemic	Near-endemic	High	x	x							x	x		
Coot, Red-knobbed	*Fulica cristata*	*x*	14.41					Low			x						x			
Cormorant, Reed	*Phalacrocorax africanus*	*x*	13.49					Low			x						x			
Crane, Blue	*Anthropoides paradiseus*	*x*	73.41	VU	NT		Endemic	High	x	x	x				x			x	x	x
Duck, African Black	*Anas sparsa*	*x*	8.33					Low			x						x			
Duck, Maccoa	*Oxyura maccoa*	*x*	1.59	NT	NT			Low			x						x			
Duck, White-faced	*Dendrocygna viduata*	*x*	2.78					Low			x						x			
Duck, Yellow-billed	*Anas undulata*	*x*	50.92					Low			x						x			
Eagle, Martial	*Polemaetus bellicosus*	*x*	7.14	VU	EN			Medium		x	x	x		x	x			x	x	
Eagle, Verreaux's	*Aquila verreauxii*	*x*	18.26	LC	VU			High	x	x		x	x	x						
Eagle-owl, Spotted	*Bubo africanus*	*x*	12.43					High		x		x	x		x	x	x	x		
Egret, Cattle	*Bubulcus ibis*	*x*	4.63					Low		x		x			x			x		
Egret, Great	*Egretta alba*	*x*	0.00					Low			x						x			
Falcon, Lanner	*Falco biarmicus*	*x*	2.78	LC	VU			Medium		x	x	x	x	x	x	x	x	x		
Falcon, Peregrine	*Falco peregrinus*	*x*	1.59					Low			x	x	x	x			x			
Fish-eagle, African	*Haliaeetus vocifer*	*x*	3.18					Low			x	x					x			

Species	Taxonomic name	Solar priority species	SABAP2 Average reporting rate: full protocol	Red Data status: International	Red Data status: Regional	Endemic - South Africa	Endemic - Southern Africa	Possibility of occurrence	Recorded during surveys	Grassy Karoo	Surface water	Alien trees	Cliffs	Powerlines	Agriculture	Fences	PV panel collisions	Displacement - disturbance	Displacement - habitat loss	Entrapment in fences
Flamingo, Greater	*Phoenicopterus ruber*	x	3.18	LC	NT			Low			x						x			
Flycatcher, Fiscal	*Sigelus silens*	x	34.40			Near endemic	Endemic	High	x	x		x				x	x	x		
Goose, Spur-winged	*Plectropterus gambensis*	x	34.79					High	x		x			x	x		x			
Goshawk, Southern Pale Chanting	*Melierax canorus*	x	34.66				Near-endemic	High	x	x	x	x		x		x	x	x		
Grebe, Black-necked	*Podiceps nigricollis*	x	0.00					Low			x						x			
Grebe, Great Crested	*Podiceps cristatus*	x	1.59					Low			x						x			
Grebe, Little	*Tachybaptus ruficollis*	x	9.12					Low			x						x			
Greenshank, Common	*Tringa nebularia*	x	12.70					Low			x						x			
Hamerkop	*Scopus umbretta*	x	1.86					Low			x						x			
Harrier, Black	*Circus maurus*	x	2.78	VU	EN	Near endemic	Endemic	Low		x	x					x	x			
Harrier-Hawk, African	*Polyboroides typus*	x	1.59					Low		x	x	x	x							
Heron, Black-headed	*Ardea melanocephala*	x	17.33					Medium		x	x	x		x	x			x		
Heron, Grey	*Ardea cinerea*	x	23.93					Low			x	x					x			
Ibis, African Sacred	*Threskiornis aethiopicus*	x	20.23					Low			x	x			x		x			
Kestrel, Greater	*Falco rupicoloides*	x	21.30					High	x	x		x		x		x		x		
Kestrel, Lesser	*Falco naumanni*	x	20.37					Medium		x				x	x			x		
Kestrel, Rock	*Falco rupicolus*	x	27.41					High	x	x		x	x	x	x	x		x		
Kingfisher, Malachite	*Alcedo cristata*	x	2.78					Low			x						x			
Kingfisher, Pied	*Ceryle rudis*	x	2.78					Low			x						x			
Kite, Black-shouldered	*Elanus caeruleus*	x	15.44					High	x	x		x		x	x					
Korhaan, Blue	*Eupodotis caerulescens*	x	56.34	NT	LC	Endemic (SA, Lesotho, Swaziland)	Endemic	High	x	x					x			x		x
Korhaan, Karoo	*Eupodotis vigorsii*	x	13.10	LC	NT		Endemic	High	x	x								x		x

Species	Taxonomic name	Solar priority species	SABAP2 Average reporting rate: full protocol	Red Data status: International	Red Data status: Regional	Endemic - South Africa	Endemic - Southern Africa	Possibility of occurrence	Recorded during surveys	Grassy Karoo	Surface water	Alien trees	Cliffs	Powerlines	Agriculture	Fences	PV panel c ollisions	Displacement - disturbance	Displacement - habitat loss	Entrapment in fences
Lapwing, Blacksmith	*Vanellus armatus*	*x*	49.33					Low			x				x		x	x		
Lark, Large-billed	*Galerida magnirostris*	*x*	75.27			Near endemic	Endemic	High	x	x						x		x		
Moorhen, Common	*Gallinula chloropus*	*x*	17.07					Low			x						x			
Night-Heron, Black-crowned	*Nycticorax nycticorax*	*x*	0.00					Low			x						x			
Owl, Barn	*Tyto alba*	*x*	7.41					Medium		x		x			x	x	x	x		
Pipit, African Rock	*Anthus crenatus*	*x*	11.11	LC	NT	Endemic (SA, Lesotho, Swaziland)	Endemic	Low					x							
Plover, Kittlitz's	*Charadrius pecuarius*	*x*	28.70					Low			x						x			
Plover, Three-banded	*Charadrius tricollaris*	*x*	57.68					Low			x						x			
Pochard, Southern	*Netta erythrophthalma*	*x*	1.59					Low			x						x			
Prinia, Karoo	*Prinia maculosa*	*x*	76.19			Near endemic	Endemic	Medium		x							x	x		
Ruff	*Philomachus pugnax*	*x*	3.18					Low			x						x			
Sandpiper, Wood	*Tringa glareola*	*x*	3.18					Low			x						x			
Secretarybird	*Sagittarius serpentarius*	*x*	19.44	VU	VU			High	x	x								x	x	x
Shelduck, South African	*Tadorna cana*	*x*	51.86				Endemic	Medium			x						x			
Shoveler, Cape	*Anas smithii*	*x*	7.14				Near-endemic	Low			x						x			
Snake-eagle, Black-chested	*Circaetus pectoralis*	*x*	1.86					High	x	x	x	x		x	x			x	x	
Snipe, African	*Gallinago nigripennis*	*x*	1.59					Low			x						x			
Sparrowhawk, Black	*Accipiter melanoleucus*	*x*	0.00					Low			x	x								
Sparrowhawk, Rufous-chested	*Accipiter rufiventris*	*x*	2.78					Low			x	x								
Sparrowlark, Black-eared	*Eremopterix australis*	*x*	2.78			Near endemic	Endemic	Low		x	x						x	x	x	
Spoonbill, African	*Platalea alba*	*x*	5.96					Low			x						x			

Species	Taxonomic name	Solar priority species	SABAP2 Average reporting rate: full protocol	Red Data status: International	Red Data status: Regional	Endemic - South Africa	Endemic - Southern Africa	Possibility of occurrence	Recorded during surveys	Grassy Karoo	Surface water	Alien trees	Cliffs	Powerlines	Agriculture	Fences	PV panel c ollisions	Displacement - disturbance	Displacement - habitat loss	Entrapment in fences
Starling, Pied	*Spreo bicolor*	*x*	94.44	94.44		Endemic (SA, Lesotho, Swaziland)	Endemic	High	x	x	x	x			x	x	x	x		
Stilt, Black-winged	*Himantopus himantopus*	*x*	23.01					Low			x						x			
Stint, Little	*Calidris minuta*	*x*	9.12					Low			x						x			
Stork, Black	*Ciconia nigra*	*x*	0.00	LC	VU			Low			x		x							
Stork, White	*Ciconia ciconia*	*x*	0.00					Medium		x	x				x			x	x	
Sunbird, Southern Double-collared	*Cinnyris chalybeus*	*x*	5.56			Near endemic	Endemic	Low		x							x	x		
Teal, Cape	*Anas capensis*	*x*	8.73					Low			x						x			
Teal, Red-billed	*Anas erythrorhyncha*	*x*	13.37					Low			x						x			
Thrush, Karoo	*Turdus smithi*	*x*	34.12			Near endemic	Endemic	Low				x								
Tit, Grey	*Parus afer*	*x*	10.19			Near endemic	Endemic	Low		x							x	x	x	
Vulture, Cape	*Gyps coprotheres*	*x*	2.78	EN	EN		Near-endemic	Low		x				x						
Weaver, Cape	*Ploceus capensis*	*x*	7.14			Near endemic	Endemic	Low				x								
White-eye, Cape	*Zosterops virens*	*x*	25.40			Near endemic	Endemic	Low				x								
Woodpecker, Ground	*Geocolaptes olivaceus*	*x*	1.86			Endemic (SA, Lesotho, Swaziland)	Endemic	Low					x							

Table 3: Powerline priority species potentially occurring at the site, conservation status, priority criteria, SABAP reporting rates, probability of occurrence, habitat use and potential impacts.

Species	Taxonomic name	SABAP2 Average reporting rate: full protocol	Red Data status: International	Red Data status: Regional	Endemic - South Africa	Endemic - Southern Africa	Possibility of occurrence	Recorded during surveys	Grassy Karoo	Surface water	Alien trees	Cliffs	Powerlines	Agriculture	Fences	Collisions	Displacement - disturbance	Displacement - habitat loss	Electrocution (substations)
Bustard, Ludwig's	*Neotis ludwigii*	25.67	EN	EN		Near-endemic	High	x	x					x		x	x		
Buzzard, Jackal	*Buteo rufofuscus*	22.22			Near endemic	Endemic	High	x	x	x	x	x	x	x	x	x	x		
Buzzard, Steppe	*Buteo vulpinus*	10.59					Medium		x	x	x		x	x	x	x	x		
Coot, Red-knobbed	*Fulica cristata*	14.41					Low			x						x			
Cormorant, Reed	*Phalacrocorax africanus*	13.49					Low			x						x			
Crane, Blue	*Anthropoides paradiseus*	73.41	VU	NT		Endemic	Low	x	x	x				x		x	x		
Crow, Pied	*Corvus albus*	88.89					High	x	x		x		x	x	x				x
Duck, African Black	*Anas sparsa*	8.33					Low			x						x			
Duck, Maccoa	*Oxyura maccoa*	1.59	NT	NT			Low			x						x			
Duck, White-faced	*Dendrocygna viduata*	2.78					Low			x						x			
Duck, Yellow-billed	*Anas undulata*	50.92					Low			x						x			
Eagle, Booted	*Aquila pennatus*	16.67					High	x	x	x	x	x	x			x	x		
Eagle, Martial	*Polemaetus bellicosus*	7.14	VU	EN			Medium		x	x	x		x	x		x	x		
Eagle, Verreaux's	*Aquila verreauxii*	18.26	LC	VU			High	x		x	x	x	x			x	x		
Eagle-owl, Spotted	*Bubo africanus*	12.43					High	x	x		x	x		x	x	x	x		
Egret, Great	*Egretta alba*	0.00					Low			x						x			
Falcon, Lanner	*Falco biarmicus*	2.78	LC	VU			Low		x	x	x	x	x	x	x	x	x		x
Falcon, Peregrine	*Falco peregrinus*	1.59					Low				x	x	x			x			
Fish-eagle, African	*Haliaeetus vocifer*	3.18					Low			x						x			
Flamingo, Greater	*Phoenicopterus ruber*	3.18	LC	NT			Low			x						x			
Goose, Egyptian	*Alopochen aegyptiacus*	77.78					High	x		x			x	x		x			x

Species	Taxonomic name	SABAP2 Average reporting rate: full protocol	Red Data status: International	Red Data status: Regional	Endemic - South Africa	Endemic - Southern Africa	Possibility of occurrence	Recorded during surveys	Grassy Karoo	Surface water	Alien trees	Cliffs	Powerlines	Agriculture	Fences	Collisions	Displacement - disturbance	Displacement - habitat loss	Electrocution (substations)
Goose, Spur-winged	*Plectropterus gambensis*	34.79					High	x		x				x		x			
Goshawk, Southern Pale Chanting	*Melierax canorus*	34.66				Near-endemic	High	x	x	x	x		x	x	x	x	x		x
Grebe, Black-necked	*Podiceps nigricollis*	0.00					Low			x						x			
Grebe, Great Crested	*Podiceps cristatus*	1.59					Low			x						x			
Guineafowl, Helmeted	*Numida meleagris*	63.22					Low	x	x		x		x	x	x	x			x
Hamerkop	*Scopus umbretta*	1.86					Low			x	x	x				x			
Harrier, Black	*Circus maurus*	2.78	VU	EN	Near endemic	Endemic	Low		x	x					x	x			
Harrier-Hawk, African	*Polyboroides typus*	1.59					Low		x	x	x	x			x	x			x
Heron, Black-headed	*Ardea melanocephala*	17.33					Medium		x	x	x		x	x		x			
Heron, Grey	*Ardea cinerea*	23.93					Low			x						x			
Ibis, African Sacred	*Threskiornis aethiopicus*	20.23					Low			x						x			
Ibis, Hadeda	*Bostrychia hagedash*	51.46					Medium				x			x		x			x
Korhaan, Blue	*Eupodotis caerulescens*	56.34	NT	LC	Endemic (SA, Lesotho, Swaziland)	Endemic	High	x	x							x			
Korhaan, Karoo	*Eupodotis vigorsii*	13.10	LC	NT		Endemic	High	x	x							x			
Korhaan, Northern Black	*Afrotis afraoides*	74.21				Endemic	High	x	x							x			
Night-Heron, Black-crowned	*Nycticorax nycticorax*	0.00					Low			x									
Pochard, Southern	*Netta erythrophthalma*	1.59					Low			x						x			
Raven, White-necked	*Corvus albicollis*	19.18					Medium					x				x			x
Sandgrouse, Namaqua	*Pterocles namaqua*	34.52				Near-endemic	High	x	x	x				x		x			
Secretarybird	*Sagittarius serpentarius*	19.44	VU	VU			High	x	x	x						x			
Shelduck, South African	*Tadorna cana*	51.86				Endemic	Medium			x						x			

Species	Taxonomic name	SABAP2 Average reporting rate: full protocol	Red Data status: International	Red Data status: Regional	Endemic - South Africa	Endemic - Southern Africa	Possibility of occurrence	Recorded during surveys	Grassy Karoo	Surface water	Alien trees	Cliffs	Powerlines	Agriculture	Fences	Collisions	Displacement - disturbance	Displacement - habitat loss	Electrocution (substations)
Shoveler, Cape	*Anas smithii*	7.14				Near-endemic	Low			x						x			
Snake-eagle, Black-chested	*Circaetus pectoralis*	1.86					High	x	x				x	x		x			
Spoonbill, African	*Platalea alba*	5.96					Low			x						x			
Stork, Black	*Ciconia nigra*	0.00	LC	VU			Low			x		x				x			
Stork, White	*Ciconia ciconia*	0.00					Medium		x	x				x		x			
Teal, Cape	*Anas capensis*	8.73					Low			x						x			
Teal, Red-billed	*Anas erythrorhyncha*	13.37					Low			x						x			
Vulture, Cape	*Gyps coprotheres*	2.78	EN	EN		Near-endemic	Low		x							x			x (powerline)

6.3.2.2 Discussion

The overall abundance of solar priority species at the site was moderate, with an average of 2.83 birds/km being recorded during the two surveys. For all birds combined, the IKA was 15.85 birds/km, which is quite high. This indicates that the impact of human activities on the natural habitat has been limited.

6.4 IMPACTS OF SOLAR PV FACILITIES AND ASSOCIATED INFRASTRUCTURE ON AVIFAUNA

Increasingly, human-induced climate change is recognized as a fundamental driver of biological processes and patterns. Historic climate change is known to have caused shifts in the geographic ranges of many plants and animals, and future climate change is expected to result in even greater redistributions of species (National Audubon Society 2015). In 2006 WWF Australia produced a report on the envisaged impact of climate change on birds worldwide (Wormworth, J. & Mallon, K. 2006). The report found that:

- Climate change now affects bird species' behaviour, ranges and population dynamics;
- Some bird species are already experiencing strong negative impacts from climate change;
- In future, subject to greenhouse gas emissions levels and climatic response, climate change will put large numbers bird species at risk of extinction, with estimates of extinction rates varying from 2 to 72%, depending on the region, climate scenario and potential for birds to shift to new habitat.

Using statistical models based on the North American Breeding Bird Survey and Audubon Christmas Bird Count datasets, the National Audubon Society assessed geographic range shifts through the end of the century for 588 North American bird species during both the summer and winter seasons under a range of future climate change scenarios (National Audubon Society 2015). Their analysis showed the following:

- 314 of 588 species modelled (53%) lose more than half of their current geographic range in all three modelled scenarios.
- For 126 species, loss occurs without accompanying range expansion.
- For 188 species, loss is coupled with the potential to colonize new areas.

Climate sensitivity is an important piece of information to incorporate into conservation planning and adaptive management strategies. The persistence of many birds will depend on their ability to colonize climatically suitable areas outside of current ranges and management actions that target climate change adaptation.

South Africa is among the world's top 10 developing countries required to significantly reduce their carbon emissions (Seymore *et al.* 2014), and the introduction of low-carbon technologies into the country's compliment of power generation will greatly assist with achieving this important objective (Walwyn & Brent 2015). Given that South Africa receives among the highest levels of solar radiation on earth (Fluri 2009; Munzhedi *et al*. 2009), it is clear that solar power generation should feature prominently in future efforts to convert to a more sustainable energy mix in order to combat climate change, also from an avifaunal impact perspective. However, while the expansion of solar power generation is undoubtedly a positive development for avifauna in the longer term in that it will help reduce the effect of climate change and thus habitat transformation, it must also be acknowledged that renewable energy facilities, including solar PV facilities, in themselves have some potential for negative impacts on avifauna.

A literature review reveals a scarcity of published, scientifically examined information regarding large-scale PV plants and birds. The reason for this is mainly that large-scale PV plants are a relatively recent phenomenon. The main source of information for these types of impacts are from compliance reports and a few government-sponsored studies relating to recently constructed solar plants in the south-west United States. In South Africa, only one published scientific study has been completed on the impacts of PV plants in a South African context (Visser *et al.* 2019).

In summary, the potential impacts of PV plants on avifauna which have emerged so far include the following:

- Displacement due to disturbance and habitat transformation associated with the construction of the solar PV plant and associated infrastructure;
- Collisions with the solar panels;
- Entrapment in perimeter fences;
- Collisions with the associated power lines; and
- Electrocutions on the associated power lines.

6.4.1 Impacts associated with PV plants

6.4.1.1 Impact trauma (collisions)

This impact refers to collision-related fatality i.e. fatality resulting from the direct contact of the bird with a project structure(s). This type of fatality has been occasionally documented at solar projects of all technology types (McCrary *et al.* 1986; Hernandez *et al*. 2014; Kagan *et al*. 2014). In some instances, the bird is not killed outright by the collision impact, but succumbs to predation later, as it cannot avoid predators due to its injured state.

Sheet glass used in commercial and residential buildings has been well established as a hazard for birds. When the sky is reflected in the sheet glass, birds fail to see the building as an obstacle and attempt to fly through the glass, mistaking it for empty space (Loss *et al*. 2014). Although very few cases have been reported it is possible that the reflective surfaces of solar panels could constitute a similar risk to avifauna.

An extremely rare but potentially related problem is the so-called “lake effect” i.e. it seems possible that reflections from solar facilities' infrastructure, particularly large sheets of dark blue photovoltaic panels, may attract birds in flight across the open desert, who mistake the broad reflective surfaces for water (Kagan *et al.* 2014)[2]. The unusually high percentage of waterbird mortalities at the Desert Sunlight PV facility (44%) may support the “lake effect” hypothesis (West 2014). Although in the case of Desert Sunlight, the proximity of evaporation ponds may act as an additional risk increasing factor, in that birds are both attracted to the water feature and habituated to the presence of an accessible aquatic environment in the area. This may translate into the misinterpretation of diffusely reflected sky or horizontal polarised light source as a body of water. However, due to limited data it would be premature to make any general conclusions about the influence of the lake effect or other factors that contribute to fatality of water-dependent birds. The activity and abundance of water-dependent species near solar facilities may depend on other site-specific or regional factors, such as the surrounding landscape (Walston *et al*. 2015). However, until such time that enough scientific evidence has been collected to discount the “lake effect” hypothesis, it must be considered as a potential source of impacts.

Weekly mortality searches at 20% coverage were conducted at the 250MW, 1300ha California Valley Solar Ranch PV site (Harvey & Associates 2014a and 2014b). According to the information that could be sourced from the internet (two quarterly reports), 152 avian mortalities were reported for the period 16 November 2013 – 15 February 2014, and 54 for the period 16 February 2014 – 15 May 2014, of which approximately 90% were based on feathers spots which precluded a finding on the cause of death. These figures give an estimated unadjusted 1 030 mortalities per year, which is obviously an underestimate as it does not include adjustments for carcasses removed by scavengers and missed by searchers. The authors stated clearly that these quarterly reports do not include the results of searcher efficiency trials, carcass removal trials, or data analyses, nor does it include detailed discussions.

In a report by the National Fish and Wildlife Forensic Laboratory (Kagan *et al.* 2014), the cause of avian mortalities was estimated based on opportunistic avian carcass collections at several solar facilities, including

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[2] This could either result in birds colliding directly with the solar panels or getting stranded and unable to take off again because many aquatic bird species find it very difficult and sometimes impossible to take off from dry land e.g. grebes and cormorants. This exposes them to predation, even if they do not get injured through direct collisions with the panels.

the 550MW, 1 600ha Desert Sunlight PV plant. Impact trauma emerged as the highest identifiable cause of avian mortality, but most mortality could not be traced to an identifiable cause.

Walston *et al*. (2015) conducted a comprehensive review of avian fatality data from large scale solar facilities (all technology types) in the USA. Collision as cause of death (19 birds) ranked second at Desert Sunlight PV plant and California Valley Solar Ranch (CVSR) PV plant, after unknown causes. Cause of death could not be determined for over 50% of the fatality observations and many carcasses included in these analyses consisted only of feather spots (feathers concentrated together in a small area) or partial carcasses, thus making determination of cause of death difficult. It is anticipated that some unknown fatalities were caused by predation or some other factor unrelated to the solar project. However, they found that the lack of systematic data collection and standardization was a major impediment in establishing the actual extent and causes of fatalities across all projects.

The only scientific investigation of potential avifaunal impacts that has been performed at a South African PV facility was completed in 2016 at the 96MW Jasper PV solar facility (28°17′53″S, 23°21′56″E) which is located on the Humansrus Farm, approximately 4 km south-east of Groenwater and 30km east of Postmasburg in the Northern Cape Province (Visser *et al*. 2019). The Jasper PV facility contains 325 360 solar panels over a footprint of 180 hectares with the capacity to deliver 180 000 MWh of renewable electricity annually. The solar panels face north at a fixed 20° angle, reaching a height of approximately 1.86 m relative to ground level with a distance of 3.11 m between successive rows of panels. Mortality surveys were conducted from the 14th of September 2015 until the 6th of December 2015, with a total of seven mortalities recorded among the solar panels which gives an average rate of 0.003 birds per hectare surveyed per month. All fatalities were inferred from feather spots. Extrapolated bird mortality within the solar field at the Jasper PV facility was 435 birds/yr (95% CI 133 - 805). The broad confidence intervals result from the small number of birds detected. The mortality estimate is likely conservative because detection probabilities were based on intact birds, and probably decrease for older carcasses and feather spots. The study concluded inter alia that the short study period, and lack of comparable results from other sources made it difficult to provide a meaningful assessment of avian mortality at PV facilities. It further stated that despite these limitations, the few bird fatalities that were recorded might suggest that there is no significant collision-related mortality at the study site. The conclusion was that to fully understand the risk of solar energy development on birds, further collation and analysis of data from solar energy facilities across spatial and temporal scales, based on scientifically rigorous research designs, is required (Visser *et al*. 2019).

The results of the available literature lack compelling evidence of collisions as a cause of large-scale mortality among birds at PV facilities. However, it is clear from this limited literature survey that the lack of systematic and standardised data collection is a major problem in the assessment of the causes and extent of avian mortality at all types of solar facilities, regardless of the technology employed. Until statistically tested results emerge from existing compliance programmes and more dedicated scientific research, conclusions will inevitably be largely speculative and based on professional opinion.

6.4.1.2 Entrapment in perimeter fences

Visser *et al* (2019) recorded a fence-line fatality (Orange River Francolin *Scleroptila gutturalis*) resulting from the bird being trapped between the inner and outer perimeter fence of the facility. This was further supported by observations of large-bodied birds unable to escape from between the two fences (e.g. Red-crested Korhaan *Lophotis ruficrista*) (Visser *et al.* 2019). Considering that one would expect the birds to be able to take off in the lengthwise direction (parallel to the fences), it seems likely that the birds panicked when they were approached by observers and thus flew into the fence.

6.4.1.3 Displacement due to disturbance and habitat transformation associated with the construction of the solar PV facility

Ground-disturbing activities affect a variety of processes in arid areas, including soil density, water infiltration rate, vulnerability to erosion, secondary plant succession, invasion by exotic plant species, and stability of cryptobiotic soil crusts. These processes have the ability – individually and together – to alter habitat quality, often to the detriment of wildlife, including avifauna. Any disturbance and alteration to the desert landscape, including the construction and decommissioning of utility-scale solar energy facilities, has the potential to increase soil erosion. Erosion can physically and physiologically affect plant species and can thus adversely influence primary production and food availability for wildlife (Lovich & Ennen 2011).

Solar energy facilities require substantial site preparation (including the removal of vegetation) that alters topography and, thus, drainage patterns to divert the surface flow associated with rainfall away from facility infrastructure. Channelling runoff away from plant communities can have dramatic negative effects on water availability and habitat quality in arid areas. Areas deprived of runoff from sheet flow support less biomass of perennial and annual plants relative to adjacent areas with uninterrupted water-flow patterns (Lovich & Ennen 2011).

The activities listed below are typically associated with the construction and operation of solar facilities and could have direct impacts on avifauna (County of Merced 2014):

- Preparation of solar panel areas for installation, including vegetation clearing, grading, cut and fill;
- Excavation/trenching for water pipelines, cables, fibre-optic lines, and the septic system;
- Construction of piers and building foundations;
- Construction of new dirt or gravel roads and improvement of existing roads;
- Temporary stockpiling and side-casting of soil, construction materials, or other construction wastes;
- Soil compaction, dust, and water runoff from construction sites;
- Increased vehicle traffic;
- Short-term construction-related noise (from equipment) and visual disturbance;
- Degradation of water quality in drainages and other water bodies resulting from project runoff;
- Maintenance of fire breaks and roads; and
- Weed removal, brush clearing, and similar land management activities related to the ongoing operation of the project.

These activities could have an impact on birds breeding, foraging and roosting in or in close proximity through disturbance and transformation of habitat, which could result in temporary or permanent displacement.

In a study comparing the avifaunal habitat use in PV arrays with adjoining managed grassland at airports in the USA, DeVault *et al.* (2014) found that species diversity in PV arrays was reduced compared to the grasslands (37 vs 46), supporting the view that solar development is generally detrimental to wildlife on a local scale.

In order to identify functional and structural changes in bird communities in and around the development footprint, Visser *et al.* (2019) gathered bird transect data at the 180 hectares, 96MW Jasper PV solar facility in the Northern Cape, representing the solar development, boundary, and untransformed landscape. The study found both bird density and diversity per unit area was higher in the boundary and untransformed landscape, however, the extent therefore was not considered to be statistically significant. This indicates that the PV facility matrix is permeable to most species. However, key environmental features, including available habitat and vegetation quality are most likely the overriding factors influencing species' occurrence and their relative density within the development footprint. Her most significant finding was that the distribution of birds in the landscape changed, from a shrubland to open country and grassland bird community, in response to changes in the distribution and abundance of habitat resources such as food, water and nesting sites. These changes in resource availability patterns were detrimental to some bird species and beneficial to others. Shrubland specialists appeared to be negatively affected by the presence of the PV facility. In contrast, open country/grassland and generalist species, were favoured by its development (Visser *et al.* 2019).

It is highly likely that the same pattern of reduced avifaunal densities and possible changes in densities and composition favouring grassland species will manifest itself at the proposed Umsobomvu SEFs.

6.4.2 Impacts associated with powerlines

Negative impacts on birds by electricity infrastructure generally take two principal forms, namely electrocution and collisions (Ledger & Annegarn 1981; Ledger 1983; Ledger 1984; Hobbs and Ledger 1986a; Hobbs & Ledger 1986b; Ledger, Hobbs & Smith, 1992; Verdoorn 1996; Kruger & Van Rooyen 1998; Van Rooyen 1998; Kruger 1999; Van Rooyen 1999; Van Rooyen 2000; Van Rooyen 2004; Jenkins *et al.* 2010). Birds also impact on the infrastructure through nesting and streamers, which can cause interruptions in the electricity supply (Van Rooyen *et al.* 2002). During the construction phase of power lines and substations, displacement of birds can also happen due to disturbance and habitat transformation.

6.4.2.1 Electrocutions

Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen 2004). The electrocution risk is largely determined by the design of the electrical hardware.

6.4.2.2 Collisions

Collision mortality is the biggest threat posed by transmission lines to birds in southern Africa (Van Rooyen 2004). Most heavily impacted upon are bustards, storks, cranes and various species of waterbirds. These species are mostly heavy-bodied birds with limited manoeuvrability, which makes it difficult for them to take the necessary evasive action to avoid colliding with transmission lines (Van Rooyen 2004, Anderson 2001). In her PhD study, Shaw (2013) provides a concise summary of the phenomenon of avian collisions with transmission lines:

"The collision risk posed by power lines is complex and problems are often localised. While any bird flying near a power line is at risk of collision, this risk varies greatly between different groups of birds, and depends on the interplay of a wide range of factors (APLIC 1994). Bevanger (1994) described these factors in four main groups – biological, topographical, meteorological and technical. Birds at highest risk are those that are both susceptible to collisions and frequently exposed to power lines, with waterbirds, gamebirds, rails, cranes and bustards usually the most numerous reported victims (Bevanger 1998, Rubolini et al. 2005, Jenkins et al. 2010).

The proliferation of man-made structures in the landscape is relatively recent, and birds are not evolved to avoid them. Body size and morphology are key predictive factors of collision risk, with large-bodied birds with high wing loadings (the ratio of body weight to wing area) most at risk (Bevanger 1998, Janss 2000). These birds must fly fast to remain airborne, and do not have sufficient manoeuvrability to avoid unexpected obstacles. Vision is another key biological factor, with many collision-prone birds principally using lateral vision to navigate in flight, when it is the lower-resolution, and often restricted, forward vision that is useful to detect obstacles (Martin & Shaw 2010, Martin 2011, Martin et al. 2012). Behaviour is important, with birds flying in flocks, at low levels and in crepuscular or nocturnal conditions at higher risk of collision (Bevanger 1994). Experience affects risk, with migratory and nomadic species that spend much of their time in unfamiliar locations also expected to collide more often (Anderson 1978, Anderson 2002). Juvenile birds have often been reported as being more collision-prone than adults (e.g. Brown et al. 1987, Henderson et al. 1996).

Topography and weather conditions affect how birds use the landscape. Power lines in sensitive bird areas (e.g. those that separate feeding and roosting areas, or cross flyways) can be very dangerous (APLIC 1994, Bevanger 1994). Lines crossing the prevailing wind conditions can pose a problem for large birds that use the wind to aid take-off and landing (Bevanger 1994). Inclement weather can disorient birds and reduce their flight altitude, and strong winds can result in birds colliding with power lines that they can see but do not have enough flight control to avoid (Brown et al. 1987, APLIC 2012).

The technical aspects of power line design and siting also play a big part in collision risk. Grouping similar power lines on a common servitude, or locating them along other features such as tree lines, are both approaches thought to reduce risk (Bevanger 1994). In general, low lines with short span lengths (i.e. the distance between two adjacent pylons) and flat conductor configurations are thought to be the least dangerous (Bevanger 1994, Jenkins et al. 2010). On many higher voltage lines, there is a thin earth (or ground) wire above the conductors, protecting the system from lightning strikes. Earth wires are widely accepted to cause the majority of collisions on power lines with this configuration because they are difficult to see, and birds flaring to avoid hitting the conductors often put themselves directly in the path of these wires (Brown et al. 1987, Faanes 1987, Alonso et al. 1994a, Bevanger 1994)."

From incidental record keeping by the Endangered Wildlife Trust, it is possible to give a measure of what species are generally susceptible to power line collisions in South Africa (see **Figure 16** below – EWT unpublished data).

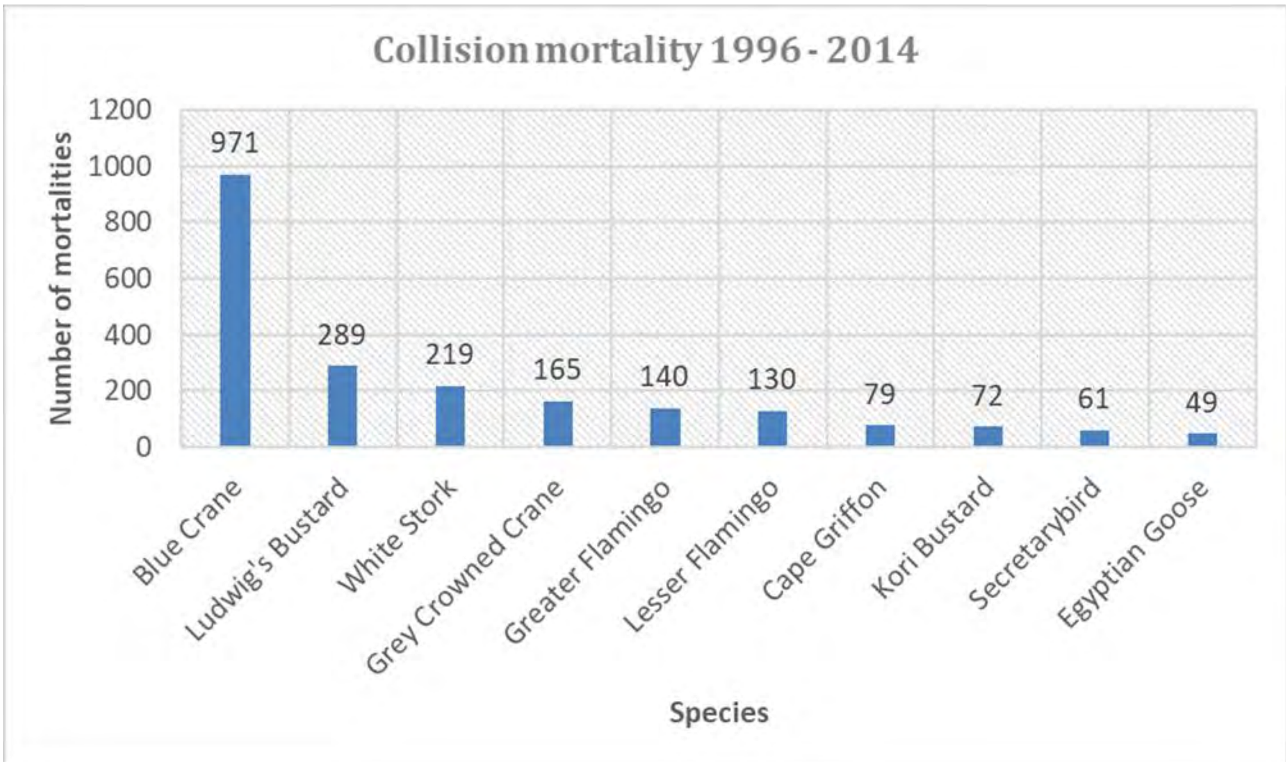

Figure 16: The top 10 collision prone bird species in South Africa, in terms of reported incidents contained in the Eskom/EWT Strategic Partnership central incident register 1996 - 2014 (EWT unpublished data).

Power line collisions are generally accepted as a key threat to bustards (Raab *et al.* 2009; Raab *et al.* 2010; Jenkins & Smallie 2009; Barrientos *et al.* 2012, Shaw 2013). In a comprehensive study, carcass surveys were performed under high voltage transmission lines in the Karoo for two years, and low voltage distribution lines for one year (Shaw 2013). Ludwig's Bustard was the most common collision victim (69% of carcasses), with bustards generally comprising 87% of mortalities recovered. Total annual mortality was estimated at 41% of the Ludwig's Bustard population, with Kori Bustards also dying in large numbers (at least 14% of the South African population killed in the Karoo alone). Karoo Korhaan was also recorded, but to a much lesser extent than Ludwig's Bustard. The reasons for the relatively low collision risk of this species probably include their smaller size (and hence greater agility in flight) as well as their more sedentary lifestyles, as local birds are familiar with their territory and are less likely to collide with power lines (Shaw 2013).
Several factors are thought to influence avian collisions, including the manoeuvrability of the bird, topography, weather conditions and power line configuration. An important additional factor that previously has received little attention is the visual capacity of birds; i.e. whether they are able to see obstacles such as power lines, and whether they are looking ahead to see obstacles with enough time to avoid a collision. In addition to helping explain the susceptibility of some species to collision, this factor is key to planning effective mitigation measures. Recent research provides the first evidence that birds can render themselves blind in the direction

of travel during flight through voluntary head movements (Martin & Shaw 2010). Visual fields were determined in three bird species representative of families known to be subject to high levels of mortality associated with power lines i.e. Kori Bustards, Blue Cranes *Anthropoides paradiseus* and White Storks *Ciconia ciconia*. In all species the frontal visual fields showed narrow and vertically long binocular fields typical of birds that take food items directly in the bill under visual guidance. However, these species differed markedly in the vertical extent of their binocular fields and in the extent of the blind areas which project above and below the binocular fields in the forward-facing hemisphere. The importance of these blind areas is that when in flight, head movements in the vertical plane (pitching the head to look downwards) will render the bird blind in the direction of travel. Such movements may frequently occur when birds are scanning below them (for foraging or roost sites, or for conspecifics). In bustards and cranes pitch movements of only 25° and 35°, respectively, are sufficient to render the birds blind in the direction of travel; in storks, head movements of 55° are necessary. That flying birds can render themselves blind in the direction of travel has not been previously recognised and has important implications for the effective mitigation of collisions with human artefacts including wind turbines and power lines. These findings have applicability to species outside of these families especially raptors (Accipitridae) which are known to have small binocular fields and large blind areas similar to those of bustards and cranes, and are also known to be vulnerable to power line collisions.

Despite doubts about the efficacy of line marking to reduce the collision risk for bustards (Jenkins *et al.* 2010; Martin *et al.* 2010), there are numerous studies which prove that marking a line with PVC spiral type Bird Flight Diverters (BFDs) generally reduce mortality rates (e.g. Bernardino *et al*. 2019; Sporer *et al.* 2013; Barrientos *et al.* 2011; Jenkins *et al.* 2010; Alonso & Alonso 1999; Koops & De Jong 1982), including to some extent for bustards (Barrientos *et al.* 2012; Hoogstad 2018 pers.comm). Beaulaurier (1981) summarised the results of 17 studies that involved the marking of earth wires and found an average reduction in mortality of 45%. Barrientos *et al.* (2011) reviewed the results of 15 wire marking experiments in which transmission or distribution wires were marked to examine the effectiveness of flight diverters in reducing bird mortality. The presence of flight diverters was associated with a decrease of 55–94% in bird mortalities. Koops and De Jong (1982) found that the spacing of the BFDs was critical in reducing the mortality rates - mortality rates are reduced up to 86% with a spacing of 5m, whereas using the same devices at 10m intervals only reduces the mortality by 57%. Barrientos *et al.* (2012) found that larger BFDs were more effective in reducing Great Bustard collisions than smaller ones. Line markers should be as large as possible, and highly contrasting with the background. Colour is probably less important as during the day the background will be brighter than the obstacle with the reverse true at lower light levels (e.g. at twilight, or during overcast conditions). Black and white interspersed patterns are likely to maximise the probability of detection (Martin *et al.* 2010).

The use of BFDs to reduce collision mortality on powerlines in South Africa has also been tested scientifically. Using a controlled experiment spanning a period of nearly eight years (2008 to 2016), the effectiveness of two types of line markers, namely the EBM Bird Flapper and EBM helical BFD in reducing power line collision mortalities of large birds were tested on three 400kV transmission lines near Hydra substation in the Karoo. Marking was highly effective for Blue Cranes, resulting in a 92% reduction in mortality. Large birds in general also benefited from the marking, with a 56% reduction in mortality. Unfortunately, the marking did not prove to be effective for Ludwig's Bustard. The two different marking devices were approximately equally effective (Shaw *et al*. 2017).

6.4.2.3 Displacement due to habitat destruction and disturbance associated with the construction of the powerlines and substation

During the construction phase and maintenance of power lines and substations, some habitat destruction and transformation inevitably takes place. This happens with the construction of access roads, the clearing of servitudes and the levelling of substation yards. These activities have an impact on birds breeding, foraging and roosting in or in close proximity of the substation and power line servitudes through transformation of habitat, which could result in temporary or permanent displacement.

Apart from direct habitat destruction, the above-mentioned construction and maintenance activities also impact on birds through disturbance; this could lead to breeding failure if the disturbance happens during a critical part of the breeding cycle. Construction activities in close proximity to breeding locations could be a source of disturbance and could lead to temporary breeding failure or even permanent abandonment of nests.

7 DISCUSSION OF IMPACTS: UMSOBOMVU PV FACILITIES AND GRID CONNECTIONS

The section below provides an overview of the envisaged impacts of the proposed Umsobomvu PV facilities and grid connections on solar and powerline priority species. Separate impact tables are provided which summarises the impacts and proposed mitigation on an individual basis for each PV facility and grid connection.

7.1 PV FACILITIES

7.1.1 Displacement due to disturbance associated with the construction and de-commissioning of the PV plants and associated infrastructure (construction and de-commissioning)

The construction (and de-commissioning) of the PV plants and associated infrastructure will result in a significant amount of movement and noise, which will lead to displacement of avifauna from the development footprints. It is highly likely that most priority species potentially occurring on the site will vacate the development footprints for the duration of these activities.

7.1.2 Displacement due to habitat transformation associated with the PV plant and associated infrastructure (operation)

The construction of the PV plants and associated infrastructure will result in the radical transformation of the existing natural habitat. The vegetation will be cleared prior to construction commencing. Once operational, less sunlight will reach the vegetation below the solar panels, which is likely to result in stunted vegetation growth and possibly complete eradication of some plant species. The natural vegetation is likely to persist in the rows between the solar panels, but it will be different to what was available before the construction of the plant, in that it will be short grassland with few (if any) shrubs.

Small to medium-sized birds are often capable of surviving in small pockets of suitable habitat and are therefore generally less affected by habitat fragmentation than larger species. It is, therefore, possible that the smaller and medium-sized species (e.g. passerines) recorded at the site will continue to use the habitat available within the solar facility, albeit at reduced densities for some, especially as far as shrubland specialists are concerned e.g. Rufous-eared Warbler *Malcorus pectoralis*.

Larger priority species which require contiguous, un-fragmented tracts of suitable habitat (e.g. large raptors, korhaans and bustards) are likely to occur at vastly reduced densities in the proposed facilities or may even be totally displaced. The only larger priority species, which was regularly encountered during surveys at the site, was the locally Near Threatened Blue Crane. According to Marnewick *et al.* (2015) the Karoo population is estimated to be around 10 800 birds and relatively stable in largely untransformed landscapes. The displacement impact on the regional population, should it occur, should therefore be low. Two other large terrestrial species were recorded in the study area, namely the locally Endangered Ludwig's Bustard and locally Vulnerable Secretarybird. None of these two wide ranging species is likely to be severely impacted on a regional level by the likely displacement resulting from the transformation of 4 800ha of Grassy Karoo habitat.

In the case of some priority raptors (e.g. Southern Pale Chanting Goshawk, Lanner Falcon, Jackal Buzzard, Black-shouldered Kite and Steppe Buzzard) the potential availability of carcasses or injured birds due to collisions with the solar panels, and enhanced prey visibility (e.g. insects, reptiles and rodents) in the short grassland between the solar panels may attract them to the area. Jeal (2017) recorded large numbers of Barn Owls at the Bokpoort parabolic trough CSP facility near Groblershoop in the Northern Cape, roosting in the 'torque tubes' that support the parabolic mirrors – while this influx of owls may have been because of a lack of suitable roosting substrate in the surrounding range land, the enhanced prey visibility due to the sparse vegetation cover in the plant itself may also have played a role in attracting the owls. Greater Kestrel and Rock Kestrel could also be attracted to the solar panels as perches from where to hunt for rodent and insect prey.

Cape Sparrows *Passer melanurus*, Cape Turtle Doves *Streptopelia capicola* and other small birds will very likely attempt to nest underneath the solar panels to take advantage of the shade, but this should not adversely affect the operation of the equipment.

Table 2 lists the solar priority species that could potentially be displaced due to habitat transformation[3].

7.1.3 Collisions with the solar panels (operation)

The priority species that may possibly occur in the development area which could potentially be exposed to collision risk are listed in Table 2. In addition, the so-called "lake effect" could act as a potential attraction to waterbirds. It is not possible to tell whether this will happen until post-construction monitoring reveals actual mortality at the site, but the lack of permanent waterbodies with large waterbird populations in close vicinity to the proposed development area decreases the probability of the lake effect being a major source of mortality.

7.1.4 Entrapment in perimeter fences

Priority species such as Karoo Korhaan, Northern Black Korhaan, Blue Korhaan and Ludwig's Bustard may be vulnerable to entrapment between double perimeter fences. The possibility of using a single perimeter fence should be investigated. Alternatively, the two fences should be placed far apart enough for birds to able to take off if they somehow end up between the two fences. In addition, staff should be sensitised to not panic birds when they discover them trapped between the fences but to approach them with caution to give them time to escape by taking off in a lengthwise direction.

7.1.5 Impact on the solar infrastructure

An impact that could potentially materialise is the pollution of the solar panels by faecal deposits of large birds, particularly Pied Crows and raptors, if they regularly perch on the panels. It is expected that the regular cleaning and maintenance activities should prevent this from becoming a problem.

7.2 GRID CONNECTIONS

7.2.1 Electrocutions

Clearance between phases on the same side of the DT 7611 132kV mono-pole structure is approximately 2.2m for this type of design, and the clearance on strain structures is 1.8m. This clearance should be sufficient to reduce the risk of phase – phase electrocutions of most birds on the poles to negligible. The length of the stand-off insulators is approximately 1.6m. If a very large species attempts to perch on the stand-off insulators, they are potentially able to touch both the conductor and the earthed pole simultaneously potentially resulting in a phase – earth electrocution. This is particularly likely when more than one bird attempts to sit on the same pole, which is an unlikely occurrence, except occasionally with vultures. Vultures are likely to occur very sporadically within the study core areas, but due to the presence of the two Hydra-Poseidon 400kV perch-friendly transmission lines in the study area, the chances of the birds perching on the

[3] In some instances, the displacement will not be complete, but will result in lower densities.

steel monopoles of the new grid connection line are relatively low. However, it cannot be entirely ruled out, therefore it would be preferable if a 100% vulture friendly structure is used. To eliminate the risk of vulture electrocutions the 7649 steel monopole structure is proposed with suspended insulators and diagonal supporting cross arms, which would make perching impossible while ensuring that birds are clear of the live phases (see Appendix 5).

Electrocutions within the proposed substation yards are possible, but should not affect the majority of the more sensitive Red Data and powerline sensitive bird species as these species are unlikely to use the infrastructure within the substation yards for perching or roosting, except possibly Spotted Eagle-Owl and Barn Owl. Other species which could potentially be exposed to electrocution risks in the proposed substations are corvids, Egyptian Geese, Hadeda Ibis, Helmeted Guineafowl and a few medium-sized raptors (see Table 3).

7.2.2 Collisions

See Table 3 for potential candidates for collision mortality in the Nama Karoo habitat on the proposed power line. The species most at risk will be Blue Crane, Ludwig's Bustard, Secretarybird and Karoo Korhaan. The risk will be exacerbated if the line is positioned near a large waterbody, as the larger dams are most likely used by Blue Crane and possibly White Storks for roosting, when water levels are higher. These dams could also attract a variety of collision-prone waterbirds, including Greater Flamingo, when full. Other areas of heightened risk are agricultural clearings, particularly irrigated fields, which attract Blue Crane, Ludwig's Bustard, Egyptian Goose, Spurwing Goose, Hadeda Ibis and Sacred Ibis.

7.2.3 Displacement due to the habitat transformation in the proposed substations

In the present instance, the risk of permanent displacement of priority species due to habitat transformation in the footprint of the proposed substations and powerline servitudes is likely to be very limited given the small size of the footprint. The displacement is likely to only affect small, locally common species and should have a negligible impact on local populations.

7.3 IMPACT RATING CRITERIA

The impact criteria used to assess the potential impacts are set-out in detail in Appendix 3.

7.3.1 Assessment of impacts for the PV facilities

The impacts of the proposed PV facilities are detailed below separately for each facility.

MOOI PLAATS SOLAR PV 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																				
Avifauna	Displacement of priority species due to disturbance associated with the construction of the PV plants and associated infrastructure	1	3	3	4	1	3	36	-	Medium	• Construction activity should be restricted to the immediate footprint of the infrastructure. • Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical. • The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint and rehabilitation of disturbed areas is concerned.	1	3	3	2	1	3	30	-	Medium

MOOI PLAATS SOLAR PV 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
Operational Phase																				
Avifauna	Displacement of priority avifauna due to habitat transformation associated with the PV plant and associated infrastructure	1	4	3	3	3	3	42	-	Medium	The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint and rehabilitation of transformed areas is concerned.	1	3	2	3	3	3	36	-	Medium
Avifauna	Entrapment in perimeter fences resulting in the mortality of priority species.	1	3	1	2	3	1	10	-	Low	A single perimeter fence should be used. Alternatively, the two fences should be at least 4 metres apart to allow medium to large birds enough space to take off.	1	1	1	2	3	1	8	-	Low
Avifauna	Collisions of priority avifauna with the solar panels resulting in the mortality of priority species.	1	2	2	2	3	1	10	-	Low	No mitigation is required due to the very low expected magnitude	1	2	2	2	3	1	10	-	Low

MOOI PLAATS SOLAR PV 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
Decommissioning Phase																				
Avifauna	The de-commissioning of the PV plant and associated infrastructure will result in a significant amount of movement and noise, which will lead to displacement of priority avifauna from the site due to disturbance. It is highly likely that most priority species will temporarily vacate the site footprint.	1	3	3	4	1	3	36	-	Medium	• Activity should be restricted to the immediate footprint of the infrastructure. • Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical. • The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the footprint and rehabilitation of disturbed areas is concerned.	1	3	3	2	1	3	30	-	Medium

MOOI PLAATS SOLAR PV 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
Cumulative																				
Avifauna	• Displacement due to disturbance and habitat transformation associated with the construction of the solar PV plant and associated infrastructure; • Collisions with the solar panels • Entrapment in perimeter fences	1	4	2	3	3	1	13	-	Low	Implement all the mitigation measures as detailed in this bird impact assessment report	1	4	2	2	3	1	12	-	Low

WONDERHEUVEL SOLAR PV 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																				
Avifauna	Displacement of priority species due to disturbance associated with the construction of the PV plants and associated infrastructure	1	3	3	4	1	3	36	-	Medium	• Construction activity should be restricted to the immediate footprint of the infrastructure. • Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical. • The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint and rehabilitation of disturbed areas is concerned.	1	3	3	2	1	3	30	-	Medium

WONDERHEUVEL SOLAR PV 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**
Operational Phase																				
Avifauna	Displacement of priority avifauna due to habitat transformation associated with the PV plant and associated infrastructure	1	4	3	3	3	3	42	-	Medium	The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint and rehabilitation of transformed areas is concerned.	1	3	2	3	3	3	36	-	Medium
Avifauna	Entrapment in perimeter fences resulting in the mortality of priority species.	1	3	1	2	3	1	10	-	Low	A single perimeter fence should be used. Alternatively, the two fences should be at least 4 metres apart to allow medium to large birds enough space to take off.	1	1	1	2	3	1	8	-	Low
Avifauna	Collisions of priority avifauna with the solar panels resulting in the mortality of priority species.	1	2	2	2	3	1	10	-	Low	No mitigation is required due to the very low expected magnitude	1	2	2	2	3	1	10	-	Low

WONDERHEUVEL SOLAR PV 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
Decommissioning Phase																				
Avifauna	The de-commissioning of the PV plant and associated infrastructure will result in a significant amount of movement and noise, which will lead to displacement of priority avifauna from the site due to disturbance. It is highly likely that most priority species will temporarily vacate the site footprint.	1	3	3	4	1	3	36	-	Medium	• Activity should be restricted to the immediate footprint of the infrastructure. • Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical. • The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the footprint and rehabilitation of disturbed areas is concerned.	1	3	3	2	1	3	30	-	Medium

WONDERHEUVEL SOLAR PV 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
Cumulative																				
Avifauna	• Displacement due to disturbance and habitat transformation associated with the construction of the solar PV plant and associated infrastructure • Collisions with the solar panels • Entrapment in perimeter fences	1	4	2	3	3	1	13	-	Low	Implement all the mitigation measures as detailed in this bird impact assessment report	1	4	2	2	3	1	12	-	Low

PAARDE VALLEY SOLAR PV 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																				
Avifauna	Displacement of priority species due to disturbance associated with the construction of the PV plants and associated infrastructure	1	3	3	4	1	3	36	-	Medium	• Construction activity should be restricted to the immediate footprint of the infrastructure. • Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical. • The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint and rehabilitation of disturbed areas is concerned.	1	3	3	2	1	3	30	-	Low

PAARDE VALLEY SOLAR PV 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	
Operational Phase																					
Avifauna	Displacement of priority avifauna due to habitat transformation associated with the PV plant and associated infrastructure	1	4	3	3	3	3	42	-	Medium	The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint and rehabilitation of transformed areas is concerned.	1	3	2	3	3	3	36	-	Medium	
Avifauna	Entrapment in perimeter fences resulting in the mortality of priority species.	1	3	1	2	3	1	10	-	Low	A single perimeter fence should be used. Alternatively, the two fences should be at least 4 metres apart to allow medium to large birds enough space to take off.	1	1	1	2	3	1	8	-	Low	
Avifauna	Collisions of priority avifauna with the solar panels resulting in the mortality of priority species.	1	2	2	2	3	1	10	-	Low	No mitigation is required due to the very low expected magnitude	1	2	2	2	3	1	10	-	Low	

PAARDE VALLEY SOLAR PV 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
Decommissioning Phase																				
Avifauna	The de-commissioning of the PV plant and associated infrastructure will result in a significant amount of movement and noise, which will lead to displacement of priority avifauna from the site due to disturbance. It is highly likely that most priority species will temporarily vacate the site footprint.	1	3	3	4	1	3	36	-	Medium	• Activity should be restricted to the immediate footprint of the infrastructure. • Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical. • The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the footprint and rehabilitation of disturbed areas is concerned.	1	3	3	2	1	3	30	-	Medium

PAARDE VALLEY SOLAR PV 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
Cumulative																				
Avifauna	• Displacement due to disturbance and habitat transformation associated with the construction of the solar PV plant and associated infrastructure • Collisions with the solar panels • Entrapment in perimeter fences	1	4	2	3	3	1	13	-	Low	Implement all the mitigation measures as detailed in this bird impact assessment report	1	4	2	2	3	1	12	-	Low

7.3.2 Assessment of impacts for the grid connections

The impacts of the proposed grid connections are detailed below separately for each facility.

MOOI PLAATS GRID CONNECTION INFRASTRUCTURE																				
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																				
Avifauna	Displacement of priority species due to disturbance associated with the construction of the powerline and substations	1	3	1	3	1	3	27	-	Medium	• Activity should be restricted to the immediate footprint of the infrastructure. • Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of avifauna. Measures to control noise should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • The recommendations of the ecological and botanical specialist studies must be strictly implemented. • A walk-through must be conducted by the avifaunal specialist to assess whether there are any Red Data species, and/or large raptors breeding in the vicinity of the powerline, which could be displaced by the construction	1	1	1	1	1	1	5	-	Low

										activities. Should this be the case, appropriate measures must be put in place to prevent the displacement of the breeding birds, through the timing of activities.									
Avifauna	Displacement of priority species due to habitat destruction associated with the construction of the substations	1	2	4	2	3	1	12	-	Low	• Activity should be restricted to the immediate footprint of the infrastructure. • Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of avifauna. Measures to control noise should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • The recommendations of the ecological and botanical specialist studies must be strictly implemented.	1	2	2	2	3	1	10	-	Low

MOOI PLAATS GRID CONNECTION INFRASTRUCTURE

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																				
Avifauna	Collisions of priority species with the earthwire of the proposed 132kV grid connection.	2	4	2	4	3	3	45	-	High	• The 132kV grid connection should be marked with Bird Flappers, on the earthwire for the entire length of the line. • A 500m powerline - free zone should be implemented around dams and agricultural areas.	2	2	2	4	3	2	26	-	Medium
Avifauna	Electrocutions on the proposed 132kV powerline and in the substations	2	2	1	4	3	3	36	-	Medium	• The final pole design must be signed off by the bird specialist to ensure that a bird-friendly design is used. • With regards to the infrastructure within the substation yard, the hardware is too complex to warrant any mitigation for electrocution at this stage. It is rather recommended that if any impacts are recorded once operational, site specific mitigation be applied reactively.	2	1	1	4	3	1	11	-	Low

MOOI PLAATS GRID CONNECTION INFRASTRUCTURE

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
Decommissioning Phase																				
Avifauna	Displacement of priority species due to disturbance associated with the dismantling of the powerline and substations	1	3	1	3	1	3	27	-	Medium	• Activity should be restricted to the immediate footprint of the infrastructure. • Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of avifauna. • Measures to control noise should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • The recommendations of the ecological and botanical specialist studies must be strictly implemented. A walk-through must be conducted by the avifaunal specialist to assess whether there are any Red Data species, and/or large raptors breeding in the vicinity of the powerline, which could be displaced by the dismantling activities. Should this be the case, appropriate measures must be put in place to prevent the displacement of the	1	1	1	1	1	1	5	-	Low

											breeding birds, through the timing of activities.									

WONDER HEUVEL GRID CONNECTION INFRASTRUCTURE

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																				
Avifauna	Displacement of priority species due to disturbance associated with the construction of the powerline and substations	1	3	1	3	1	3	27	-	Medium	• Activity should be restricted to the immediate footprint of the infrastructure. • Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of avifauna. Measures to control noise should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • The recommendations of the ecological and botanical specialist studies must be strictly implemented. • A walk-through must be conducted by the avifaunal specialist to assess whether there are any Red Data species, and/or large raptors breeding in the vicinity of the powerline, which could be displaced by the construction activities. Should this be the case, appropriate measures must be put in place to prevent the displacement of the breeding birds, through the timing of activities.	1	1	1	1	1	1	5	-	Low

Avifauna	Displacement of priority species due to habitat destruction associated with the construction of the substations	1	2	4	2	3	1	12	-	Low	• Activity should be restricted to the immediate footprint of the infrastructure. • Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of avifauna. Measures to control noise should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • The recommendations of the ecological and botanical specialist studies must be strictly implemented.	1	2	2	2	3	1	10	-	Low

WONDERHEUVEL GRID CONNECTION INFRASTRUCTURE																				
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																				
Avifauna	Collisions of priority species with the earthwire of the proposed 132kV grid connection.	2	4	2	4	3	3	45	-	High	• The 132kV grid connection should be marked with Bird Flappers, on the earthwire for the entire length of the line. • A 500m powerline - free zone should be implemented around dams and agricultural areas.	2	2	2	4	3	2	26	-	Medium
Avifauna	Electrocutions on the proposed 132kV powerline and in the substations	2	2	1	4	3	3	36	-	Medium	• The final pole design must be signed off by the bird specialist to ensure that a bird-friendly design is used. • With regards to the infrastructure within the substation yard, the hardware is too complex to warrant any mitigation for electrocution at this stage. It is rather recommended that if any impacts are recorded once operational, site specific mitigation be applied reactively.	2	1	1	4	3	1	11	-	Low

WONDERHEUVEL GRID CONNECTION INFRASTRUCTURE

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
Decommissioning Phase																				
Avifauna	Displacement of priority species due to disturbance associated with the dismantling of the powerline and substations	1	3	1	3	1	3	27	-	Medium	• Activity should be restricted to the immediate footprint of the infrastructure. • Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of avifauna. • Measures to control noise should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • The recommendations of the ecological and botanical specialist studies must be strictly implemented. • A walk-through must be conducted by the avifaunal specialist to assess whether there are any Red Data species, and/or large raptors breeding in the vicinity of the powerline, which could be displaced by the dismantling activities. Should this be the case, appropriate measures must be put	1	1	1	1	1	1	5	-	Low

											in place to prevent the displacement of the breeding birds, through the timing of activities.									

PAARDE VALLEY GRID CONNECTION INFRASTRUCTURE																					
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																					
Avifauna	Displacement of priority species due to disturbance associated with the construction of the powerline and substations	1	3	1	3	1	3	27	-	Medium	• Activity should be restricted to the immediate footprint of the infrastructure. • Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of avifauna. Measures to control noise should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • The recommendations of the ecological and botanical specialist studies must be strictly implemented. • A walk-through must be conducted by the avifaunal specialist to assess whether there are any Red Data species, and/or large raptors breeding in the vicinity of the powerline, which could be displaced by the construction activities. Should this be the case, appropriate measures must be put in place to prevent the displacement of the breeding birds, through the timing of activities.	1	1	1	1	1	1	5	-	Low

Avifauna	Displacement of priority species due to habitat destruction associated with the construction of the substations	1	2	4	2	3	1	12	-	Low	• Activity should be restricted to the immediate footprint of the infrastructure. • Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of avifauna. Measures to control noise should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • The recommendations of the ecological and botanical specialist studies must be strictly implemented.	1	2	2	2	3	1	10	-	Low

PAARDE VALLEY GRID CONNECTION INFRASTRUCTURE																					
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																					
Avifauna	Collisions of priority species with the earthwire of the proposed 132kV grid connection.	2	4	2	4	3	3	45	-	High	• The 132kV grid connection should be marked with Bird Flappers, on the earthwire for the entire length of the line. • A 500m powerline - free zone should be implemented around dams and agricultural areas.	2	2	2	4	3	2	26	-	Medium
Avifauna	Electrocutions on the proposed 132kV powerline and in the substations	2	2	1	4	3	3	36	-	Medium	• The final pole design must be signed off by the bird specialist to ensure that a bird-friendly design is used. • With regards to the infrastructure within the substation yard, the hardware is too complex to warrant any mitigation for electrocution at this stage. It is rather recommended that if any impacts are recorded once operational, site specific mitigation be applied reactively.	2	1	1	4	3	1	11	-	Low

PAARDE VALLEY GRID CONNECTION INFRASTRUCTURE																				
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**
Decommissioning Phase																				
Avifauna	Displacement of priority species due to disturbance associated with the dismantling of the powerline and substations	1	3	1	3	1	3	27	-	Medium	• Activity should be restricted to the immediate footprint of the infrastructure. • Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of avifauna. • Measures to control noise should be applied according to current best practice in the industry. Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • The recommendations of the ecological and botanical specialist studies must be strictly implemented. A walk-through must be conducted by the avifaunal specialist to assess whether there are any Red Data species, and/or large raptors breeding in the vicinity of the powerline, which could be displaced by the dismantling activities. Should this be the case, appropriate measures must be put in place to prevent the displacement of the	1	1	1	1	1	1	5	-	Low

											breeding birds, through the timing of activities.									

7.4 CUMULATIVE IMPACTS

Cumulative effects are commonly understood to be impacts from different projects that combine to result in significant change, which could be larger than the sum of all the individual impacts. The assessment of cumulative effects therefore needs to consider all renewable energy developments (wind and solar) within at least a 35km radius of the proposed site. The 17 renewable projects which are planned or authorised are displayed in Figure 17. Appendix 4 lists the projects together with the relevant recommended mitigation measures pertaining to birds.

7.4.1 PV sites

In the case of solar projects, the potentially most significant impact from an avifaunal perspective is the transformation of the natural habitat. The total land parcel area taken up by existing and proposed solar energy projects are approximately 13 000ha, and the wind energy projects come to approximately 47 000ha. The three Umsobomvu SEF's will add another approximately 13 500ha of land parcel to these. The total area of the 35km radius around the proposed projects equates to about 400 000ha. The total combined size of the land parcels taken up by SEF's and WEF's, including the three Umsobomvu projects, equates to about 60 500ha, which is just over 15% of the available land in the 35km radius. However, the actual footprint of the solar facilities will be much smaller that the land parcel area, between 20 - 40% of the land parcel area. In the case of the WEF's the situation is much the same. The total area to be taken up by renewable energy developments will therefore comprise less than 10% of the land surface within the 35km radius around the proposed Umsobomvu projects. The cumulative impact of the habitat transformation which will come about as a result of the three proposed Umsobomvu projects should therefore be **low**.

7.4.2 Grid connection

In the case of the grid connections, the existing high voltage grid (66 - 400kV) in the 35km radius around the proposed Umsobomvu SEF's comes to about 300km. The existing and proposed renewable energy projects add approximately 60km of sub-transmission lines to this. The three Umsobomvu SEF's will add another approximately 34 – 40km of sub-transmission line, depending which alternative is used. This translates into an 11% increase in the length of existing and proposed high voltage line within the 35km radius around the proposed Umsobomvu projects. The most significant potential impact of high voltage lines within the aforesaid 35km radius is bird collisions with the earth wires of the lines. An 11% increase in line length should represent a **medium** increase in cumulative risk, which could be mitigated to a **low** level with the application of appropriate mitigation measures. This is on the assumption that the proposed mitigation measures as detailed in the EIA reports, namely the marking of lines, will be implemented at all the relevant sites.

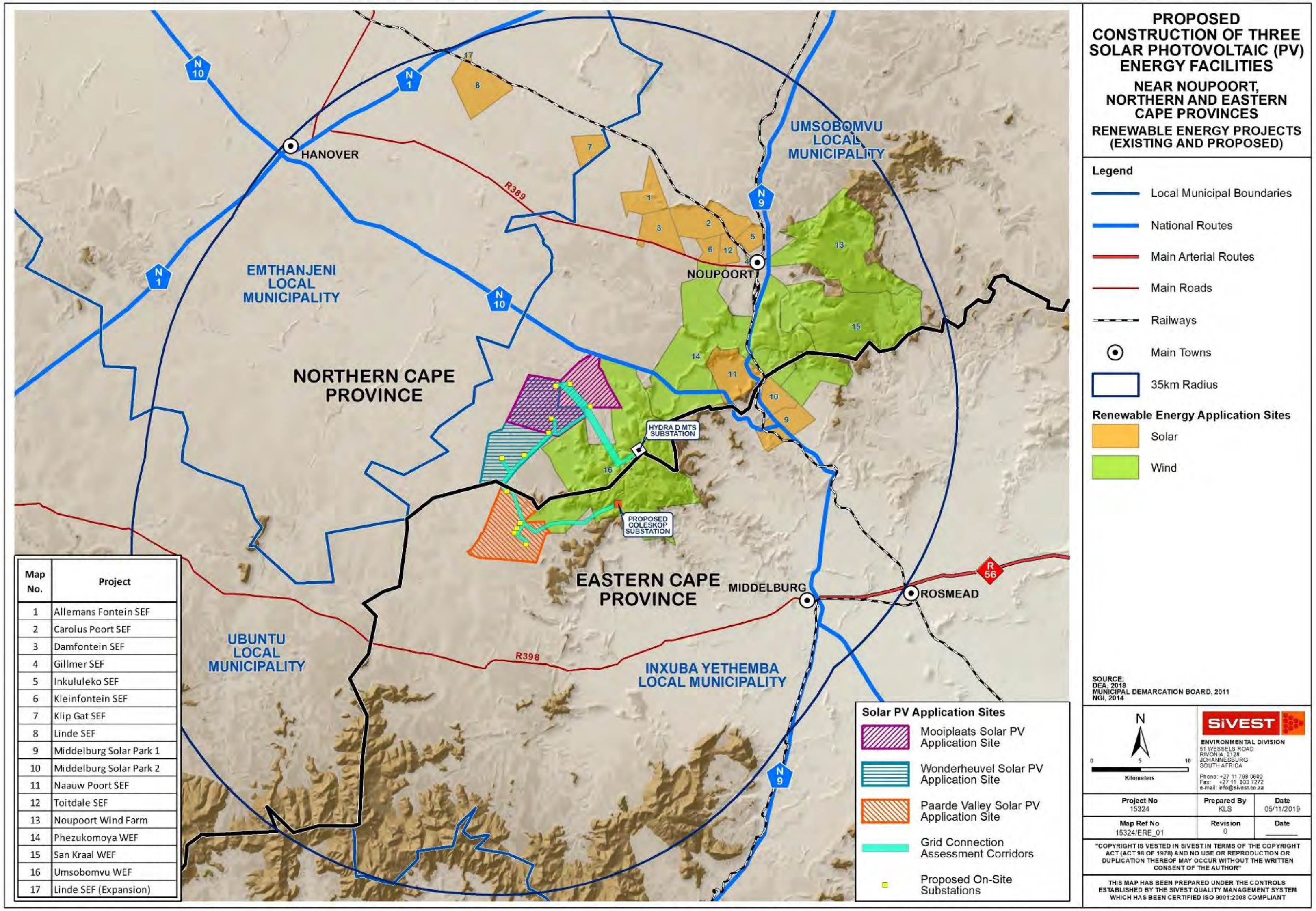

Figure 17: The locality of existing and proposed renewable energy projects within a 35km radius around the proposed Umsobomvu SEFs

7.5 NO-GO ALTERNATIVE

The no-go alternative will result in the current status quo being maintained as far as the avifauna is concerned. The low human population in the area is definitely advantageous to avifauna. The no-go option would therefore eliminate any additional impact on the ecological integrity of the proposed development area as far as avifauna is concerned.

8 NO-GO AREAS

No no-go areas have been identified for the solar fields or road network.

For the grid connection, two types of no-go areas have been identified, both based on the risk of powerline collisions. These areas are dams and agricultural fields. Both these habitat classes serve as focal points for powerline sensitive avifauna, which includes Red Data species such as Blue Cranes, Ludwig's Bustard and Greater Flamingo, large raptors and various non-Red Data waterbirds. It is suggested that a 500m powerline-free buffer is created around all these potential hot-spots, to minimise the risk of collision mortality. See Figure 18 for the location of the proposed powerline-free zones.

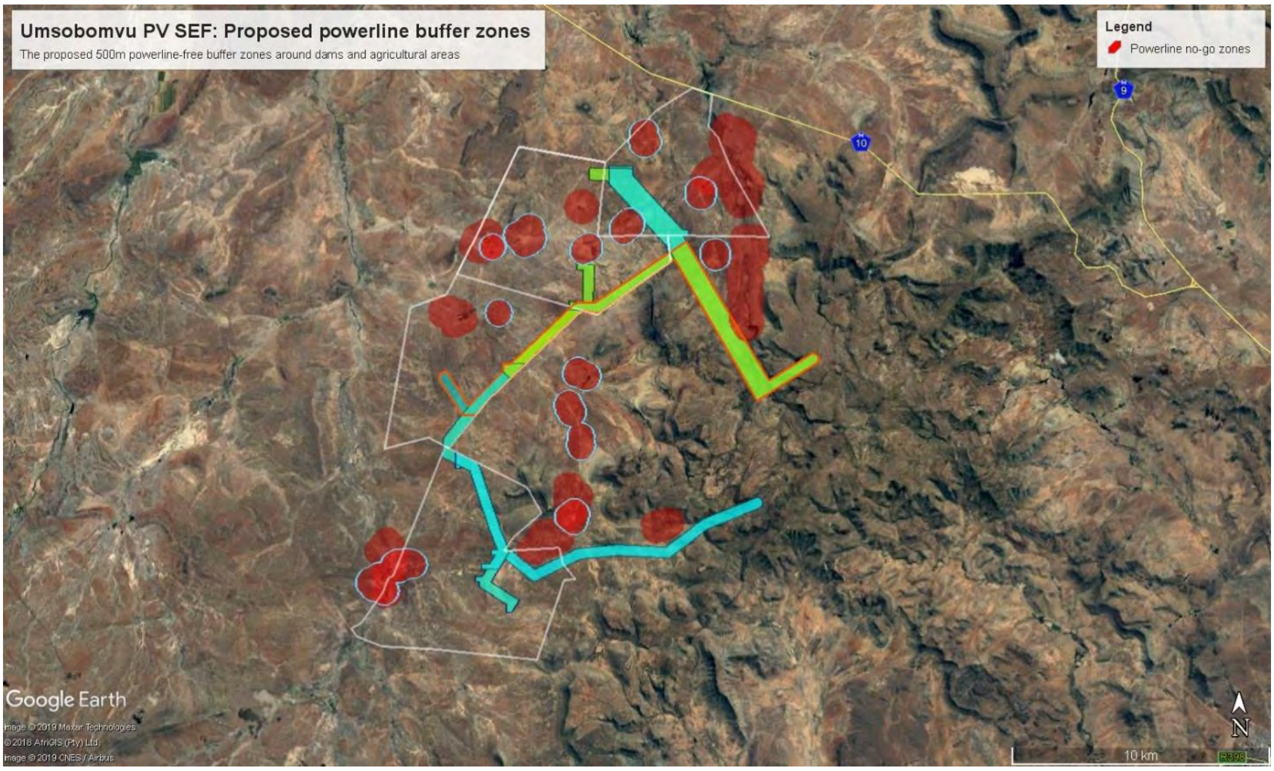

Figure 18: Location of the proposed powerline-free buffer zones around dams and agricultural areas, relative to the proposed grid connection corridors.

9 ASSESSMENT OF ALTERNATIVES

Several infrastructure alternative options have been put, for each PV facility. These options are evaluated in the assessment tables below.

Key

PREFERRED	The alternative will result in a low impact / reduce the impact
FAVOURABLE	The impact will be relatively insignificant
LEAST PREFERRED	The alternative will result in a high impact / increase the impact
NO PREFERENCE	The alternative will result in equal impacts

PV INFRASTRUCTURE ALTERNATIVES (LAYDOWN AREAS AND O&M BUILDINGS)	Preference	Reasons (incl. potential issues)
MOOI PLAATS SOLAR PV FACILITY:		
Laydown Area and O&M Building Site Option 1	No preference	All the proposed alternative locations for Mooi Plaats are in similar bird habitat and will therefore result in similar impacts.
Laydown Area and O&M Building Site Option 2	No preference	All the proposed alternative locations for Mooi Plaats are in similar bird habitat and will therefore result in similar impacts.
Laydown Area and O&M Building Site Option 3	No preference	All the proposed alternative locations for Mooi Plaats are in similar bird habitat and will therefore result in similar impacts.
Laydown Area and O&M Building Site Option 4	No preference	All the proposed alternative locations for Mooi Plaats are in similar bird habitat and will therefore result in similar impacts.
Laydown Area and O&M Building Site Option 5	No preference	All the proposed alternative locations for Mooi Plaats are in similar bird habitat and will therefore result in similar impacts.
Laydown Area and O&M Building Site Option 6	No preference	All the proposed alternative locations for Mooi Plaats are in similar bird habitat and will therefore result in similar impacts.
WONDERHEUVEL SOLAR PV FACILITY:		
Laydown Area and O&M Building Site Option 1	No preference	All the proposed alternative locations for Wonderheuvel are in similar bird

PV INFRASTRUCTURE ALTERNATIVES (LAYDOWN AREAS AND O&M BUILDINGS)	Preference	Reasons (incl. potential issues)
		habitat and will therefore result in similar impacts.
Laydown Area and O&M Building Site Option 2	No preference	All the proposed alternative locations for Wonderheuvel are in similar bird habitat and will therefore result in similar impacts.
Laydown Area and O&M Building Site Option 3	No preference	All the proposed alternative locations for Wonderheuvel are in similar bird habitat and will therefore result in similar impacts.
Laydown Area and O&M Building Site Option 4	No preference	All the proposed alternative locations for Wonderheuvel are in similar bird habitat and will therefore result in similar impacts.
Laydown Area and O&M Building Site Option 5	No preference	All the proposed alternative locations for Wonderheuvel are in similar bird habitat and will therefore result in similar impacts.
Laydown Area and O&M Building Site Option 6	No preference	All the proposed alternative locations for Wonderheuvel are in similar bird habitat and will therefore result in similar impacts.
Laydown Area and O&M Building Site Option 7	No preference	All the proposed alternative locations for Wonderheuvel are in similar bird habitat and will therefore result in similar impacts.
Laydown Area and O&M Building Site Option 8	No preference	All the proposed alternative locations for Wonderheuvel are in similar bird habitat and will therefore result in similar impacts.
PAARDE VALLEY SOLAR PV FACILITY:		
Laydown Area and O&M Building Site Option 1	No preference	All the proposed alternative locations for PaardeValley are in similar bird habitat and will therefore result in similar impacts.
Laydown Area and O&M Building Site Option 2	No preference	All the proposed alternative locations for PaardeValley are in similar bird

PV INFRASTRUCTURE ALTERNATIVES (LAYDOWN AREAS AND O&M BUILDINGS)	Preference	Reasons (incl. potential issues)
		habitat and will therefore result in similar impacts.
Laydown Area and O&M Building Site Option 3	No preference	All the proposed alternative locations for PaardeValley are in similar bird habitat and will therefore result in similar impacts.
Laydown Area and O&M Building Site Option 4	No preference	All the proposed alternative locations for PaardeValley are in similar bird habitat and will therefore result in similar impacts.
Laydown Area and O&M Building Site Option 5	No preference	All the proposed alternative locations for PaardeValley are in similar bird habitat and will therefore result in similar impacts.
Laydown Area and O&M Building Site Option 6	No preference	All the proposed alternative locations for PaardeValley are in similar bird habitat and will therefore result in similar impacts.
Laydown Area and O&M Building Site Option 7	No preference	All the proposed alternative locations for PaardeValley are in similar bird habitat and will therefore result in similar impacts.
Laydown Area and O&M Building Site Option 8	No preference	All the proposed alternative locations for PaardeValley are in similar bird habitat and will therefore result in similar impacts.
Laydown Area and O&M Building Site Option 9	No preference	All the proposed alternative locations for PaardeValley are in similar bird habitat and will therefore result in similar impacts.

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS and ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
MOOI PLAATS SOLAR PV FACILITY:		

Grid Connection Option 1a	Preferred	This is the shorter than both alternatives for Option 2
Grid Connection Option 1b	Preferred	This is the shorter than both alternatives for Option 2
Grid Connection Option 2a	Not preferred	This is longer than both alternatives for Option 1
Grid Connection Option 2b	Not preferred	This is longer than both alternatives for Option 1
WONDERHEUVEL SOLAR PV FACILITY:		
Grid Connection Option 1a	Not preferred	This is longer than all the alternatives for Options 2 and 3
Grid Connection Option 1b	Not preferred	This is longer than all the alternatives for Options 2 and 3
Grid Connection Option 1c	Not preferred	This is longer than all the alternatives for Options 2 and 3
Grid Connection Option 1d	Not preferred	This is longer than all the alternatives for Options 2 and 3
Grid Connection Option 2a	Preferred	This is shorter than all the alternatives for Option 1 approximately equal to Option 3
Grid Connection Option 2b	Preferred	This is shorter than all the alternatives for Option 1 approximately equal to Option 3
Grid Connection Option 3	Preferred	This is shorter than all the alternatives for Option 1 approximately equal to Option 2
PAARDE VALLEY SOLAR PV FACILITY:		
Grid Connection Option 1a	Not preferred	Option 1 will create a new impact, because for most of the way it does not run parallel to any of the other options.
Grid Connection Option 1b	Not preferred	Option 1 will create a new impact, because for most of the way it does not run parallel to any of the other options.
Grid Connection Option 1c	Not preferred	Option 1 will create a new impact, because for most of the way it does

		not run parallel to any of the other options.
Grid Connection Option 1d	Not preferred	Option 1 will create a new impact, because for most of the way it does not run parallel to any of the other options.
Grid Connection Option 2a	Preferred	The majority of Option 2 run parallel to the proposed Mooiplaats and Wonderheuvel grid connection options, which is preferable to creating a new impact as is the case with Option 1.
Grid Connection Option 2a	Preferred	The majority of Option 2 run parallel to the proposed Mooiplaats and Wonderheuvel grid connection options, which is preferable to creating a new impact as is the case with Option 1.
Grid Connection Option 2a	Preferred	The majority of Option 2 run parallel to the proposed Mooiplaats and Wonderheuvel grid connection options, which is preferable to creating a new impact as is the case with Option 1.
Grid Connection Option 2a	Preferred	The majority of Option 2 run parallel to the proposed Mooiplaats and Wonderheuvel grid connection options, which is preferable to creating a new impact as is the case with Option 1.

10 CONCLUSIONS

The proposed Umsobomvu PV facilities will have some pre-mitigation impacts on avifauna at a site and local level which will range from **Medium to Low**.

The impact of displacement due to disturbance during the construction phase is rated as **Medium** and will remain at a **Medium** level after mitigation. The impact of displacement of priority species due to habitat transformation associated with the operation of the plant and associated infrastructure is rated as **Medium**. This impact can be partially reversed through mitigation, but it will remain at a **Medium** level, after mitigation. The envisaged impacts in the operational phase, i.e. mortalities due to collisions with the solar panels and entrapment in perimeter fences are both rated as **Low** pre-mitigation and could be further reduced with appropriate mitigation. The impact of displacement due to disturbance during the decommissioning phase is rated as **Medium**, and it will remain at a **Medium** level after mitigation. The cumulative impact of the proposed PV facilities within a 35km radius is rated as **Low**, both per- and post mitigation.

The impact of displacement due to disturbance associated with the construction of the proposed 132kV grid connection and substations, is assessed to be **Medium** and can be mitigated to a **Low** level. The potential for displacement due to habitat destruction associated with the construction of the substations is rated as **Low** and could be further reduced with appropriate mitigation. The impact of bird collisions with the 132kV grid connection is rated as **High** and could be reduced to **Medium** with the application of mitigation measures. The potential impact of electrocutions is assessed to be **Medium**, but it can be reduced to **Low** with appropriate mitigation. The impact of displacement due to disturbance associated with the de-commissioning of the proposed 132kV grid connection and substations, is assessed to be **Medium** and can be mitigated to a **Low** level. The cumulative impact of the proposed grid connections within a 35km radius is rated as **Medium**, but it can be reduced to **Low** with the application of appropriate mitigation.

11 IMPACT STATEMENT

From an avifaunal impact perspective, there is no objection to the proposed development of the Umsobomvu PV facilities and associated grid connections, provided the proposed mitigation measures are strictly implemented. No further monitoring will be required during the operational phase.

12 REFERENCES

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APPENDIX 1: FIELD SURVEYS

1 Methodology

Monitoring was conducted in the following manner:

- A visit to the site and general area was conducted on 15 and 16 January 2019, followed up by on-site surveys from 17 - 19 January and 9-12 May 2019. Eighteen walk transects were identified totalling 1km each in the proposed PV development area (see Figure 1 below).
- One observer walking slowly recorded all species on both sides of the transect. The observer stopped at regular intervals to scan the environment with binoculars.
- Each transect was counted twice over a period of three days.
- The following variables were recorded:
  - Species;
  - Number of birds;
  - Date;
  - Start time and end time;
  - Estimated distance from transect (m);
  - Wind direction;
  - Wind strength (estimated Beaufort scale 1 - 7);
  - Weather (sunny; cloudy; partly cloudy; rain; mist);
  - Temperature (cold; mild; warm; hot);
  - Behaviour (flushed; flying-display; perched; perched-calling; perched-hunting; flying- foraging; flying-commute; foraging on the ground.
- All incidental sightings of priority species were recorded.
- The sections of the Hydra – Poseidon 1 and 2 400kV transmission lines running through to the study area was inspected for evidence of breeding raptors on the towers.

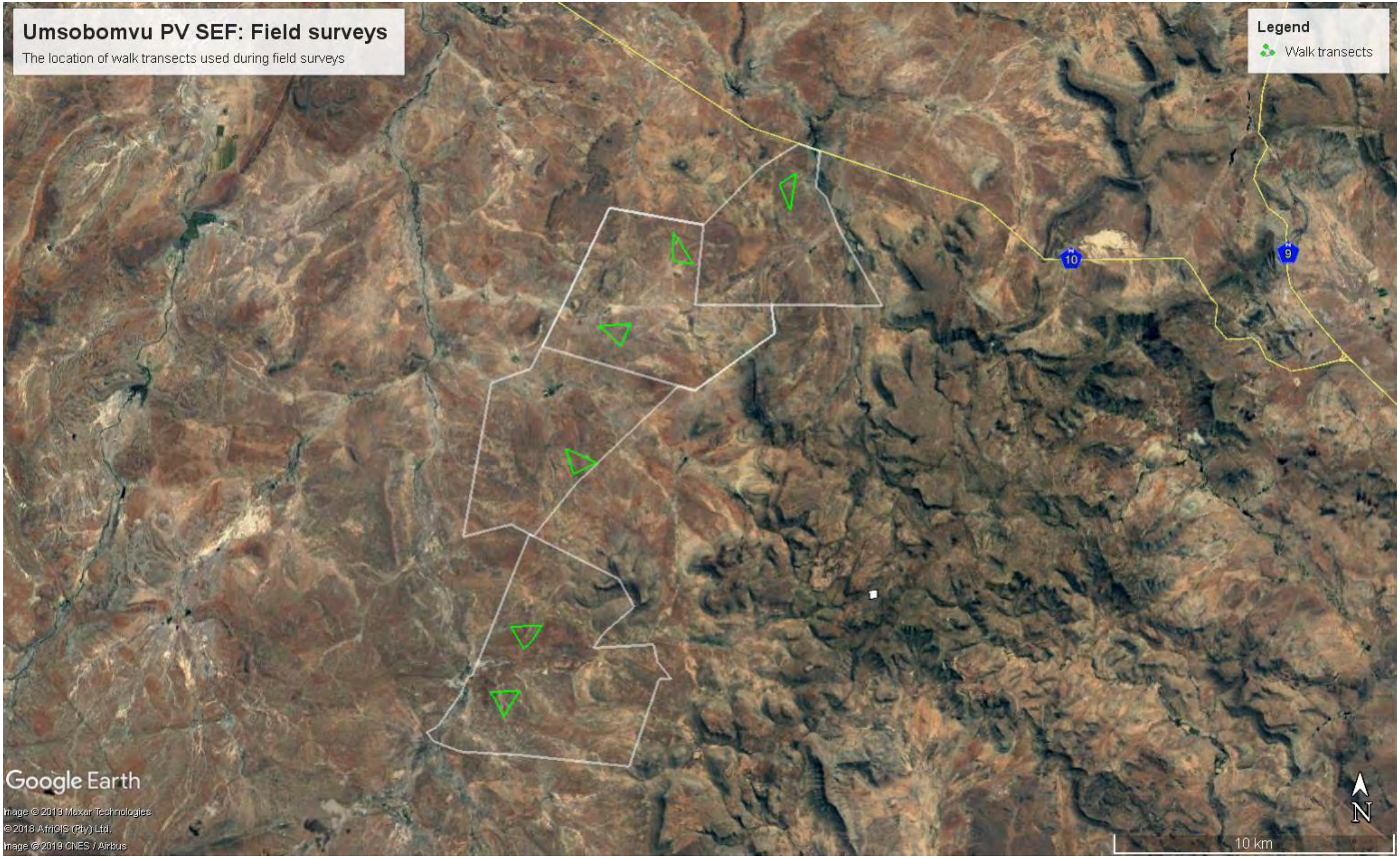


Figure 1: Walk transects used during field surveys.

APPENDIX 2: AVIFAUNA IN THE BROADER AREA

Species	Taxonmic name	Solar priority species	Powerline sensitive species	SABAP2 Average reporting rate: full protocol	Red Data status: International	Red Data status: Regional	Endemic - South Africa	Endemic - Southern Africa
Apalis, Bar-throated	*Apalis thoracica*			1.86				
Avocet, Pied	*Recurvirostra avosetta*	x		15.48				
Barbet, Acacia Pied	*Tricholaema leucomelas*			75.00				Near-endemic
Batis, Pririt	*Batis pririt*			1.86				Near-endemic
Bee-eater, European	*Merops apiaster*			21.96				
Bishop, Southern Red	*Euplectes orix*			69.99				
Bishop, Yellow-crowned	*Euplectes afer*			2.78				
Bokmakierie	*Telophorus zeylonus*			88.49				
Bulbul, African Red-eyed	*Pycnonotus nigricans*			81.48				Near-endemic
Bunting, Cape	*Emberiza capensis*			52.78				Near-endemic
Bunting, Cinnamon-breasted	*Emberiza tahapisi*			7.41				
Bunting, Lark-like	*Emberiza impetuani*			63.49				Near-endemic
Bustard, Ludwig's	*Neotis ludwigii*	x	x	25.67	EN	EN		Near-endemic
Buzzard, Jackal	*Buteo rufofuscus*	x	x	22.22			Near endemic	Endemic
Buzzard, Steppe	*Buteo vulpinus*		x	10.59				
Canary, Black-headed	*Serinus alario*	x		14.56			Near endemic	Endemic
Canary, Black-throated	*Crithagra atrogularis*			25.00				
Canary, Cape	*Serinus canicollis*			3.44				Endemic
Canary, White-throated	*Crithagra albogularis*			59.26				Near-endemic
Canary, Yellow	*Crithagra flaviventris*			20.51				Near-endemic
Canary, Yellow-fronted	*Crithagra mozambicus*			0.00				
Chat, Anteating	*Myrmecocichla formicivora*			11.57				Endemic
Chat, Familiar	*Cercomela familiaris*			92.59				
Chat, Karoo	*Cercomela schlegelii*			0.00				Near-endemic
Chat, Sickle-winged	*Cercomela sinuata*	x		48.81			Near endemic	Endemic
Cisticola, Cloud	*Cisticola textrix*	x		0.00			Near endemic	Near-endemic
Cisticola, Desert	*Cisticola aridulus*			17.33				
Cisticola, Grey-backed	*Cisticola subruficapilla*			45.77				Near-endemic
Cisticola, Levaillant's	*Cisticola tinniens*			30.43				
Cisticola, Zitting	*Cisticola juncidis*			1.86				
Cliff-swallow, South African	*Hirundo spilodera*			6.33			Endemic (SA, Lesotho, Swaziland) Breeding	Breeding-endemic
Coot, Red-knobbed	*Fulica cristata*	x	x	14.41				
Cormorant, Reed	*Phalacrocorax africanus*	x	x	13.49				
Cormorant, White-breasted	*Phalacrocorax carbo*			4.77				
Courser, Double-banded	*Rhinoptilus africanus*			2.78				
Crane, Blue	*Anthropoides paradiseus*	x	x	73.41	VU	NT		Endemic
Crane, Grey Crowned	*Balearica regulorum*	x	x	0.00	EN	EN		
Crombec, Long-billed	*Sylvietta rufescens*			14.96				
Crow, Cape	*Corvus capensis*			1.86				
Crow, Pied	*Corvus albus*		x	88.89				
Cuckoo, Diderick	*Chrysococcyx caprius*			10.19				
Dove, Laughing	*Streptopelia senegalensis*			42.22				
Dove, Namaqua	*Oena capensis*			27.51				
Dove, Red-eyed	*Streptopelia semitorquata*			60.44				
Drongo, Fork-tailed	*Dicrurus adsimilis*			1.86				
Duck, African Black	*Anas sparsa*	x	x	8.33				

Species	Taxonmic name	Solar priority species	Powerline sensitive species	SABAP2 Average reporting rate: full protocol	Red Data status: International	Red Data status: Regional	Endemic - South Africa	Endemic - Southern Africa
Duck, Maccoa	*Oxyura maccoa*	x	x	1.59	NT	NT		
Duck, White-faced	*Dendrocygna viduata*	x	x	2.78				
Duck, Yellow-billed	*Anas undulata*	x	x	50.92				
Eagle, Booted	*Aquila pennatus*		x	16.67				
Eagle, Martial	*Polemaetus bellicosus*	x	x	7.14	VU	EN		
Eagle, Verreaux's	*Aquila verreauxii*	x	x	18.26	LC	VU		
Eagle-owl, Spotted	*Bubo africanus*	x	x	12.43				
Egret, Cattle	*Bubulcus ibis*	x		4.63				
Egret, Great	*Egretta alba*	x	x	0.00				
Eremomela, Yellow-bellied	*Eremomela icteropygialis*			20.37				
Falcon, Lanner	*Falco biarmicus*	x	x	2.78	LC	VU		
Falcon, Peregrine	*Falco peregrinus*	x	x	1.59				
Finch, Red-headed	*Amadina erythrocephala*			13.89				Near-endemic
Fiscal, Common (Southern)	*Lanius collaris*			96.82				
Fish-eagle, African	*Haliaeetus vocifer*	x	x	3.18				
Flamingo, Greater	*Phoenicopterus ruber*		x	3.18	LC	NT		
Flycatcher, Chat	*Bradornis infuscatus*			20.38				Near-endemic
Flycatcher, Fiscal	*Sigelus silens*	x		34.40			Near endemic	Endemic
Flycatcher, Spotted	*Muscicapa striata*			4.63				
Francolin, Grey-winged	*Scleroptila africanus*			10.84			Endemic (SA, Lesotho, Swaziland)	Endemic
Goose, Egyptian	*Alopochen aegyptiacus*		x	77.78				
Goose, Spur-winged	*Plectropterus gambensis*	x	x	34.79				
Goshawk, Southern Pale Chanting	*Melierax canorus*	x	x	34.66				Near-endemic
Grebe, Black-necked	*Podiceps nigricollis*	x	x	0.00				
Grebe, Great Crested	*Podiceps cristatus*	x	x	1.59				
Grebe, Little	*Tachybaptus ruficollis*	x		9.12				
Greenshank, Common	*Tringa nebularia*	x		12.70				
Guineafowl, Helmeted	*Numida meleagris*		x	63.22				
Hamerkop	*Scopus umbretta*	x	x	1.86				
Harrier, Black	*Circus maurus*	x	x	2.78	VU	EN	Near endemic	Endemic
Harrier-Hawk, African	*Polyboroides typus*	x	x	1.59				
Heron, Black-headed	*Ardea melanocephala*	x	x	17.33				
Heron, Grey	*Ardea cinerea*	x	x	23.93				
Hoopoe, African	*Upupa africana*			51.86				
Ibis, African Sacred	*Threskiornis aethiopicus*	x	x	20.23				
Ibis, Hadeda	*Bostrychia hagedash*		x	51.46				
Kestrel, Greater	*Falco rupicoloides*	x		21.30				
Kestrel, Lesser	*Falco naumanni*	x		20.37				
Kestrel, Rock	*Falco rupicolus*	x		27.41				
Kingfisher, Malachite	*Alcedo cristata*	x		2.78				
Kingfisher, Pied	*Ceryle rudis*	x		2.78				
Kite, Black-shouldered	*Elanus caeruleus*	x		15.44				
Korhaan, Blue	*Eupodotis caerulescens*	x	x	56.34	NT	LC	Endemic (SA, Lesotho, Swaziland)	Endemic
Korhaan, Karoo	*Eupodotis vigorsii*	x	x	13.10	LC	NT		Endemic
Korhaan, Northern Black	*Afrotis afraoides*		x	74.21				Endemic
Lapwing, Blacksmith	*Vanellus armatus*	x		49.33				
Lapwing, Crowned	*Vanellus coronatus*			28.44				
Lark, Eastern Clapper	*Mirafra fasciolata*			82.01				Near-endemic
Lark, Large-billed	*Galerida magnirostris*	x		75.27			Near endemic	Endemic
Lark, Red-capped	*Calandrella cinerea*			28.97				
Lark, Sabota	*Calendulauda sabota*			8.33				Near-endemic
Lark, Spike-heeled	*Chersomanes albofasciata*			70.23				Near-endemic

Species	Taxonmic name	Solar priority species	Powerline sensitive species	SABAP2 Average reporting rate: full protocol	Red Data status: International	Red Data status: Regional	Endemic - South Africa	Endemic - Southern Africa
Longclaw, Cape	*Macronyx capensis*			17.07				Endemic
Martin, Brown-throated	*Riparia paludicola*			29.89				
Martin, Rock	*Hirundo fuligula*			58.19				
Masked-weaver, Southern	*Ploceus velatus*			80.81				
Moorhen, Common	*Gallinula chloropus*	x		17.07				
Mousebird, Red-faced	*Urocolius indicus*			17.59				
Mousebird, Speckled	*Colius striatus*			41.93				
Mousebird, White-backed	*Colius colius*			62.30				Endemic
Neddicky	*Cisticola fulvicapilla*			23.54				
Night-Heron, Black-crowned	*Nycticorax nycticorax*	x	x	0.00				
Owl, Barn	*Tyto alba*	x		7.41				
Paradise-flycatcher, African	*Terpsiphone viridis*			2.78				
Penduline-tit, Cape	*Anthoscopus minutus*			36.78				Near-endemic
Pigeon, Speckled	*Columba guinea*			73.41				
Pipit, African	*Anthus cinnamomeus*			70.89				
Pipit, African Rock	*Anthus crenatus*	x		11.11	LC	NT	Endemic (SA, Lesotho, Swaziland)	Endemic
Pipit, Long-billed	*Anthus similis*			13.89				
Pipit, Plain-backed	*Anthus leucophrys*			5.56				
Plover, Kittlitz's	*Charadrius pecuarius*	x		28.70				
Plover, Three-banded	*Charadrius tricollaris*	x		57.68				
Pochard, Southern	*Netta erythrophthalma*	x	x	1.59				
Prinia, Karoo	*Prinia maculosa*	x		76.19			Near endemic	Endemic
Quail, Common	*Coturnix coturnix*			12.70				
Quailfinch, African	*Ortygospiza atricollis*			43.66				
Quelea, Red-billed	*Quelea quelea*			18.26				
Raven, White-necked	*Corvus albicollis*		x	19.18				
Reed-warbler, African	*Acrocephalus baeticatus*			10.84				
Robin-chat, Cape	*Cossypha caffra*			66.00				
Ruff	*Philomachus pugnax*	x		3.18				
Sandgrouse, Namaqua	*Pterocles namaqua*		x	34.52				Near-endemic
Sandpiper, Wood	*Tringa glareola*	x		3.18				
Scrub-robin, Karoo	*Cercotrichas coryphoeus*			84.26				Endemic
Secretarybird	*Sagittarius serpentarius*	x	x	19.44				
Shelduck, South African	*Tadorna cana*	x	x	51.86				Endemic
Shoveler, Cape	*Anas smithii*	x	x	7.14				Near-endemic
Snake-eagle, Black-chested	*Circaetus pectoralis*	x	x	1.86				
Snipe, African	*Gallinago nigripennis*	x		1.59				
Sparrow, Cape	*Passer melanurus*			89.81				Near-endemic
Sparrow, House	*Passer domesticus*			22.62				
Sparrow, Southern Grey-headed	*Passer diffusus*			46.16				
Sparrowhawk, Black	*Accipiter melanoleucus*	x		0.00				
Sparrowhawk, Rufous-chested	*Accipiter rufiventris*	x		2.78				
Sparrowlark, Black-eared	*Eremopterix australis*	x		2.78			Near endemic	Endemic
Sparrowlark, Grey-backed	*Eremopterix verticalis*			25.79				Near-endemic
Spoonbill, African	*Platalea alba*	x	x	5.96				
Starling, Cape Glossy	*Lamprotornis nitens*			17.59				
Starling, Common	*Sturnus vulgaris*			5.56				
Starling, Pale-winged	*Onychognathus nabouroup*			2.78				Near-endemic
Starling, Pied	*Spreo bicolor*			94.44			Endemic (SA, Lesotho, Swaziland)	Endemic
Starling, Red-winged	*Onychognathus morio*			48.01				
Starling, Wattled	*Creatophora cinerea*			4.37				

Species	Taxonmic name	Solar priority species	Powerline sensitive species	SABAP2 Average reporting rate: full protocol	Red Data status: International	Red Data status: Regional	Endemic - South Africa	Endemic - Southern Africa
Stilt, Black-winged	*Himantopus himantopus*	*x*		23.01				
Stint, Little	*Calidris minuta*	*x*		9.12				
Stonechat, African	*Saxicola torquatus*			26.19				
Stork, Black	*Ciconia nigra*	*x*	*x*	0.00	LC	VU		
Stork, White	*Ciconia ciconia*	*x*	*x*	0.00				
Sunbird, Malachite	*Nectarinia famosa*			1.86				
Sunbird, Southern Double-collared	*Cinnyris chalybeus*	*x*		5.56			Near endemic	Endemic
Swallow, Barn	*Hirundo rustica*			51.71				
Swallow, Greater Striped	*Hirundo cucullata*			69.31				
Swallow, White-throated	*Hirundo albigularis*			31.34				
Swamp-warbler, Lesser	*Acrocephalus gracilirostris*			13.10				
Swift, African Black	*Apus barbatus*			0.00				
Swift, Alpine	*Tachymarptis melba*			4.63				
Swift, Little	*Apus affinis*			28.70				
Swift, White-rumped	*Apus caffer*			27.28				
Teal, Cape	*Anas capensis*	*x*	*x*	8.73				
Teal, Red-billed	*Anas erythrorhyncha*	*x*	*x*	13.37				
Thick-knee, Spotted	*Burhinus capensis*			23.54				
Thrush, Karoo	*Turdus smithi*	*x*		34.12			Near endemic	Endemic
Tit, Grey	*Parus afer*	*x*		10.19			Near endemic	Endemic
Tit-babbler, Chestnut-vented	*Parisoma subcaeruleum*			38.37				Near-endemic
Tit-babbler, Layard's	*Parisoma layardi*			30.56			Near endemic	Endemic
Turtle-dove, Cape	*Streptopelia capicola*			98.14				
Vulture, Cape	*Gyps coprotheres*	*x*	*x*	2.78	EN	EN		Near-endemic
Wagtail, Cape	*Motacilla capensis*			90.73				
Warbler, Rufous-eared	*Malcorus pectoralis*			92.46				Endemic
Warbler, Willow	*Phylloscopus trochilus*			1.86				
Waxbill, Common	*Estrilda astrild*			24.87				
Weaver, Cape	*Ploceus capensis*	*x*		7.14			Near endemic	Endemic
Wheatear, Capped	*Oenanthe pileata*			34.40				
Wheatear, Mountain	*Oenanthe monticola*			71.69				Near-endemic
White-eye, Cape	*Zosterops virens*	*x*		25.40			Near endemic	Endemic
Whydah, Pin-tailed	*Vidua macroura*			26.71				
Woodpecker, Cardinal	*Dendropicos fuscescens*			2.78				
Woodpecker, Ground	*Geocolaptes olivaceus*	*x*		1.86			Endemic (SA, Lesotho, Swaziland)	Endemic

APPENDIX 3: IMPACT CRITERIA

2 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.

2.1 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.

2.2 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).

2.2.1 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 4: 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:

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.

APPENDIX 4: LIST OF EXISTING AND PROPOSED RENEWABLE ENERGY PROJECTS

Project	DEA Reference No	Technology	Capacity	Status of Application / Development	Avifaunal specialist study conducted	Recommendations pertaining to avifauna
Allemans Fontein SEF	14/12/16/3/3/1/730	Solar	20MW	Approved	Yes	Micro-siting of infrastructure to avoid Blue Crane habitat. Strict control of construction activities to limit damage to the vegetation.
Carolus Poort SEF	14/12/16/3/3/1/729	Solar	20MW	Approved	Yes	Micro-siting of infrastructure to avoid Blue Crane habitat. Strict control of construction activities to limit damage to the vegetation.
Carolus Poort SEF	14/12/16/3/3/1/730	Solar	20MW	Approved	Yes	Micro-siting of infrastructure to avoid Blue Crane habitat. Strict control of construction activities to limit damage to the vegetation.
Gillmer SEF	14/12/16/3/3/1/735	Solar	20MW	Approved	No	Mark powerlines with bird flappers. Record electrocutions and collisions. Use bird-friendly tower designs.
Inkululeko SEF	14/12/16/3/3/1/553	Solar	20MW	Approved	No	None
Kleinfontein SEF	12/12/20/2654	Solar	20MW	Approved	No	None
Klip Gat SEF	14/12/16/3/3/2/354	Solar	75M	Approved	No	Mark powerlines with bird flappers. Do nest searches
Linde SEF	12/12/20/2258	Solar	40MW	In Operation	No	None
Linde SEF (Expansion)	14/12/16/3/3/1/1122	Solar	75MW	Approved	No	None
Middelburg Solar Park 1	12/12/20/2465/2	Solar	75MW	Approved	No	None
Middelburg Solar Park 2	12/12/20/2465/1	Solar	75MW	Approved	No	None
Naauw Poort SEF	14/12/16/3/3/2/355	Solar	75MW	Approved	No	Mark powerlines with bird flappers. Do nest searches
Toitdale SEF	12/12/20/2653	Solar	20MW	Approved	No	Do nest searches. Pre- and post-construction surveys

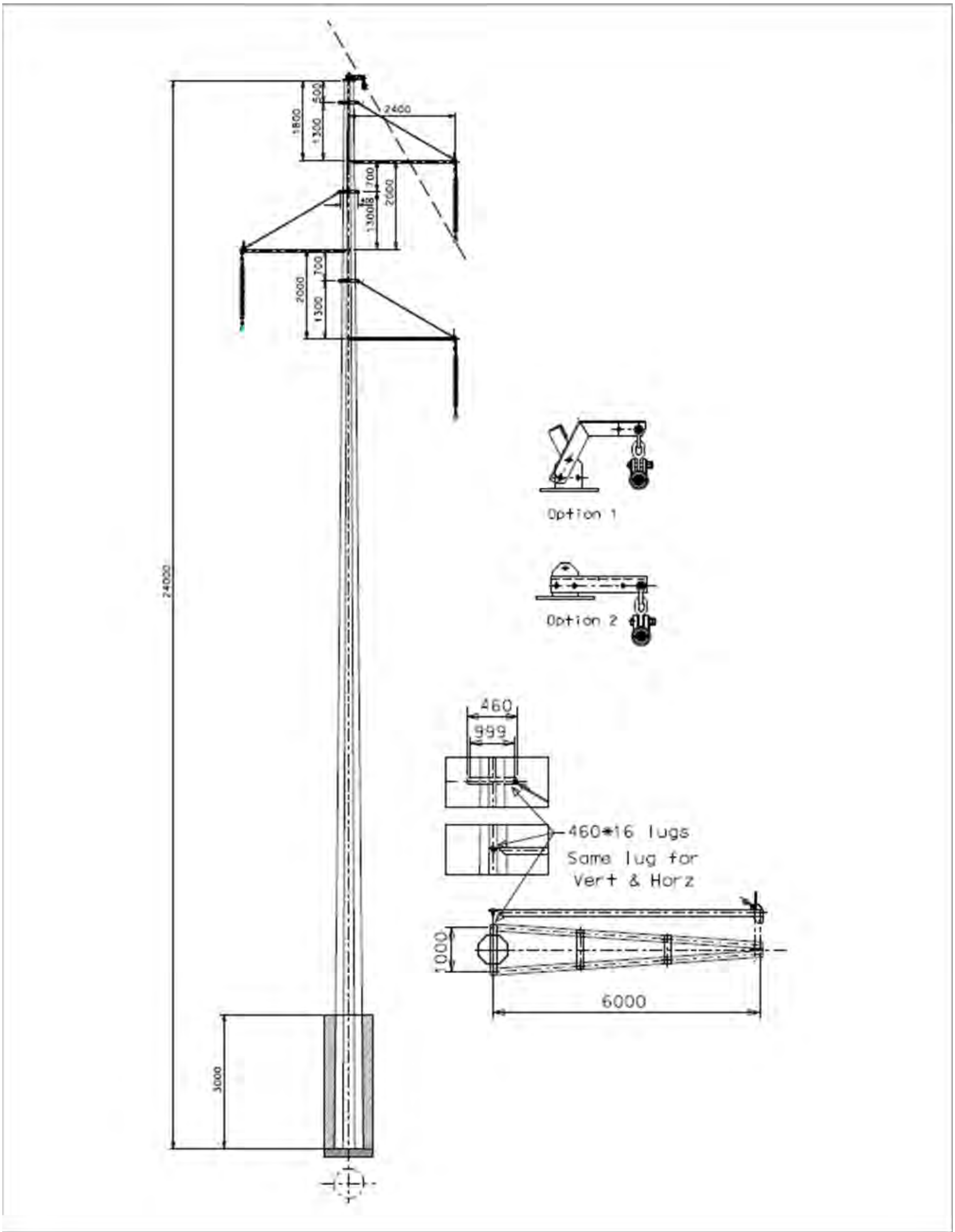
Noupoort Wind Farm	12/12/20/2319	Wind	188MW	In Operation	Yes	• Ensuring that key areas of conservation importance and sensitivity are avoided, in this instance slopes and potential funnels of bird flight activity. • Habitat destruction should be limited to what is absolutely necessary for the construction of the infrastructure, including the construction of new roads. In this respect, the recommendations from the Ecological Specialist Study (see Chapter 12 of the EIR) should be applied strictly. Personnel should be adequately briefed on the need to restrict habitat destruction, and must be restricted to the actual construction area. • The proposed power line should be routed as far as possible from high risk areas (e.g. Blue Crane nest, agricultural lands, and dams). In addition, the proposed alignment must be assessed for potential collision risks and those sections must be marked with Bird Flight Diverters. • The proposed pole design must be assessed by the author of this report to ensure that the power line design poses no potential electrocution risk of large raptors, particularly Martial Eagle, which may use the poles as hunting perches. • A 500m exclusion zone should be implemented around the existing Blue Crane breeding pair where no construction activity should take place. Ideally, construction of turbines within a 1km line of sight around the nest should not take place during the sensitive part of the breeding cycle i.e. October to December. • Once the turbines have been constructed, post-construction monitoring should be implemented as part of the continuation of the current monitoring programme, to assess displacement and actual collision rates. If actual collision and displacement levels are deemed too high, the following mitigation measures would need to be considered: - Negotiating appropriate off-set compensation for turbine related displacement and collision mortality; - As a last resort, halting operation of specific turbines during peak flight periods, or reducing rotor speed, to reduce the risk of collision mortality.

Phezukomoya WEF	14/12/16/3/3/1/1028	Wind	315MW	EIA in Process		• Restrict the construction activities to the wind farm construction footprint area. • Do not allow any access to the remainder of the property during the construction period. Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum • It is recommended that a 2.5km pre-cautionary no-go buffer is implemented around the Verreaux's Eagle nest at FP1 (31°12'59.66"S 24°57'26.08"). • The appointed Environmental Control Officer (ECO) should be trained by an avifaunal specialist to identify the signs that indicate possible breeding by priority species. The ECO must then, during audits/site visits, make a concerted effort to look out for such breeding activities of such species, and such efforts may include the training of construction staff to identify such species, followed by regular questioning of staff as to the regular whereabouts on site of the species. If any priority species are confirmed to be breeding (e.g. if a nest site is found), construction activities within 500m of the breeding site must cease, and the avifaunal specialist will be contacted immediately for further assessment of the situation and instruction on how to proceed. • Restrict the construction activities to the powerline construction footprint area. • Do not allow any access to the remainder of the property during the construction period. • Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • Use Alternative A or B for the 400kV turn-in to the proposed Umsobomvu MTS • The final powerline route should be assessed by the avifaunal specialist way of a walk-down to identify any priority species nests which could be impacted by the construction activities. Should a nest be discovered, the avifaunal specialist must have input into the construction schedule to assess how and which of the construction activities can be timed to minimize the disturbance potential to the occupants of the nest. • The final powerline design and associated electrocution mitigation measures (if necessary) must be approved and signed off by the avifaunal specialist. • The recommendations of the specialist ecological study must be strictly adhered to. Maximum used should be made of existing access roads and the construction of new roads should be kept to a minimum. • Following construction, rehabilitation of all areas disturbed (e.g. temporary access tracks and laydown areas) must be undertaken and to this end a habitat restoration plan is to be developed by a rehabilitation specialist. • Once the turbines have been constructed, post-construction monitoring should be implemented to compare actual collision rates with predicted collision rates. • The avifaunal specialist, in consultation with external experts and relevant NGO's such as BLSA, should determine annual mortality thresholds for priority anticipated to be at risk of collision mortality, prior to the wind farm going operational. • If actual collision rates exceed the pre-determined threshold levels, curtailment of turbines should be implemented for high risk situations. • A 150m no-turbine set-back buffer zone (infrastructure is allowed) is required around the escarpment to minimise the risk of collisions for slope soaring species. • It is recommended that a 2.5km pre-cautionary no-go buffer is implemented around the Verreaux's Eagle nest at FP1 (31°12'59.66"S 24°57'26.08"). • In addition, it is recommended that turbines 7, 62 and 63 are relocated to the top of the plateau as they pose a high collision risk on the slopes where they are situated. • Care should be taken not to create habitat for prey species that could draw priority raptors into the area and expose them to collision risk. Rock piles must be removed from site or covered with topsoil to prevent them from becoming habitat for Rock Hyrax (Dassie).

San Kraal WEF	14/12/16/3/3/1/1069	Wind	390MW	EIA in Process		• Restrict the construction activities to the wind farm construction footprint area. • Do not allow any access to the remainder of the property during the construction period. • Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • Implement a 500m no development buffer zone around each of the two pans at FP3 at31°14'15.02"S 25° 2'44.17"E and FP4 at 31°13'55.42"S 25° 2'50.37"E to protect the pair of Blue Cranes from disturbance. • The appointed Environmental Control Officer (ECO) should be trained by an avifaunal specialist to identify the signs that indicate possible breeding by priority species. The ECO must then, during audits/site visits, make a concerted effort to look out for such breeding activities of such species, and such efforts may include the training of construction staff to identify such species, followed by regular questioning of staff as to the regular whereabouts on site of the species. If any priority species are confirmed to be breeding (e.g. if a nest site is found), construction activities within 500m of the breeding site must cease, and the avifaunal specialist will be contacted immediately for further assessment of the situation and instruction on how to proceed. • The final powerline design and associated electrocution mitigation measures (if necessary) must be approved and signed off by the avifaunal specialist. • Once the turbines have been constructed, post-construction monitoring should be implemented to compare actual collision rates with predicted collision rates. • The avifaunal specialist, in consultation with external experts and relevant NGO's such as BLSA, should determine annual mortality thresholds for priority species anticipated to be at risk of collision mortality, prior to the wind farm going operational. • If actual collision rates exceed the pre-determined threshold levels, curtailment of turbines should be implemented for high risk situations. • A 150m no-turbine set-back buffer zone (infrastructure is allowed) is required around the escarpment to minimise the risk of collisions for slope soaring species. • Care should be taken not to create habitat for prey species that could draw priority raptors into the area and expose them to collision risk. Rock piles must be removed from site or covered with topsoil to prevent them from becoming habitat for Rock Hyrax (Dassie). • The final power line route should be assessed by way of a walk-through and those sections requiring Bird Flight Diverters (BFDs) must be identified. • Use the Preferred Alternative or Alternative 1 for the grid connection in order to avoid the No-Go zone around the Verreaux's Eagle nest at FP1.

msobomvu WEF	14/12/16/3/3/2/730	Wind	140MW	Approved		• No infrastructure should be built in the areas identified as HIGH sensitivity. • There may be a requirement to avoid construction of certain infrastructure during Verreaux's Eagle breeding season (approximately May to September-October). This will be determined by the avifaunal walk through prior to construction and once the infrastructure layout is final. All power line linking the turbines and linking turbine strings to the on-site substation should be placed underground. • The power line linking the site to the Eskom grid will be above ground but must conform to all Eskom standards in terms of bird friendly pole monopole structures with Bird Perches on every pole top (to mitigate for bird electrocution), and anti-bird collision line marking devices (to mitigate for bird collision). It is particularly important that the collision mitigation devices used are durable and remain in place on the line for the full lifespan of the power line. It will be InnoWind/Eskom's responsibility to maintain these devices in effective condition for this period. • Systematic patrols of this power line should be conducted during post construction bird monitoring for the wind energy facility, in order to monitor the impacts, the effectiveness of mitigation, and the durability of the mitigation measures. • An avifaunal walk down will need to be conducted to assess the route of this power line once available. • A final avifaunal walk through should be conducted prior to construction to ensure that all the avifaunal aspects have been adequately managed and to ground truth the final layout of all infrastructure. This will most likely be done as part of the site specific Environmental Management Plan. This will also allow the development of specific management actions for the Environmental Control Officer during construction and training for relevant on site personnel if necessary. • The post-construction bird monitoring programme outlined by this report should be implemented by a suitably qualified avifaunal specialist, in accordance with the latest available best practice guidelines at the time (see Jenkins et al. 2014). As mentioned above this monitoring should include the grid connection power line. • The findings of post-construction monitoring should be used to measure the effects of this facility on birds. If significant impacts are identified the wind farm operator will have to identify and implement suitable mitigation measures.

APPENDIX 5: PROPOSED 7649 POLE DESIGN FOR GRID CONNECTION



SiVEST

Appendix 6C

Geotechnical

UMSOBOMVU PV ENERGY FACILITIES GEOTECHNICAL DESKTOP STUDY

NOVEMBER 2019

REVISION 1 FINAL

Prepared for:

MOOI PLAATS SOLAR POWER (PTY) LTD / WONDERHEUVEL SOLAR POWER (PTY) LTD / PAARDE VALLEY (PTY) LTD

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UMSOBOMVU PV ENERGY FACILITIES

GEOTECHNICAL DESKTOP STUDY

JGA REF. NO.	DATE:	REPORT STATUS
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SYNOPSIS

Revision 1: High-level geotechnical desktop study for the proposed Umsobomvu PV Facility.

KEY WORDS:

Solar Energy, Geotechnical Study, Umsobomvu, Inxuba Yethemba, Northern Cape, Eastern Cape, South Africa

QUALITY VERIFICATION

This report has been prepared under the controls established by a quality management system that meets the requirements of ISO9001: 2015 which has been independently certified by DEKRA Certification

Verification	Capacity	Name	Signature	Date
By Author	Technical Director	C Canahai		29/10/2019
Checked by:	Engineering Geologist	K Naidoo Pr. Sci. Nat		30/10/2019
Authorised by:	Technical Director	C. Canahai Pr. Sci. Nat		04/11/2019

Filename:	W:\Earth Sciences\4817 - Various Small Geotech Projects 2018\07 - Umsobomvu PV Farm Desktop Study\Report Final\Revision 1\4817-07- Umsobomvu PV Farm Rev 1_Final.docx

National Environmental Management Act, 1998 (Act No. 107 of 1998) and Environmental Impact Regulations 2014 (as amended) Requirements for Specialist Reports (Appendix 6)

Section in EIA Regulations 2014 (as amended)		Clause	Section in Report
Appendix 6	(1)	A specialist report prepared in terms of these Regulations must contain —	
	(a)	details of –	
		(i) the specialist who prepared the report; and	Verification Page
		(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae.	Annexure B
	(b)	A declaration that the person is independent in a form as may be specified by the competent authority;	Declaration of interest form
	(c)	An indication of the scope of, and the purpose for which, the report was prepared;	1
	(cA)	An indication of the quality and age of base data used for the specialist report;	11
	(cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Tables 2, 3, 4, 5, 6, 7
	(d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Non-Applicable
	(e)	A description of the methodology adopted in preparing the report or carrying out the specialised process; inclusive of equipment and modelling used;	5
	(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;	Figures 6,7, 8
	(g)	An indication of any areas to be avoided, including buffers;	Figures 6, 7, 8
	(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;	Figures 5, 6, 7, 8
	(i)	A description of any assumptions made and any uncertainties or gaps in knowledge;	1,11
	(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;	Figures 6, 7, 8
	(k)	Any mitigation measures for inclusion in the EMPr;	Tables 2, 3, 4, 5, 6, 7
	(l)	Any conditions for inclusion in the environmental authorization;	Tables 2, 3, 4, 5, 6, 7
	(m)	Any monitoring requirements for inclusion in the EMPr or environmental authorization;	Tables 2, 3, 4, 5, 6, 7
	(n)	A reasoned opinion –	
		(i) as to whether the proposed activity, activities or portions thereof should be authorized;	49
		(iA) regarding the acceptability of the proposed activity or activities; and	49
		(ii) if the opinion is that the proposed activity, activities or portions thereof should be authorized, any avoidance, management and mitigation measures	Tables 2, 3, 4, 5, 6, 7

		that should be included in the EMPr, and where applicable, the closure plan;	
	(o)	A description of any consultation process that was undertaken during the course of preparing the specialist report;	Non-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 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.	Non-Applicable

UMSOBOMVU PV ENERGY FACILITIES

GEOTECHNICAL DESKTOP STUDY

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FIGURES

ANNEXURES

UMSOBOMVU PV ENERGY FACILITIES
GEOTECHNICAL DESKTOP STUDY

1 INTRODUCTION

This report presents the high-level, scoping phase, geotechnical desktop study, undertaken for Mooi Plaats (Pty) Ltd, Wonderheuvel (Pty) Ltd and Paarde Valley (Pty) Ltd, via SiVEST Environmental Division, for the proposed construction of Photovoltaic (PV) Energy Facilities. The proposed development crosses the Northern Cape / Eastern Cape provincial border and comprises of three PV Energy facilities with associated grid infrastructure. Further investigation will be needed at the design stage to aid the engineers in their design.

The information provided in this report is based on published geological maps, published geological and geotechnical information, the interpretation of aerial photography and the review of existing environmental study reports. Site verification was not undertaken. This information is provided for planning purposes only and as part of the Environmental Impact Assessment process.

2 PROJECT DESCRIPTION

We understand that the geotechnical desktop study will form part of the Environmental Impact Assessment to be undertaken by the SiVEST Environmental Division. From the information provided by SiVEST, there are three proposed PV facilities (with associated grid infrastructure) namely; Mooi Plaats Solar PV Facility, Wonderheuvel Solar PV Facility and Paarde Valley Solar PV Facility. These facilities are to comprise of:

- ***Mooi Plaats Solar PV Facility***, on an application site of approximately 5 303ha, comprising the following farm portions:
  - Portion 1 of Leuwe Kop No 120
  - Remainder of Mooi Plaats No 121

- ***Wonderheuvel Solar PV Facility***, on an application site of approximately 5 652ha, comprising the following farm portions:
  - Remainder of Mooi Plaats No 121
  - Portion 3 of Wonder Heuvel No 140
  - Portion 5 of Holle Fountain No 133

- ***Paarde Valley Solar PV Facility***, on an application site of approximately 3 695ha, comprising the following farm portion:
  - Portion 2 of Paarde Valley No 62: and
  - Portion 7 of the Farm Leeuw Hoek No. 61.

2.1 SOLAR PV COMPONENTS

2.1.1 Mooi Plaats Solar PV Energy Facility

The proposed Mooi Plaats Solar PV Energy Facility will include the following components:

- Three (3) PV array areas, occupying a combined total area of approximately 777 hectares (ha).
- The proposed solar PV energy facility will have a maximum total generation capacity of approximately **400MW** and will comprise approximately **1 142 857** PV modules. The final number of modules as well as their configuration will only be determined in the detailed design phase.
- PV modules will be either fixed tilt mounting or single axis tracking mounting, and the modules will be either crystalline silicon or thin film technology. Each module will be approximately 2m wide and between 1m and 4m in height, depending on the mounting type.
- Internal roads, between 4m and 10m wide, will provide access to the PV arrays. Existing site roads will be used wherever possible, although new site roads will be constructed where necessary.
- Up to three (3) temporary construction laydown / staging areas of approximately 4ha each.
- Operation and maintenance (O&M) buildings will be provided for each PV array area, occupying a site of approximately 1ha each. Up to a maximum of three (3) O&M buildings will thus be constructed.
- Medium voltage cabling will link the solar PV energy facility to the grid connection infrastructure. These cables will be laid underground wherever technically feasible.

2.1.2 Wonderheuvel Solar PV Energy Facility:

The proposed Wonderheuvel Solar PV Energy Facility will include the following components:

- Six (6) PV array areas, occupying a combined total area of approximately 864ha.
- The proposed solar PV energy facility will have a maximum total generation capacity of approximately **480MW** and will comprise approximately **1 371 429** PV modules. The final number of modules as well as their configuration will only be determined in the detailed design phase.
- PV modules will be either fixed tilt mounting or single axis tracking mounting, and the modules will be either crystalline silicon or thin film technology. Each module will be approximately 2m wide and between 1m and 4m in height, depending on the mounting type.
- Internal roads, between 4m and 10m wide, will provide access to the PV arrays. Existing site roads will be used wherever possible, although new site roads will be constructed where necessary.
- Up to a maximum of four (4) temporary construction laydown / staging areas of approximately 4ha each.
- Operation and maintenance (O&M) buildings will be provided for each PV array area, occupying a site of approximately 1ha each. However, certain PV array areas will share O&M buildings. Up to a maximum of four (4) O&M buildings will thus be constructed.
- Medium voltage cabling will link the solar PV energy facility to the grid connection infrastructure. These cables will be laid underground wherever technically feasible.

2.1.3 Paarde Valley Solar PV Energy Facility

The proposed Paarde Valley Solar PV Energy Facility will include the following components:

- Five (5) PV array areas, occupying a combined total area of approximately 1 337ha.

- The proposed solar PV energy facility will have a maximum total generation capacity of approximately **700MW** and will comprise approximately **2 000 000** PV modules. The final number of modules as well as their configuration will only be determined in the detailed design phase.
- PV modules will be either fixed tilt mounting or single axis tracking mounting, and the modules will be either crystalline silicon or thin film technology. Each module will be approximately 2m wide and between 1m and 4m in height, depending on the mounting type.
- Internal roads, between 4m and 10m wide, will provide access to the PV arrays. Existing site roads will be used wherever possible, although new site roads will be constructed where necessary.
- Up to five (5) temporary construction laydown / staging areas of approximately 4ha each.
- Operation and maintenance (O&M) buildings will be provided for each PV array area, occupying a site of approximately 1ha each. Up to a maximum of five (5) O&M buildings will thus be constructed.
- Medium voltage cabling will link the solar PV energy facility to the grid connection infrastructure. These cables will be laid underground wherever technically feasible.

2.2 Grid Connection Infrastructure

The proposed grid connection infrastructure will include the following components:

- New on-site substations and collector substations to serve each solar PV energy facility, each occupying an area of up to approximately 4ha.
- A new 132kV overhead power line connecting the on-site substations and/or collector substations to either the Hydra D Main Transmission Substation (MTS) or the proposed Coleskop Wind Energy Facility (WEF) substation, from where the electricity will be fed into the national grid. The type of power line towers being considered at this stage to include both lattice and monopole towers which will be up to 25m in height.

Grid connection infrastructure alternatives have been provided for each PV project. These alternatives essentially provide for different route alignments with associated substations contained within an assessment corridor between approximately 400m and 900m wide. This is to allow for flexibility to route the power line on either side of the existing high voltage Eskom power lines. The respective alternatives are as follows:

2.2.1 Mooi Plaats Solar PV Grid Connection

The alternatives essentially provide for two (2) different route alignments with associated substations contained within an assessment corridor between approximately 400m and 900m wide. The alternatives are as follows:

OPTION 1:

- **Corridor Option 1a** - links Substation 2 and Substation 1a to the Hydra D MTS.
- **Corridor Option 1b** - links Substation 2 and Substation 1b to the Hydra D MTS.

OPTION 2:

- **Corridor Option 2a** - links Substation 2 and Substation 1a to the Hydra D MTS via the proposed Central Collector substation located on the Wonderheuvel PV project application site.

- **Corridor Option 2b** - links Substation 2 and Substation 1b to the Hydra D MTS via the proposed Central Collector substation located on the Wonderheuvel PV project application site.

2.2.2 Wonderheuvel Solar PV Grid Connection

The alternatives essentially provide for three (3) different route alignments with associated substations contained within an assessment corridor between approximately 400m and 900m wide. The alternatives are as follows:

OPTION 1:

- **Corridor Option 1a** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links the Proposed Substation 3a to the Hydra D MTS via the proposed Northern Collector Substation located on the Mooi Plaats PV project application site.
  ii. The *southern connection* links the proposed Substation 4a to the Coleskop WEF Substation via the proposed Southern Collector Substation located on the Paarde Valley PV Project application site.

- **Corridor Option 1b** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern* connection links the Proposed Substation 3a to the Hydra D MTS via the proposed Northern Collector Substation located on the Mooi Plaats PV project application site.
  ii. The *southern connection* links the proposed Substation 4b to the Coleskop WEF Substation via the proposed Southern Collector Substation located on the Paarde Valley PV Project application site.

- **Corridor Option 1c** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern* connection links the Proposed Substation 3b to the Hydra D MTS via the proposed Northern Collector Substation located on the Mooi Plaats PV project application site.
  ii. The *southern connection* links the proposed Substation 4a to the Coleskop WEF Substation via the proposed Southern Collector Substation located on the Paarde Valley PV Project application site.

- **Corridor Option 1d** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links the Proposed Substation 3b to Hydra D MTS via the proposed Northern Collector Substation located on the Mooi Plaats PV project application site.

ii. The *southern connection* links the proposed Substation 4b to the Coleskop WEF Substation via the proposed Southern Collector Substation located on the Paarde Valley PV Project application site.

OPTION 2:

- **Corridor Option 2a** - links Substation 3a to the Hydra D MTS via the proposed Central Collector Substation.
- **Corridor Option 2b** - Option 2b links Substation 3b to Hydra D MTS via the proposed Central Collector Substation.

OPTION 3:

- **Corridor Option 3** links Substation 4b to Hydra D MTS via the proposed Central Collector Substation.

2.2.3 Paarde Valley Solar PV Grid Connection

The alternatives essentially provide for two (2) different route alignments with associated substations contained within an assessment corridor between approximately 400m and 900m wide. The alternatives are as follows:

OPTION 1:

- Corridor **Option 1a** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links Substation 5 to Coleskop Substation via the proposed Southern Collector Sub (Substation 6a will act as Central Collector for this option).
  ii. The *southern connection* links Substation 7a to the Coleskop Substation via the proposed Southern Collector Substation (Substation 6a will act as Southern Collector for this option).

- Corridor **Option 1b** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links Substation 5 to Coleskop Substation via the proposed Southern Collector Sub (Substation 6b will act as Southern Collector for this option).
  ii. The *southern connection* links Substation 7a to the Coleskop Substation via the proposed Southern Collector Substation (Substation 6b will act as Southern Collector for this option).

- Corridor **Option 1c** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links Substation 5 to Coleskop Substation via the proposed Southern Collector Sub (Substation 6a will act as Southern Collector for this option).
  ii. The *southern connection* links Substation 7b to the Coleskop Substation via the proposed Southern Collector Substation (Substation 6a will act as Southern Collector for this option).

- Corridor **Option 1d** involves two (2) separate grid connections to serve the northern and southern sections of the application site.

i. The *northern connection* links Substation 5 to Coleskop Substation via the proposed Southern Collector Sub (Substation 6b will act as Southern Collector for this option).
ii. The *southern connection* links Substation 7b to the Coleskop Substation via the proposed Southern Collector Substation (Substation 6b will act as Southern Collector for this option).

OPTION 2:

- Corridor **Option 2a** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links Substation 5 to Hydra D MTS via the proposed Central Collector Sub located on the Wonderveuvel PV Project application site.
  ii. The *southern connection* links Substation 6a and 7a to the Hydra D MTS via the proposed Central Collector Substation located on the Wonderheuvel PV Project application site.

- Corridor **Option 2b** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links Substation 5 to Hydra D MTS via the proposed Central Collector Sub located on the Wonderheuvel PV Project application site.
  ii. The *southern connection* links Substation 6b and 7b to the Hydra D MTS via the proposed Central Collector Substation located on the Wonderheuvel PV Project application site.

- Corridor **Option 2c** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links Substation 5 to Hydra D MTS via the proposed Central Collector Sub located on the Wonderheuvel PV Project application site.
  ii. The *southern connection* links Substation 6a and 7b to the Hydra D MTS via the proposed Central Collector Substation located on the Wonderheuvel PV Project application site.

- Corridor **Option 2d** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links Substation 5 to Hydra D MTS via the proposed Central Collector Sub located on the Wonderheuvel PV Project application site.
  ii. The *southern connection* links Substation 6b and 7a to the Hydra D MTS via the proposed Central Collector Substation located on the Wonderheuvel PV Project application site.

The EIA phase geotechnical desktop study comprises of an Impact Assessment (from a geotechnical / geological perspective) of each proposed PV facility, a Comparative Assessment of the grid alternatives and a Cumulative Impact Assessment for each proposed PV facility (should other Energy facility / large infrastructure be developed within a 35 km radius) and takes into account other updated / revised issues to include the following:

- a review of the findings in accordance with detailed site layouts, including the PV array areas put forward as a result of the identified sensitive areas;
- a comparative assessment of the layout alternatives provided; and

- addressing any comments or concerns arising from the public participation process.

3 APPOINTMENT

JG Afrika submitted a quotation on the 18th September 2018 to SiVEST and were appointed via email, by SiVEST's Andrea Gibb, on the 11th January 2019.

4 AVAILABLE INFORMATION

SiVEST provided all maps alternatives of all infrastructure proposed in .kml format. The following sources of information were used during the study:

- 1:250 000 scale Geological Map titled 3124 Middleburg published by the Council for Geoscience.
- Engineering Geology of South Africa Volume 4 (Brink, 1985).
- Aerial photography (Google Earth imagery).

5 METHODOLOGY

SiVEST provided the following guidelines / format for assessing the sites and grid infrastructure:

- "Proposed Umsobomvu Solar PV Energy Facilities Comparative Assessment of Alternatives Grid Connection Infrastructure"
- "Updated Environmental Impact Assessment Methodology_Ver1 - 2019 SJ"

Areas with steep slopes and potential talus deposits were identified using available satellite imagery and 20m contour data.

6 SITE LOCATION

Three areas have been identified for the proposed PV facilities namely; Mooi Plaats Solar PV Facility, Wonderheuvel Solar PV Facility and Paarde Valley Solar Facility. These areas lie adjacent to each other, in a north east / south west trending line, and are located approximately 35 km north west of Middelburg and 31 km south west of Noupoort. The entire study area crosses over the Northern Cape / Eastern Cape provincial border. The following location information was provided by SiVEST:

- Mooi Plaats Solar PV Facility, on an application site of approximately 5 303ha, comprising the following farm portions:
  - Portion 1 of Leuwe Kop No 120
  - Remainder of Mooi Plaats No 121

- Wonderheuvel Solar PV Facility, on an application site of approximately 5 652ha, comprising the following farm portions:
  - Remainder of Mooi Plaats No 121
  - Portion 3 of Wonder Heuvel No 140
  - Portion 5 of Holle Fountain No 133

- Paarde Valley Solar PV Facility, on an application site of approximately 2 631ha, comprising the following farm portion:
  - Portion 2 of Paarde Valley No 62

Note that the Remainder of Mooi Plaats No 121 forms part of both the Mooi Plaats Solar PV Facility and Wonderheuvel Solar PV Facility i.e., there is overlap between these sites.

A regional locality map is provided in Figure 1 and locality maps showing the locations of the proposed PV facilities with corresponding corridor options are provided in Figures 2 to 4.

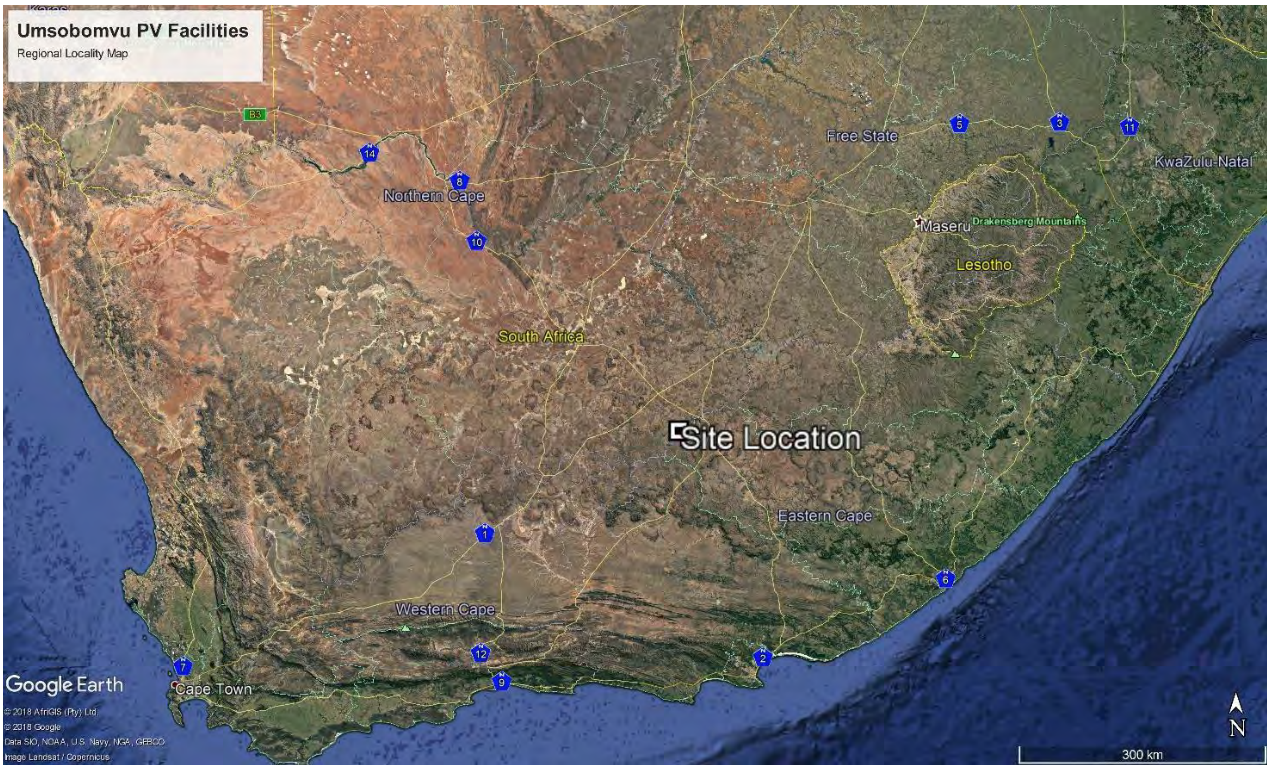

Figure 1 Regional Location Map (Google Earth)

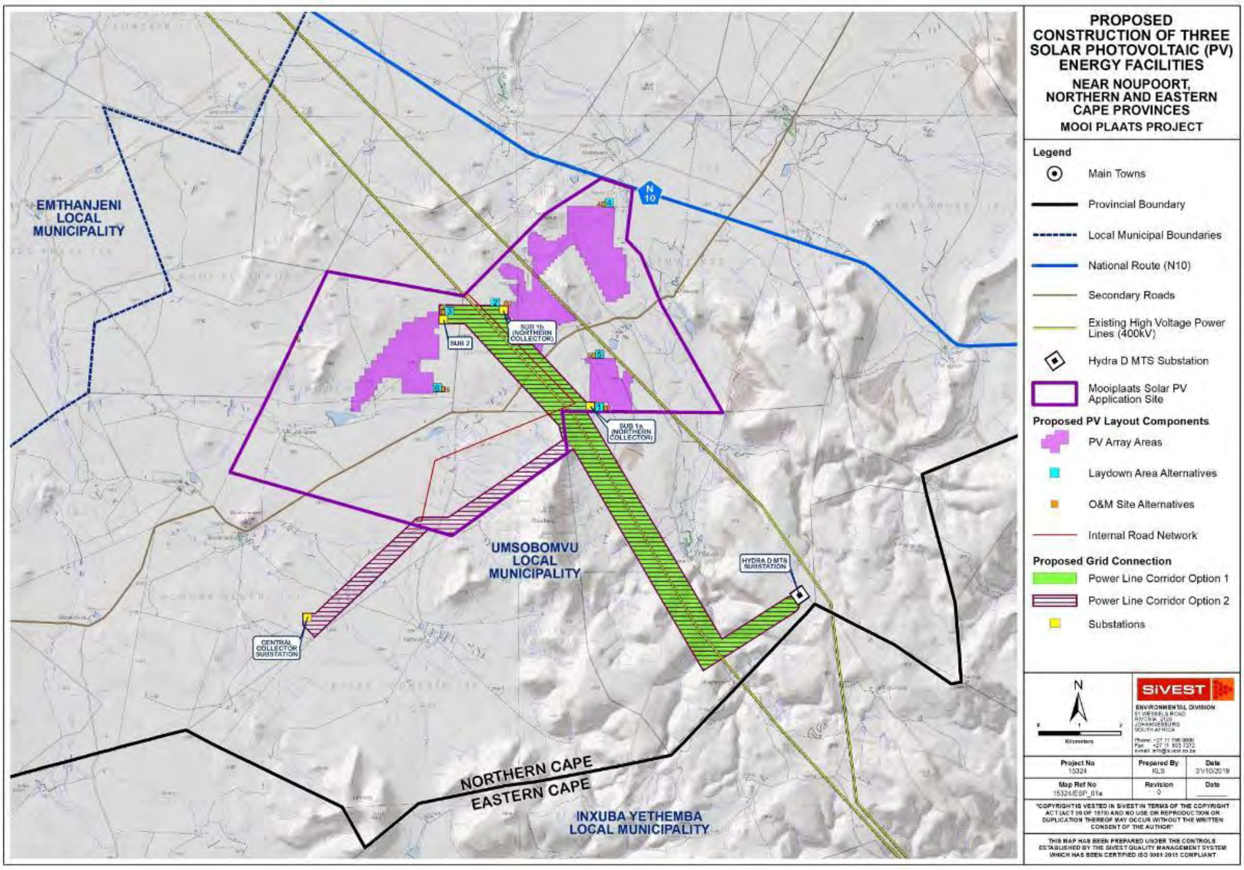

Figure 2 Mooi Plaats PV Facility Locality Map (as provided by SiVEST)

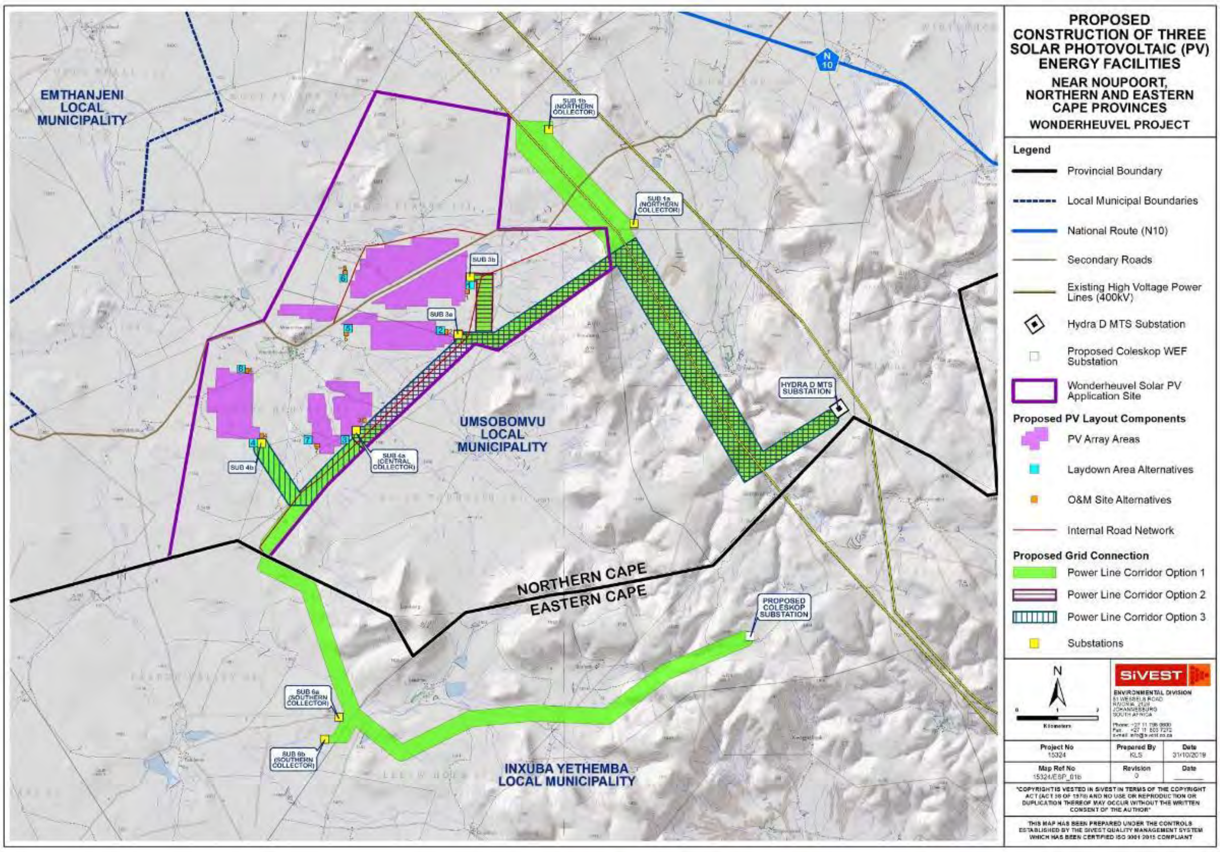

Figure 3 Wonderheuvel PV Facility Locality Map (as provided by SiVEST)

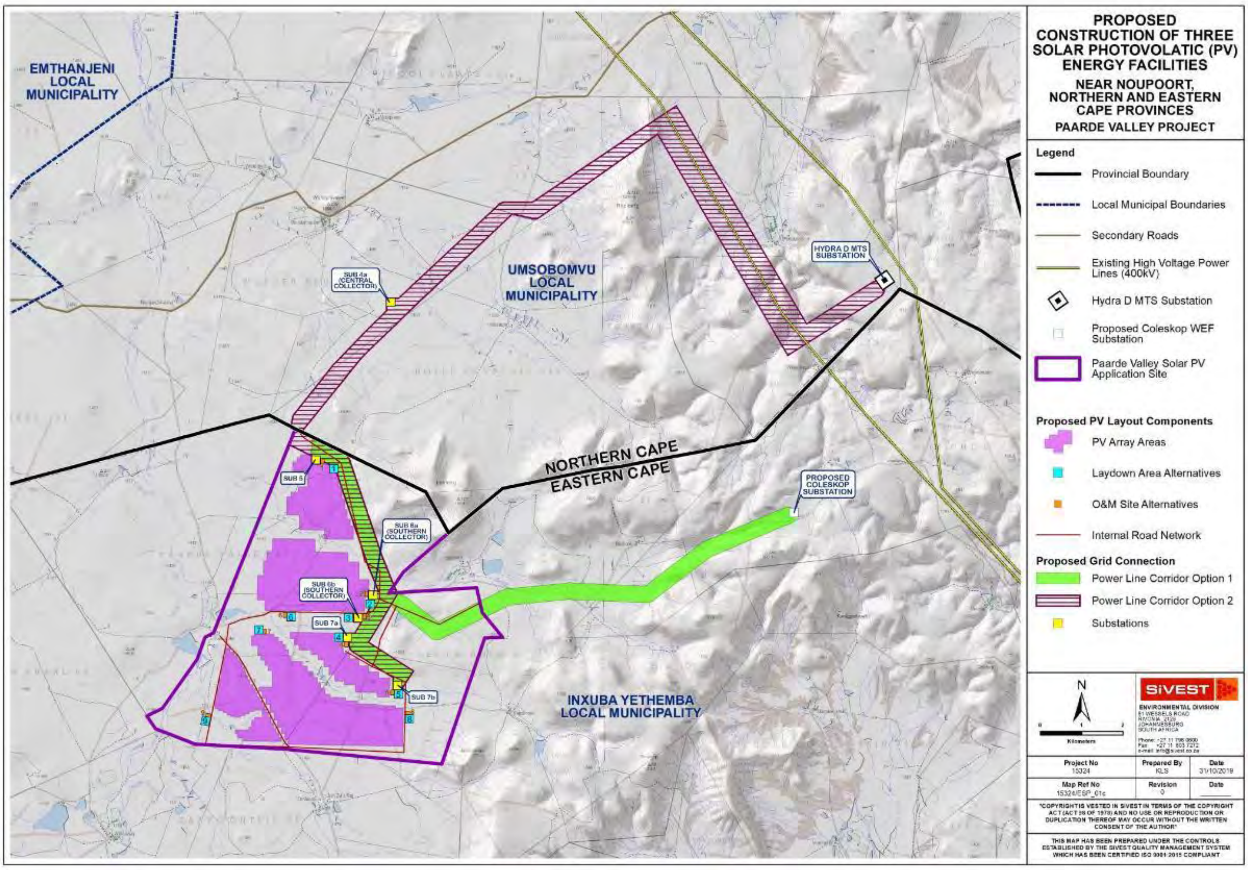

Figure 4 Paarde Valley PV Facility Locality Map (as provided by SiVEST) Site Conditions

6.1 Geology

According to the 1:250 000 series Geological Map 3124 Middelburg, the entire study area is predominantly underlain by sedimentary rock units of the Adelaide Subgroup and the Katberg Formation (which forms part of the Tarkastad Subgroup). The Adelaide Subgroup is overlain by the Tarkastad Subgroup. Together these Subgroups make up the Beaufort Group, which forms part of the Karoo Supergroup. The sedimentary rocks are often intruded by volcanic rocks - dolerite, of the Jurassic age. In addition to the above rock types, the study area is also underlain by scattered quaternary deposits associated with valley lines and lower lying areas.

The geology and stratigraphy of the site is given in Table 1 below.

Table 1 Geology and Stratigraphy of the site

Stratigraphy	Map Symbol	Lithology
Quaternary		Alluvium, Colluvium
Quaternary	**Qc**	Calcrete
Jurassic	**Jd**	Dolerite
Katberg Formation, Tarkastad Subgroup, Beaufort Group, Karoo Supergroup	**Rk**	Sandstone, Mudrock
Adelaide Subgroup, Beaufort Group, Karoo Supergroup	**Pa**	Mudrock, subordinate sandstone

The geological map of the study area is depicted in Figure 5 overleaf.

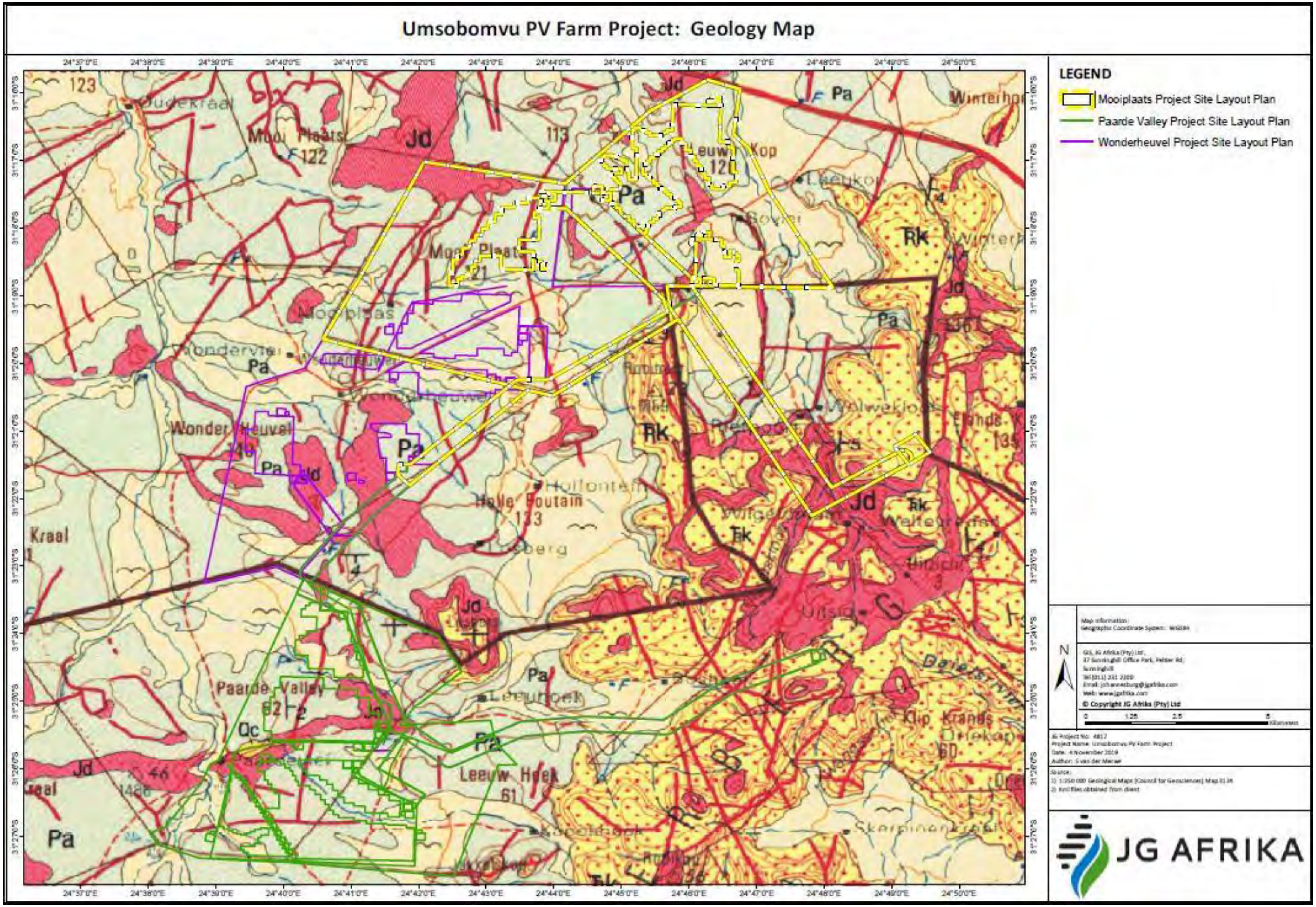

Figure 5 Geology Map

6.2 Topography and Drainage

From satellite imagery, it is observed that all three sites exhibit similar topography. The general topography of area is gentle with localised undulations, hills and occasional koppies. There are scattered hilly/mountainous regions with steep slopes in the study area. Brink (1979) mentions 4 slope elements on concave slopes namely; crest, free face, talus and foot slope. Talus deposits are a type of colluvial deposits that accumulate on talus element of slopes. Numerous rock outcrops and potential talus deposits were identified and highlighted in red in Figures 6 - 8.

Various localised drainage features are to be expected given the undulating nature of the topography. The topographical and drainage features will need to be confirmed by site investigation.

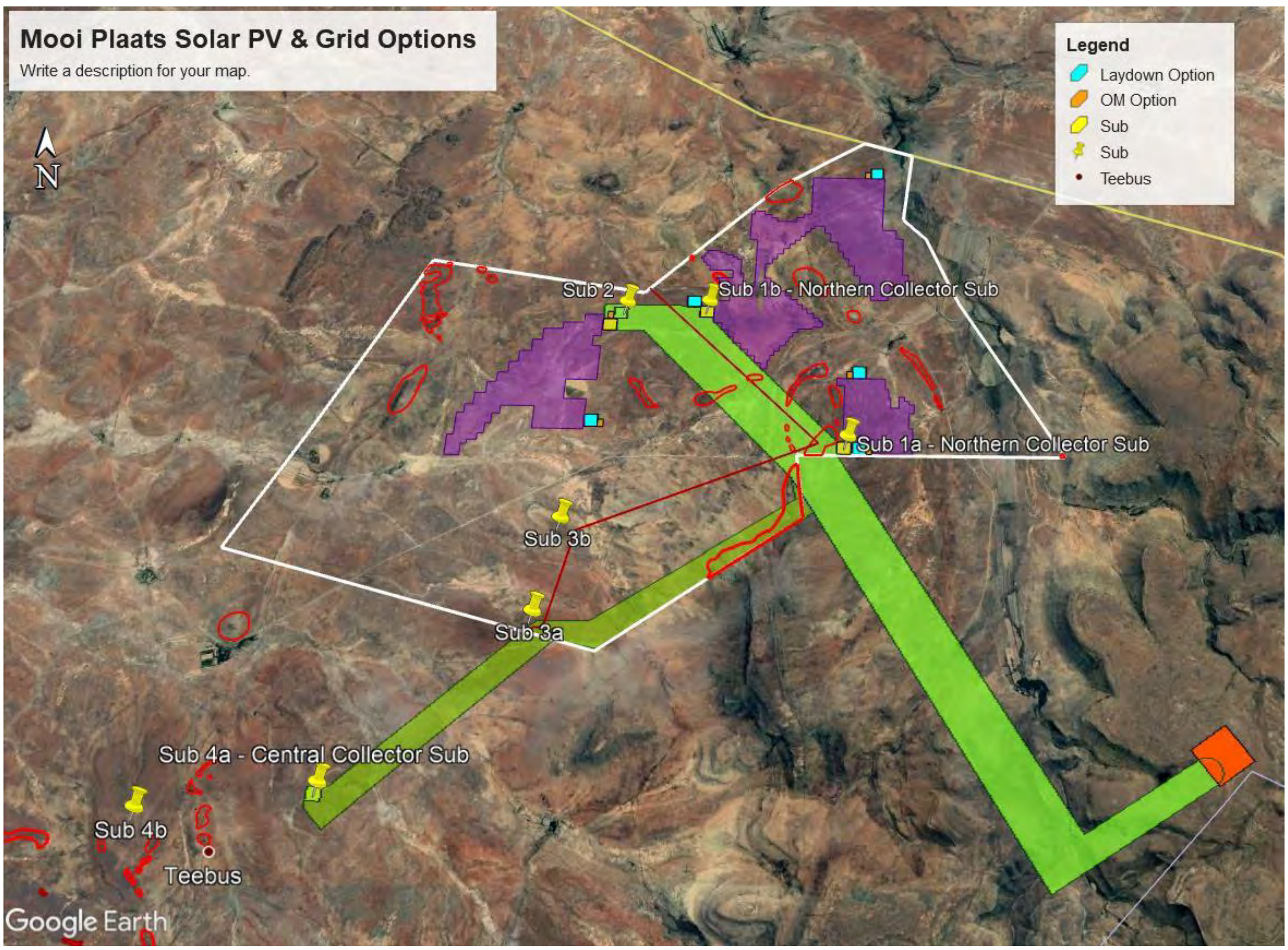

Figure 6 Mooi Plaats PV Facility and Grid Options Rock Outcrops and Talus Slopes (in red)

6.2.1 Mooi Plaats PV Facility

The topography is generally mildly undulating, with a few isolated ridges and koppies. There are numerous scattered rock outcrops. Talus deposits can be anticipated on the slopes of ridges and koppies. A water point/spring (with small reservoir) was identified in the north eastern section of the study area. A prominent drainage feature / river (approximately east-west trending) was identified in the central region of the site. Another drainage feature borders the eastern boundary of the site.

6.2.1.1 Mooi Plaats Grid Option 1

- **Corridor Option 1a -** links Substation 2 and Substation 1a to the Hydra D MTS.
- **Corridor Option 1b -** links Substation 2 and Substation 1b to the Hydra D MTS.

The northern section of the corridor has generally mildly undulating topography with a few isolated ridges. Talus deposits can be anticipated on the slopes of ridges and koppies (see red outlined areas).

The southern portion of the corridor traverses a number of drainage features as it moves into a hilly / mountainous region in the south. Thereafter it is making a turn to the north east and crosses a prominent drainage feature before meeting the Hydra D substation.

6.2.1.2 Mooi Plaats Grid Option 2

- **Corridor Option 2a -** links Substation 2 and Substation 1a to the Hydra D MTS via the proposed Central Collector substation located on the Wonderheuvel PV project application site.
- **Corridor Option 2b -** links Substation 2 and Substation 1b to the Hydra D MTS via the proposed Central Collector substation located on the Wonderheuvel PV project application site.

This Option 2 is longer than Option 1. The northern and southern sections of the Option 2 corridor overlap or runs parallel to a large extent to sections of Option 1. Therefore, in the north, the topography is generally mildly undulating topography with a few isolated ridges. Talus deposits can be anticipated on the slopes of ridges and koppies (see red outlined areas). In the south the corridor traverses several drainage features as it moves into a hilly / mountainous region in the south. Thereafter it is making a turn to the east via central collector substation before meeting the Hydra D substation.

The topography is mildly undulating, except for a ridge roughly in the middle of the section (see red outlines on Figure 6).

6.2.2 Wonderheuvel PV Facility and Grid Infrastructure

The topography is generally mildly undulating with a few localised ridges and koppies scattered across the site. There are a number of scattered outcrops/boulders across the site (especially in the north western corner of the site). A hilly/ mountainous region was identified in the north eastern section of the site. A prominent ridge was also identified in the north western section of the site. Steep slopes and talus may be expected in these areas. Prominent drainage features / rivers were identified in the central and northern region of the site.

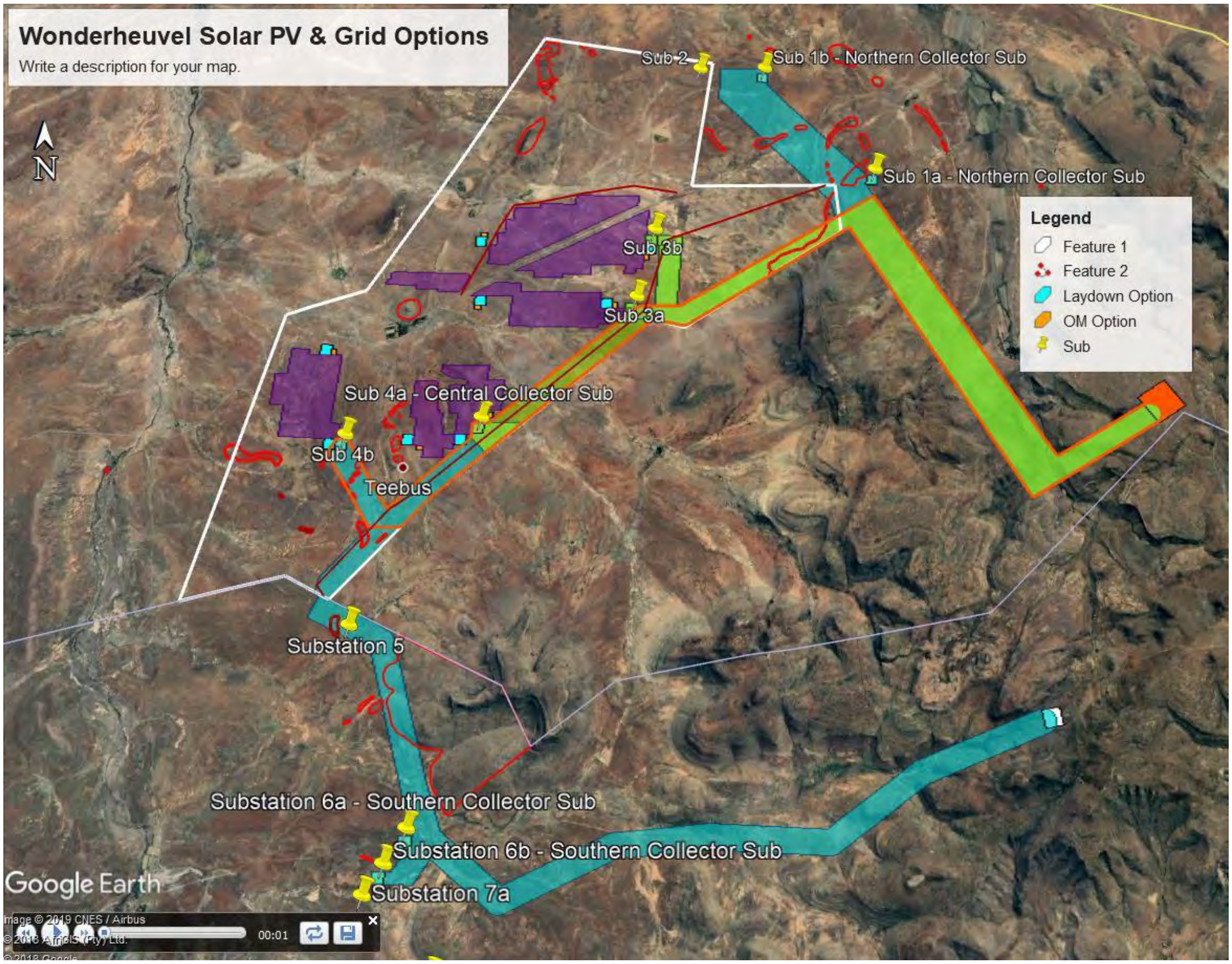

Figure 7 Wonderheuvel PV Facility and Grid Options Rock Outcrops and Talus Slopes (in red)

6.2.2.1 Wonderheuvel Grid Option 1

- **Corridor Option 1a** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  - i. The *northern connection* links the Proposed Substation 3a to the Hydra D MTS via the proposed Northern Collector Substation located on the Mooi Plaats PV project application site.

ii. The *southern connection* links the proposed Substation 4a to the Coleskop WEF Substation via the proposed Southern Collector Substation located on the Paarde Valley PV Project application site.

- **Corridor Option 1b** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern* connection links the Proposed Substation 3a to the Hydra D MTS via the proposed Northern Collector Substation located on the Mooi Plaats PV project application site.
  ii. The *southern connection* links the proposed Substation 4b to the Coleskop WEF Substation via the proposed Southern Collector Substation located on the Paarde Valley PV Project application site.

- **Corridor Option 1c** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern* connection links the Proposed Substation 3b to the Hydra D MTS via the proposed Northern Collector Substation located on the Mooi Plaats PV project application site.
  ii. The *southern connection* links the proposed Substation 4a to the Coleskop WEF Substation via the proposed Southern Collector Substation located on the Paarde Valley PV Project application site.

- **Corridor Option 1d** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  i. The *northern connection* links the Proposed Substation 3b to Hydra D MTS via the proposed Northern Collector Substation located on the Mooi Plaats PV project application site.
  ii. The *southern connection* links the proposed Substation 4b to the Coleskop WEF Substation via the proposed Southern Collector Substation located on the Paarde Valley PV Project application site.

All grid Option 1 consists of two limbs a northern and a southern limb, with minor variations. The northern limb has predominantly mildly undulating topography with a few isolated ridges and koppies and drainage valleys especially in the north. Towards the south, the corridor traverses over a prominent drainage feature before it moves into a mountainous/hilly region, towards the Hydra D substation.

The southern limb of the corridor has very similar topography in the west i.e. mildly undulating with a few isolated ridges. Moving east, the corridor tends to follow existing valley lines with steep side slopes before it climbs to the Coleskop Substation. Talus deposits may be expected in this region. The extreme eastern section, close to the Coleskop Substation, traverses a hilly/mountainous region. Steep slopes and talus deposits may be expected.

6.2.2.2 Wonderheuvel Grid Option 2

- **Corridor Option 2a** - links Substation 3a to the Hydra D MTS via the proposed Central Collector Substation.
- **Corridor Option 2b** - Option 2b links Substation 3b to Hydra D MTS via the proposed Central Collector Substation.

All corridor Option 2 are shorter and follow similar paths with generally minor variations. The topography is predominantly mildly undulating with a few isolated ridges and koppies and drainage valleys towards the north. Towards the south, the corridor traverses over a prominent drainage feature before it moves into a mountainous/hilly region, towards the Hydra D substation.

6.2.2.3 Wonderheuvel Grid Option 3

- **Corridor Option 3** links Substation 4b to Hydra D MTS via the proposed Central Collector Substation.

Corridor Option 3 consists of a slightly longer limb than grid Option 2 and follow similar topography as grid Option 2.

6.2.3 Paarde Valley PV Facility and Grid Infrastructure

The topography is generally mildly undulating with a few localised ridges and koppies scattered across the site. There are a number of scattered outcrops/boulders across the site. The north eastern section of the site is situated on a hilly/mountainous zone with steep slopes. There could potentially be talus deposits in this hilly region.

There are a number of drainage features in the southern, central and north eastern regions of the site. A prominent river channel runs parallel to the south western border of the proposed site. The site may be located in or in close proximity to the river flood plains. An approximately east-west trending stream/small river was identified in the northern region of the study area.

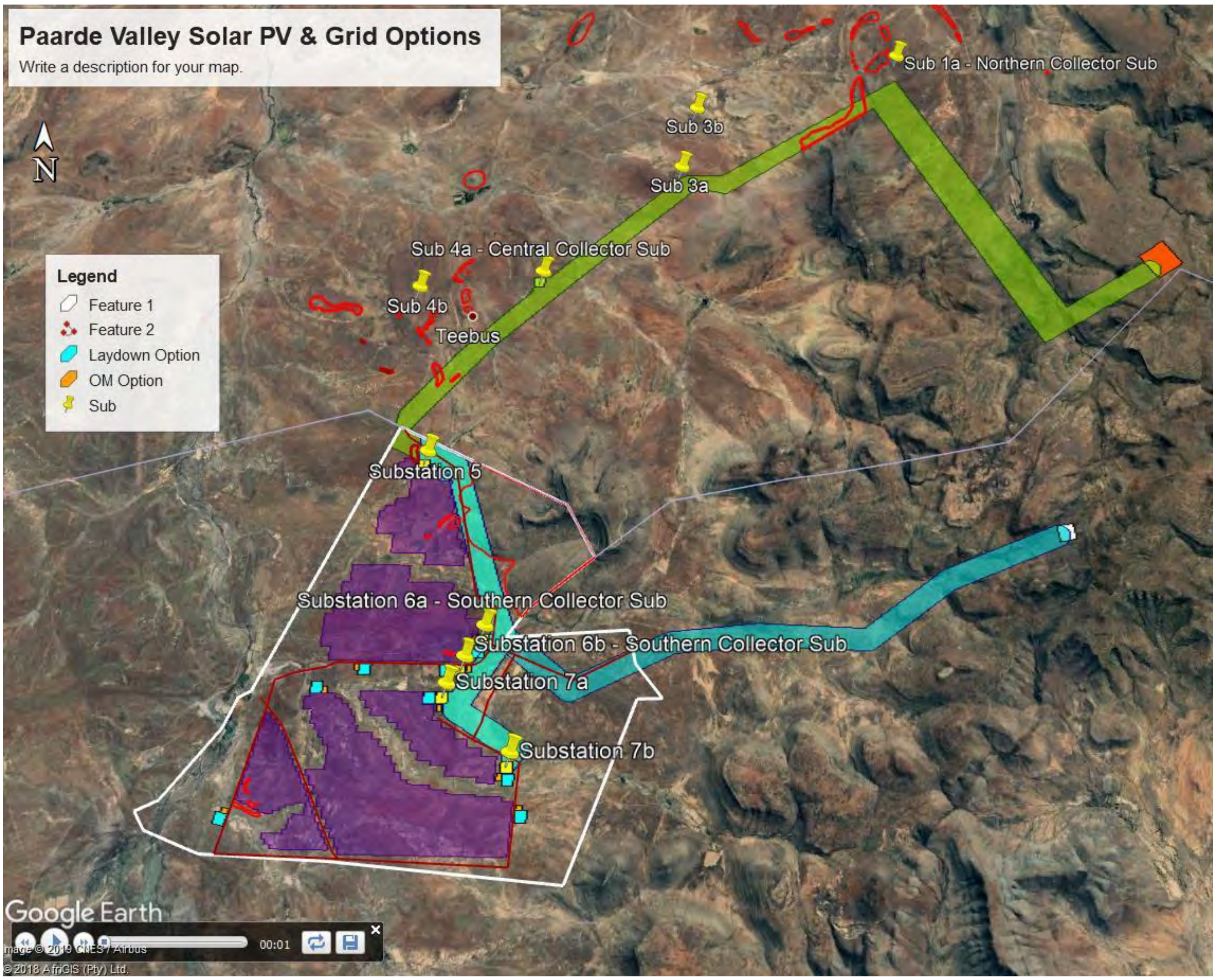

Figure 8 Paarde Valley PV Facility and Grid Options Rock Outcrops and Talus Slopes (in red)

6.2.3.1 Paarde Valley Grid Option 1

a. Corridor **Option 1a** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
   i. The *northern connection* links **Substation 5** to Coleskop Substation via the proposed Southern Collector Sub (Substation 6a will act as Central Collector for this option).
   ii. The *southern connection* links **Substation 7a** to the Coleskop Substation via the proposed Southern Collector Substation (Substation 6a will act as Southern Collector for this option).

b. Corridor **Option 1b** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
   i. The *northern connection* links **Substation 5** to Coleskop Substation via the proposed Southern Collector Sub (Substation 6b will act as Southern Collector for this option).
   ii. The *southern connection* links **Substation 7a** to the Coleskop Substation via the proposed Southern Collector Substation (Substation 6b will act as Southern Collector for this option).

c. Corridor **Option 1c** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
   i. The *northern connection* links **Substation 5** to Coleskop Substation via the proposed Southern Collector Sub (Substation 6a will act as Southern Collector for this option).
   ii. The *southern connection* links **Substation 7b** to the Coleskop Substation via the proposed Southern Collector Substation (Substation 6a will act as Southern Collector for this option).

d. Corridor **Option 1d** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
   i. The *northern connection* links **Substation 5** to Coleskop Substation via the proposed Southern Collector Sub (Substation 6b will act as Southern Collector for this option).
   ii. The *southern connection* links **Substation 7b** to the Coleskop Substation via the proposed Southern Collector Substation (Substation 6b will act as Southern Collector for this option).

All corridor Options 1 are fairly similar from a geotechnical perspective. The extreme western portion of the Option 1 corridor has mildly undulating topography with a few isolated ridges. Moving east, the corridor traverses and then runs parallel to a stream/ small river. The extreme eastern section, close to the Coleskop Substation, traverses a hilly/mountainous region. Steep upslopes and talus deposits may be expected.

6.2.3.2 Paarde Valley Grid Option 2

a. Corridor **Option 2a** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
   iii. The *northern connection* links **Substation 5** to Hydra D MTS via the proposed Central Collector Sub (<u>substation 4a acts as Central Collector)</u> located on the Wonderveuvel PV Project application site.
   iv. The *southern connection* links **Substation 6a and 7a** to the Hydra D MTS via the proposed Central Collector Substation (<u>substation 4a acts as Central Collector</u>) located on the Wonderheuvel PV Project application site.

b. Corridor **Option 2b** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
   v. The *northern connection* links **Substation 5** to Hydra D MTS via the proposed Central Collector Sub (<u>substation 4a acts as Central Collector</u>) located on the Wonderheuvel PV Project application site.
   vi. The *southern connection* links **Substation 6b and 7b** to the Hydra D MTS via the proposed Central Collector Substation (<u>substation 4a acts as Central Collector</u>) located on the Wonderheuvel PV Project application site.

c. Corridor **Option 2c** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
   vii. The *northern connection* links **Substation 5** to Hydra D MTS via the proposed Central Collector Sub (<u>substation 4a acts as Central Collector</u>) located on the Wonderheuvel PV Project application site.
   viii. The *southern connection* links **Substation 6a and 7b** to the Hydra D MTS via the proposed Central Collector Substation (<u>substation 4a acts as Central Collector</u>) located on the Wonderheuvel PV Project application site.

d. Corridor **Option 2d** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
   ix. The *northern connection* links **Substation 5** to Hydra D MTS via the proposed Central Collector Sub (<u>substation 4a acts as Central Collector</u>) located on the Wonderheuvel PV Project application site.
   x. The *southern connection* links **Substation 6b and 7a** to the Hydra D MTS via the proposed Central Collector Substation (<u>substation 4a acts as Central Collector</u>) located on the Wonderheuvel PV Project application site.

All Corridor Options 2 are fairly similar form a geotechnical perspective although they all seem to be longer than the corridor Options 1. They run in a north easterly direction with predominantly mildly undulating topography with a few isolated ridges and koppies. Boulders and/or a possible rock outcrop were identified in the southern/central region of the corridor. The corridor route traverses a hilly / mountainous region in the northern section with a steep valley, just before the route makes a turn to the south east. Steep slopes and talus deposits may be expected in this mountainous region. The eastern/south eastern portion of the corridor, before it meets the Hydra D substation, has a steep hilly/mountainous topography with incised valleys. Steep slopes and talus deposits may be expected in this region. The grid Option 2 traverses a number of drainage features in the southern, central and northern sections.

6.3 Climate

The climatic regime plays a fundamental role in the development of a soil profile. Weinert (1964) demonstrated that mechanical disintegration is the predominant mode of rock weathering in areas where his climatic "N-value" is greater than 5, while chemical decomposition predominates where the N-value is less than 5. Weinert's climatic N-value for the site ranges between 5 – 10. This implies that mechanical disintegration is the dominant mode of weathering at the site.

6.4 Geotechnical Characteristics and Potential Constraints

From the 1:250 000 Geology map, the following near surface conditions may be encountered on site:

6.4.1 Beaufort Group

The Beaufort Group, which forms part of the Karoo Supergroup, is represented by the Adelaide Subgroup across all six sites. As mentioned above, the Adelaide Formation is comprised of mud stone with subordinate sandstone. The geotechnical characteristics of these rock types are discussed below:

6.4.2 Sandstone

The sandstones of the Karoo Supergroup are closely intercalated with mudrock. The sandstones usually poorly sorted (often containing rock fragments) and have a matrix comprised of clay or iron oxide, and occasionally calcite.

Due to the local climatic conditions, mechanical disintegration is the predominate form of weathering. This typically results in the formation of a relatively thin residual soil mantle overlying the bedrock.

Brink (1983) highlights this variability in the Beaufort Group, where similarly aged thick quartz rich (more resistant to weathering) sandstones are found adjacent to thin, poorly sorted sandstone.

Karoo Sandstone is also noted for have a non-uniform weathering pattern. Dense competent layers are sometimes underlain by less competent layers of lower consistency, therefore, founding conditions in feldspathic sandstones may not always improve with depth (Brink, 1983).

Slope instability may also be encountered in the Karoo sandstones. Brink (1983) notes four main instability types namely; Disintegration of intercalated mudrock, Pore water pressures on intercalated siltstone, Erosion of underlying strata and Block and wedge failures. Slope instability will be assessed during the detailed site investigation however, weathering and erosion of the intercalated mudstone and block/wedge failures are anticipated be the primary instability types.

6.4.3 Mudrock

The mudrocks of the Karoo Supergroup are known to break down upon exposure. The mechanisms of breakdown are still unclear, however changes in temperature, humidity, moisture content and stress relief are believed to be possible causes. Three main responses to the breakdown are highlighted by Brink (1983) namely; very little break down of the rock, disintegration of the rock into pieces of various sizes and shapes and lastly, slaking into silt and clay sized particles.

Brink (1983) also noted moisture content related volumetric changes in the Karoo mudrock. Fresh mudrock samples from the Beaufort group were observed to swell upon exposure to water. This property should be considered when founding any structures in or in close proximity to flood plains.

Slope instability may also be encountered in the Karoo mudrock. Brink (1983) highlight two main types of instability namely: the movement of completely weathered / colluvial material and the sliding of rock on bedding planes. Although these instability events were predominantly noted in Kwa Zulu Natal, care should be taken when working with cuttings and long / deep excavations. As mentioned above, mudrock is closely intercalated with sandstone. Undercutting of more weathering resistant sandstone may also occur, which could cause slope instability.

Due to the dry climate, a deep weathering profile/thick residual soils are not expected on site. Residual mudrock soils are also known to be potentially expansive and laboratory tests will need to be undertaken to confirm this.

6.4.4 Dolerite

The Karoo Supergroup contains many Jurassic aged dolerite intrusions. The magma predominantly intruded into the weaker argillaceous horizons in the form of sills and occasionally dykes (Brink, 1983).

Fresh/solid dolerite typically forms boulder/fractured dolerite during the initial stages of weathering. Due to mechanical breakdown being the predominate form of weathering in this region, further weathering results in the formation of gravel and/or granular dolerite with sandy soils (Brink, 1983).

Founding conditions on residual dolerite are generally non-problematic in areas with a dry climate. Care should be taken in areas with calcrete, as calcrete powder has being noted to increase the Plasticity Index of the residual dolerite (Brink, 1983).

Dolerite boulders will cause difficult excavation conditions due to their size and scattered occurrences. Hard excavation conditions are also expected in areas with shallow bedrock. Additional site clearing may be required to remove boulders from potential development sites. Potentially unstable talus deposits formed from dolerite corestones may be encountered on slopes.

Weathered dolerite may be targeted for use during construction of internal roads etc. The identification of potential borrow pits and the usage of the dolerite for construction material will need to be confirmed during a more comprehensive site investigation with laboratory testing.

Figure 9 Dolerite weathering profile with corestones and surface boulders (N10 near the Mooi Plaats site – Google Earth)

Figure 10 Dolerite profile with boulders on the surface (N10 near the Mooi Plaats site – Google Earth)

Figure 11 Dolerite Ridge with Boulders on surface (N10 near the Mooi Plaats site– Google Earth)

6.4.5 Quaternary Deposits

6.4.5.1 Alluvium / Colluvium/Talus

Alluvial deposits are created when sediments are transported and deposited by water. Alluvial deposits may be quite thick, variable in composition and be prone to settlement.

Colluvial deposits are created when sediments are transported and deposited by gravity. As mentioned above, talus deposits are a type of colluvial deposits that accumulate on talus element of slopes Talus deposits generally occur where there are steep slopes below a stronger caprock. The caprock on this site is expected to be dolerite and/or sandstone. Talus deposits accumulate at their natural angle of repose and the upper part of talus slopes have a factor of safety that is close to 1.0. Due to weathering and colluvial action, talus deposits are generally poorly sorted, with large/coarse particles occurring with a finer matrix. The finer matrix has less strength than the surrounding unweathered rock fragments/debris, therefore the properties of this matrix influence the stability of the slope. With time, deterioration and weathering of the talus deposits results in instability. In addition to potential slope instability, difficult excavation conditions may be expected due to the large unweathered boulders.

6.4.5.2 Calcrete

According to the geology map, calcrete underlies a small portion of the proposed Paarde Valley PV facility and the associated grid options.

Calcrete is a deposit formed when soils have been cemented and/or replaced by carbonates. Calcretes are either formed by percolating groundwater or by pedogenic methods. Calcrete deposits may have thicknesses of over 30 m, however they are usually not continuous over depths exceeding 1 – 2 m (Brink, 1979).

Caution should be exercised when founding heavy structures on pedocretes (calcrete) as hard calcrete layers may be underlain by less competent material. Calcretes may also be laterally discontinuous over short distances (in occurrence, composition and degree of development/ cementation).

Brink (1979) notes that a collapsible fabric has been suspected in some powder and nodular calcrete and cemented soils. Small scale karst structures and evidence of small sinkholes have also been observed in weathered calcretes.

Hard excavation conditions are expected in well developed, cemented, calcretes.

Calcrete may be used for wearing course and all layers within the road prism for unpaved roads.

7 PRELIMINARY GEOLOGICAL & GEOTECHNICAL IMPACT ASSESSMENT

From a geological / geotechnical perspective, no fatal flaws have been identified that would prevent the construction of the proposed development at this site.

Further intrusive investigation is recommended for detailed design purposes.

7.1 Impact of the Project on the Geological Environment

The impact of the project alternatives on the geological environment will predominantly relate to the impact that the development will have on the soils / rock units beneath the site. Various outcrops/ boulders have been noted across the sites generally associated with ridges. Removal of the boulders (during site clearing) and construction on hilltops and ridge tops, may have a negative (aesthetic / visual) impact on the environment (besides increasing the cost of site preparation in these areas). It is assumed that a visual impact will be undertaken by others.

Both vertebrate and invertebrate fossils have also been found in the Beaufort Group of the Karoo Supergroup. Reptiles, mammal-like reptile (therapsid), amphibian, fish, insect and plant fossils have been discovered (Johnson, 2006). Excavation into the rock and removal of the material will potentially result in damage/destruction of the fossils. The locations of the fossils will have to be determined during an archaeological / palaeontological investigation.

The main potential impact of the project on the geological environment will be the increased ***potential for soil erosion***, caused by the removal of vegetation and the construction activities. Removal of vegetation for terrace preparation and compaction during earthworks will reduce the infiltration of rainwater and therefore increase surface runoff. An increase in runoff will lead to an increase in erosion. Potential impacts of the project on the soils are provided in Sections 7.2 to 7.4 below. The proposed duration of the construction phase was not provided at the time that this report was compiled. For the purpose of the assessment, a construction duration of 1 year was assumed. Please note that the impact rating will change should the construction duration increase. A description of the weighting system and description of terms used is attached in Annexure A.

7.2 Mooi Plaats PV Facility and Grid Infrastructure

The impact of the Mooi Plaats PV facility on the general environment was found to be ***"Low"***. The scoring was based on SiVEST guidelines / format for assessing the sites and grid infrastructure:

- "Updated Environmental Impact Assessment Methodology_Ver1 - 2019 SJ"

Areas with steep slopes associated with slope instability and surface bedrock / boulders associated with ridges, where construction will be difficult, have been outlined in red in Figure 6.

It is our professional opinion that the Mooi Plaats PV Facility project may go ahead, if all mitigation measures given in this report are implemented.

Table 2: MOOI PLAATS SOLAR PV FACILITY & INFRASTRUCTURE IMPACT RATING TABLE

MOOI PLAATS SOLAR PV 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																					
Soils	Soil disturbance during construction at the PV Facility may destabilise the soil and lead to soil erosion. - Increased soil erosion / runoff due to clearing of vegetation - Construction and use of access roads by heavy duty vehicles and construction equipment may destabilise the soil and lead to soil erosion. - There may be spillages (petroleum/lubricants) from the vehicles - There may be siltation of watercourses due to increased runoff and dust	1	4	2	1	1	1	9	-	Low	- Use of berms and drainage channels to direct water away from the construction areas where necessary - Minimise earthworks and levelling - Use existing access roads wherever possible - Rehabilitate disturbed areas as soon as possible after construction - Correct engineering design of stream and water course crossings - Correct engineering design of any new access roads - Maintain vehicles and only undertake repairs and maintenance work in designated areas - Implement groundcover measures to prevent erosion such as keeping as much natural vegetation as possible, straw mulch, erosion control mats etc. - Contain and control stormwater flow	1	2	1	1	1	1	6	-	Low	
Operational Phase																					
Soils	Increased soil erosion / runoff due to clearing of vegetation and alteration of natural drainage (paved areas) - There may be spillages (petroleum/lubricants) from the vehicles	1	2	1	1	1	1	6	-	Low	- Use existing access roads wherever possible - Correct engineering design of stream and water course crossings - Correct engineering design of access roads - Maintain vehicles and only undertake repairs and maintenance work in designated areas - Implement groundcover measures to prevent erosion such as keeping as much natural vegetation as possible, straw mulch, erosion control mats etc. - Contain and control stormwater flow	1	2	1	1	1	1	6	-	Low	
Decommissioning Phase																					
Soils	Soil disturbance during decommissioning/deconstruction at the PV Facility may destabilise the soil and lead to soil erosion. - Contamination of soil due to chemical spillages from equipment - Construction and use of access roads by heavy duty vehicles and construction equipment may destabilise the soil and lead to soil erosion. - There may be spillages (petroleum/lubricants) from the vehicles - There may be siltation of watercourses due to increased runoff and dust	1	4	2	1	1	1	9	-	Low	Use of berms and drainage channels to direct water away from the decommissioning/deconstruction areas where necessary - Minimise earthworks and levelling - use existing access roads wherever possible - Rehabilitate disturbed areas as soon as possible - Add as much natural vegetation back as possible - Try reinstate natural drainage patterns - Have chemical spill kits on site and remove all spill material when decommissioning any substations. - Maintain vehicles and only undertake repairs and maintenance work in designated areas - Contain and control stormwater flow	1	2	1	1	1	1	6	-	Low	
Cumulative																					
Soils	No cumulative effect							0			No cumulative effect							0			

Table 3: MOOI PLAATS GRID CONNECTION IMPACT RATING TABLE

MOOI PLAATS GRID CONNECTION INFRASTRUCTURE																					
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																					
Soils	Soil disturbance during construction at the PV Facility may destabilise the soil and lead to soil erosion. - Increased soil erosion / runoff due to clearing of vegetation - Construction and use of access roads by heavy duty vehicles and construction equipment may destabilise the soil and lead to soil erosion. - There may be spillages (petroleum/lubricants) from the vehicles - There may be siltation of watercourses due to increased runoff and dust	1	4	2	1	1	1	9	-	Low	- Use of berms and drainage channels to direct water away from the construction areas where necessary - Minimise earthworks and levelling - Use existing access roads wherever possible - Rehabilitate disturbed areas as soon as possible after construction - Correct engineering design of stream and water course crossings - Correct engineering design of any new access roads - Maintain vehicles and only undertake repairs and maintenance work in designated areas - Implement groundcover measures to prevent erosion such as keeping as much natural vegetation as possible, straw mulch, erosion control mats etc. - Contain and control stormwater flow	1	2	1	1	1	1	6	-	Low
Operational Phase																					
Soils	Increased soil erosion / runoff due to clearing of vegetation and alteration of natural drainage (paved areas) - There may be spillages (petroleum/lubricants) from the vehicles	1	2	1	1	1	1	6	-	Low	- Use existing access roads wherever possible - Correct engineering design of stream and water course crossings - Correct engineering design of access roads - Maintain vehicles and only undertake repairs and maintenance work in designated areas - Implement groundcover measures to prevent erosion such as keeping as much natural vegetation as possible, straw mulch, erosion control mats etc. - Contain and control stormwater flow	1	2	1	1	1	1	6	-	Low
Decommissioning Phase																					
Soils	Soil disturbance during decommissioning/deconstruction at the PV Facility may destabilise the soil and lead to soil erosion. - Contamination of soil due to chemical spillages from equipment - Construction and use of access roads by heavy duty vehicles and construction equipment may destabilise the soil and lead to soil erosion. - There may be spillages (petroleum/lubricants) from the vehicles - There may be siltation of watercourses due to increased runoff and dust	1	4	2	1	1	1	9	-	Low	Use of berms and drainage channels to direct water away from the decommissioning/deconstruction areas where necessary - Minimise earthworks and levelling - use existing access roads wherever possible - Rehabilitate disturbed areas as soon as possible - Add as much natural vegetation back as possible - Try reinstate natural drainage patterns - Have chemical spill kits on site and remove all spill material when decommissioning any substations. - Maintain vehicles and only undertake repairs and maintenance work in designated areas - Contain and control stormwater flow	1	2	1	1	1	1	6	-	Low
Cumulative																					
Soils	No cumulative effect							0			No cumulative effect							0		

7.3 Wonderheuvel PV Facility and Grid Infrastructure

The impact of the Wonderheuvel PV facility and Grid Infrastructure on the general environment was found to be ***"Low"***. The scoring was based on SiVEST guidelines / format for assessing the sites and grid infrastructure:

- "Updated Environmental Impact Assessment Methodology_Ver1 - 2019 SJ"

Areas with steep slopes associated with slope instability and surface bedrock / boulders associated with ridges, where construction will be difficult, have been outlined in red in Figure 7.

It is our professional opinion that the Wonderheuvel PV Facility and Grid Infrastructure project may go ahead, if all mitigation measures given in this report are implemented.

Table 4: WONDERHEUVEL SOLAR PV FACILITY & INFRASTRUCTURE IMPACT RATING TABLE																					
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 (+	S		E	P	R	L	D	I / M	TOTAL	STATUS (+	S
Construction Phase																					
Soils	Soil disturbance during construction at the PV Facility may destabilise the soil and lead to soil erosion. - Increased soil erosion / runoff due to clearing of vegetation - Construction and use of access roads by heavy duty vehicles and construction equipment may destabilise the soil and lead to soil erosion. - There may be spillages (petroleum/lubricants) from the vehicles - There may be siltation of watercourses due to increased runoff and dust	1	4	2	1	1	1	9	-	Low	- Use of berms and drainage channels to direct water away from the construction areas where necessary - Minimise earthworks and levelling - Use existing access roads wherever possible - Rehabilitate disturbed areas as soon as possible after construction - Correct engineering design of stream and water course crossings - Correct engineering design of any new access roads - Maintain vehicles and only undertake repairs and maintenance work in designated areas - Implement groundcover measures to prevent erosion such as keeping as much natural vegetation as possible, straw mulch, erosion control mats etc. - Contain and control stormwater flow	1	2	1	1	1	1	6	-	Low
Operational Phase																					
Soils	Increased soil erosion / runoff due to clearing of vegetation and alteration of natural drainage (paved areas) - There may be spillages (petroleum/lubricants) from the vehicles	1	2	1	1	1	1	6	-	Low	- Use existing access roads wherever possible - Correct engineering design of stream and water course crossings - Correct engineering design of access roads - Maintain vehicles and only undertake repairs and maintenance work in designated areas - Implement groundcover measures to prevent erosion such as keeping as much natural vegetation as possible, straw mulch, erosion control mats etc. - Contain and control stormwater flow	1	2	1	1	1	1	6	-	Low
Decommissioning Phase																					
Soils	Soil disturbance during decommissioning/deconstruction at the PV Facility may destabilise the soil and lead to soil erosion. - Contamination of soil due to chemical spillages from equipment - Construction and use of access roads by heavy duty vehicles and construction equipment may destabilise the soil and lead to soil erosion. - There may be spillages (petroleum/lubricants) from the vehicles - There may be siltation of watercourses due to increased runoff and dust	1	4	2	1	1	1	9	-	Low	Use of berms and drainage channels to direct water away from the decommissioning/deconstruction areas where necessary - Minimise earthworks and levelling - use existing access roads wherever possible - Rehabilitate disturbed areas as soon as possible - Add as much natural vegetation back as possible - Try reinstate natural drainage patterns - Have chemical spill kits on site and remove all spill material when decommissioning any substations. - Maintain vehicles and only undertake repairs and maintenance work in designated areas - Contain and control stormwater flow	1	2	1	1	1	1	6	-	Low
Cumulative																					
Soils	No cumulative effect							0			No cumulative effect							0		

Table 5: WONDERHEUVEL GRID CONNECTION INFRASTRUCTURE IMPACT RATING TABLE																				
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																				
Soils	Soil disturbance during construction at the PV Facility may destabilise the soil and lead to soil erosion. - Increased soil erosion / runoff due to clearing of vegetation - Construction and use of access roads by heavy duty vehicles and construction equipment may destabilise the soil and lead to soil erosion. - There may be spillages (petroleum/lubricants) from the vehicles - There may be siltation of watercourses due to increased runoff and dust	1	4	2	1	1	1	9	-	Low	- Use of berms and drainage channels to direct water away from the construction areas where necessary - Minimise earthworks and levelling - Use existing access roads wherever possible - Rehabilitate disturbed areas as soon as possible after construction - Correct engineering design of stream and water course crossings - Correct engineering design of any new access roads - Maintain vehicles and only undertake repairs and maintenance work in designated areas - Implement groundcover measures to prevent erosion such as keeping as much natural vegetation as possible, straw mulch, erosion control mats etc. - Contain and control stormwater flow	1	2	1	1	1	1	6	-	Low
Operational Phase																				
Soils	Increased soil erosion / runoff due to clearing of vegetation and alteration of natural drainage (paved areas) - There may be spillages (petroleum/lubricants) from the vehicles	1	2	1	1	1	1	6	-	Low	- Use existing access roads wherever possible - Correct engineering design of stream and water course crossings - Correct engineering design of access roads - Maintain vehicles and only undertake repairs and maintenance work in designated areas - Implement groundcover measures to prevent erosion such as keeping as much natural vegetation as possible, straw mulch, erosion control mats etc. - Contain and control stormwater flow	1	2	1	1	1	1	6	-	Low
Decommissioning Phase																				
Soils	Soil disturbance during decommissioning/deconstruction at the PV Facility may destabilise the soil and lead to soil erosion. - Contamination of soil due to chemical spillages from equipment - Construction and use of access roads by heavy duty vehicles and construction equipment may destabilise the soil and lead to soil erosion. - There may be spillages (petroleum/lubricants) from the vehicles - There may be siltation of watercourses due to increased runoff and dust	1	4	2	1	1	1	9	-	Low	Use of berms and drainage channels to direct water away from the decommissioning/deconstruction areas where necessary - Minimise earthworks and levelling - use existing access roads wherever possible - Rehabilitate disturbed areas as soon as possible - Add as much natural vegetation back as possible - Try reinstate natural drainage patterns - Have chemical spill kits on site and remove all spill material when decommissioning any substations. - Maintain vehicles and only undertake repairs and maintenance work in designated areas - Contain and control stormwater flow	1	2	1	1	1	1	6	-	Low
Cumulative																				
Soils	No cumulative effect							0			No cumulative effect							0		

7.4 Paarde Valley PV Facility and Grid Infrastructure

The impact of the Paarde Valley PV facility and Grid Infrastructure on the general environment was found to be ***"Low"***. The scoring was based on SiVEST guidelines / format for assessing the sites and grid infrastructure:

- "Updated Environmental Impact Assessment Methodology_Ver1 - 2019 SJ"

Areas with steep slopes associated with slope instability and surface bedrock / boulders associated with ridges, where construction will be difficult, have been outlined in red in Figure 8.

It is our professional opinion that the Paarde Valley PV Facility project may go ahead, if all mitigation measures given in this report are implemented.

The grid options are discussed separately in Section 9.

Table 6: PAARDE VALLEY SOLAR PV FACILITY & INFRASTRUCTURE IMPACT RATING TABLE

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																				
Soils	Soil disturbance during construction at the PV Facility may destabilise the soil and lead to soil erosion. - Increased soil erosion / runoff due to clearing of vegetation - Construction and use of access roads by heavy duty vehicles and construction equipment may destabilise the soil and lead to soil erosion. - There may be spillages (petroleum/lubricants) from the vehicles - There may be siltation of watercourses due to increased runoff and dust	1	4	2	1	1	1	9	-	Low	- Use of berms and drainage channels to direct water away from the construction areas where necessary - Minimise earthworks and levelling - Use existing access roads wherever possible - Rehabilitate disturbed areas as soon as possible after construction - Correct engineering design of stream and water course crossings - Correct engineering design of any new access roads - Maintain vehicles and only undertake repairs and maintenance work in designated areas - Implement groundcover measures to prevent erosion such as keeping as much natural vegetation as possible, straw mulch, erosion control mats etc. - Contain and control stormwater flow	1	2	1	1	1	1	6	-	Low
Operational Phase																				
Soils	Increased soil erosion / runoff due to clearing of vegetation and alteration of natural drainage (paved areas) - There may be spillages (petroleum/lubricants) from the vehicles	1	2	1	1	1	1	6	-	Low	- Use existing access roads wherever possible - Correct engineering design of stream and water course crossings - Correct engineering design of access roads - Maintain vehicles and only undertake repairs and maintenance work in designated areas - Implement groundcover measures to prevent erosion such as keeping as much natural vegetation as possible, straw mulch, erosion control mats etc. - Contain and control stormwater flow	1	2	1	1	1	1	6	-	Low
Decommissioning Phase																				
Soils	Soil disturbance during decommissioning/deconstruction at the PV Facility may destabilise the soil and lead to soil erosion. - Contamination of soil due to chemical spillages from equipment - Construction and use of access roads by heavy duty vehicles and construction equipment may destabilise the soil and lead to soil erosion. - There may be spillages (petroleum/lubricants) from the vehicles - There may be siltation of watercourses due to increased runoff and dust	1	4	2	1	1	1	9	-	Low	Use of berms and drainage channels to direct water away from the decommissioning/deconstruction areas where necessary - Minimise earthworks and levelling - use existing access roads wherever possible - Rehabilitate disturbed areas as soon as possible - Add as much natural vegetation back as possible - Try reinstate natural drainage patterns - Have chemical spill kits on site and remove all spill material when decommissioning any substations. - Maintain vehicles and only undertake repairs and maintenance work in designated areas - Contain and control stormwater flow	1	2	1	1	1	1	6	-	Low
Cumulative																				
Soils	No cumulative effect							0			No cumulative effect							0		

Table 7: PAARDE GRID CONNECTION INFRASTRUCTURE IMPACT RATING TABLE

Table 7: PAARDE VALLEY GRID CONNECTION INFRASTRUCTURE																					
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 (+ O	S		E	P	R	L	D	I / M	TOTAL	STATUS (+ O	S	
Construction Phase																					
Soils	Soil disturbance during construction at the PV Facility may destabilise the soil and lead to soil erosion. - Increased soil erosion / runoff due to clearing of vegetation - Construction and use of access roads by heavy duty vehicles and construction equipment may destabilise the soil and lead to soil erosion. - There may be spillages (petroleum/lubricants) from the vehicles - There may be siltation of watercourses due to increased runoff and dust	1	4	2	1	1	1	9	-	Low	- Use of berms and drainage channels to direct water away from the construction areas where necessary - Minimise earthworks and levelling - Use existing access roads wherever possible - Rehabilitate disturbed areas as soon as possible after construction - Correct engineering design of stream and water course crossings - Correct engineering design of any new access roads - Maintain vehicles and only undertake repairs and maintenance work in designated areas - Implement groundcover measures to prevent erosion such as keeping as much natural vegetation as possible, straw mulch, erosion control mats etc. - Contain and control stormwater flow	1	2	1	1	1	1	6	-	Low	
Operational Phase																					
Soils	Increased soil erosion / runoff due to clearing of vegetation and alteration of natural drainage (paved areas) - There may be spillages (petroleum/lubricants) from the vehicles	1	2	1	1	1	1	6	-	Low	- Use existing access roads wherever possible - Correct engineering design of stream and water course crossings - Correct engineering design of access roads - Maintain vehicles and only undertake repairs and maintenance work in designated areas - Implement groundcover measures to prevent erosion such as keeping as much natural vegetation as possible, straw mulch, erosion control mats etc. - Contain and control stormwater flow	1	2	1	1	1	1	6	-	Low	
Decommissioning Phase																					
Soils	Soil disturbance during decommissioning/deconstruction at the PV Facility may destabilise the soil and lead to soil erosion. - Contamination of soil due to chemical spillages from equipment - Construction and use of access roads by heavy duty vehicles and construction equipment may destabilise the soil and lead to soil erosion. - There may be spillages (petroleum/lubricants) from the vehicles - There may be siltation of watercourses due to increased runoff and dust	1	4	2	1	1	1	9	-	Low	Use of berms and drainage channels to direct water away from the decommissioning/deconstruction areas where necessary - Minimise earthworks and levelling - use existing access roads wherever possible - Rehabilitate disturbed areas as soon as possible - Add as much natural vegetation back as possible - Try reinstate natural drainage patterns - Have chemical spill kits on site and remove all spill material when decommissioning any substations. - Maintain vehicles and only undertake repairs and maintenance work in designated areas - Contain and control stormwater flow	1	2	1	1	1	1	6	-	Low	
Cumulative																					
Soils	No cumulative effect							0			No cumulative effect							0			

8 COMPARATIVE ASSESSMENT OF ALTERNATIVES GRID CONNECTIONS

A comparative assessment of the PV Infrastructure Alternatives as well as alternative grid connections is given in Tables 8 and 9 below.

Construction over mountainous and steep/hilly areas has a higher risk of causing erosion than construction over flatter areas (roads in steep areas are more prone to erosion and require longer routes to be constructed, not just straight roads along the route). Longer routes will have a greater impact on the soils, as there will be a greater area affected by the construction activities, greater distance for vehicles to travel, etc.

Construction on, or in close proximity to mountainous and steep/hilly areas, has a higher risk of slope instability. Loose/unstable talus deposits are expected to be present in these areas. Mitigation measures, to allow construction in these areas, will increase the construction costs.

Therefore, from a geological and geotechnical perspective the following corridor options are preferred:

- Mooi Plaats PV Facility – Option1
- Wonderheuven PV Facility – Options 2 and 3
- Paarde Valley PV Facility – Option 1

Table8: PV Infrastructure Alternatives (Laydown Areas & O&M Buildings); Power Line Corridors and Associated Substations)

Key

PREFERRED	The alternative will result in a low impact / reduce the impact
FAVOURABLE	The impact will be relatively insignificant
LEAST PREFERRED	The alternative will result in a high impact / increase the impact
NO PREFERENCE	The alternative will result in equal impacts

PV INFRASTRUCTURE ALTERNATIVES (LAYDOWN AREAS AND O&M BUILDINGS)	Preference	Reasons (incl. potential issues)
MOOI PLAATS SOLAR PV FACILITY:		
Laydown Area and O&M Building Site Option 1	No preference	The geology is the same at all 6 site options: mudrock and sandstone of Adelaide Formation. Hence there is no preference.
Laydown Area and O&M Building Site Option 2	No preference	
Laydown Area and O&M Building Site Option 3	No preference	

PV INFRASTRUCTURE ALTERNATIVES (LAYDOWN AREAS AND O&M BUILDINGS)	Preference	Reasons (incl. potential issues)
Laydown Area and O&M Building Site Option 4	No preference	
Laydown Area and O&M Building Site Option 5	No preference	
Laydown Area and O&M Building Site Option 6	No preference	
WONDERHEUVEL SOLAR PV FACILITY:		
Laydown Area and O&M Building Site Option 1	Favourable	The geology is comprised of quaternary unconsolidated sands; sands could be of significant thickness and founding conditions could be adverse.
Laydown Area and O&M Building Site Option 2	Favourable	The geology is comprised of quaternary unconsolidated sands; sands could be of significant thickness and founding conditions could be adverse.
Laydown Area and O&M Building Site Option 3	Preferred	The geology is comprised of mudrock and sandstone of Adelaide Formation
Laydown Area and O&M Building Site Option 4	Preferred	The geology is comprised of mudrock and sandstone of Adelaide Formation
Laydown Area and O&M Building Site Option 5	Favourable	The geology is comprised of quaternary unconsolidated sands; sands could be of significant thickness and founding conditions could be adverse.
Laydown Area and O&M Building Site Option 6	Preferred	The geology is comprised of mudrock and sandstone of Adelaide Formation
Laydown Area and O&M Building Site Option 7	Preferred	The geology is comprised of mudrock and sandstone of Adelaide Formation
Laydown Area and O&M Building Site Option 8	Preferred	The geology is comprised of mudrock and sandstone of Adelaide Formation
PAARDE VALLEY SOLAR PV FACILITY:		
Laydown Area and O&M Building Site Option 1	Favourable	The geology is comprised of quaternary unconsolidated sands; sands could be of significant thickness and founding conditions could be adverse.

PV INFRASTRUCTURE ALTERNATIVES (LAYDOWN AREAS AND O&M BUILDINGS)	Preference	Reasons (incl. potential issues)
Laydown Area and O&M Building Site Option 2	Favourable	The geology is comprised of Jurassic age dolerite; it appears that this Site Option 2 is close or at a contact with the sedimentary rock of Adelaide Formation. Founding problems may arise.
Laydown Area and O&M Building Site Option 3	Preferred	The geology is comprised of mudrock and sandstone of Adelaide Formation
Laydown Area and O&M Building Site Option 4	Preferred	The geology is comprised of mudrock and sandstone of Adelaide Formation
Laydown Area and O&M Building Site Option 5	Favourable	The geology is comprised of quaternary unconsolidated sands; sands could be of significant thickness and founding conditions could be adverse.
Laydown Area and O&M Building Site Option 6	Preferred	The geology is comprised of Jurasic age dolerite
Laydown Area and O&M Building Site Option 7	Preferred	The geology is comprised of Jurasic age dolerite
Laydown Area and O&M Building Site Option 8	Favourable	The geology is comprised of quaternary unconsolidated sands; sands could be of significant thickness and founding conditions could be adverse.
Laydown Area and O&M Building Site Option 9	Preferred	The geology is comprised of mudrock and sandstone of Adelaide Formation

Table 9: Grid Connection Infrastructure Alternatives (Power Line Corridors and Associated Substations)

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS AND ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
MOOI PLAATS SOLAR PV FACILITY:		
Grid Connection Option 1a	Preferred	Shorter Route Both routes, Option 1a and 1b, underlain by similar bedrock Both routes traverse drainage features/small rivers From an engineering perspective, both options will have similar founding conditions Smaller section of this route traverses near / over mountainous / hilly topography in the north west region of the corridors. Therefore, the corridor Option 1 has less risk of slope instability, possibly less talus deposits, less chance of soil erosion, possibly lower construction cost.
Grid Connection Option 1b	Preferred	Shorter Route Both routes, Option 1a and 1b, underlain by similar bedrock Both routes traverse drainage features/small rivers From an engineering perspective, both options will have similar founding conditions Smaller section of this route traverses near / over mountainous / hilly topography in the north west region of the corridors. Therefore, the corridor Option 1 has less risk of slope instability, possibly less talus deposits, less chance of soil

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS AND ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
		erosion, possibly lower construction cost.
Grid Connection Option 2a	Favourable	Longer Route Both routes, Options 2a and 2b, underlain by similar bedrock Both routes traverse drainage features/small rivers From an engineering perspective, both options will have similar founding conditions Therefore, the corridor option has more risk of slope instability, possibly more talus deposits, higher chance of soil erosion, possibly higher construction cost.
Grid Connection Option 2b	Favourable	Longer Route Both routes, Options 2a and 2b, underlain by similar bedrock Both routes traverse drainage features/small rivers From an engineering perspective, both options will have similar founding conditions Therefore, the corridor option has more risk of slope instability, possibly more talus deposits, higher chance of soil erosion, possibly higher construction cost.
WONDERHEUVEL SOLAR PV FACILITY:		
Grid Connection Option 1a	Favourable	Two separate grid connection All options (Options 1a, 1b, 1c and 1d) underlain by similar bedrock All routes traverse drainage features / small rivers

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS AND ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
		From an engineering perspective, all options will have similar founding conditions This route traverses more mountainous / hilly topography than corridor Options 2 and 3. Therefore, the corridor Option 1 has more risk of slope instability, possibly more talus deposits, higher chance of soil erosion, possibly higher construction cost.
Grid Connection Option 1b	Favourable	Two separate grid connection All options (Options 1a, 1b, 1c and 1d) underlain by similar bedrock All routes traverse drainage features / small rivers From an engineering perspective, all options will have similar founding conditions This route traverses more mountainous / hilly topography than corridor Options 2 and 3. Therefore, the corridor Option 1 has more risk of slope instability, possibly more talus deposits, higher chance of soil erosion, possibly higher construction cost.
Grid Connection Option 1c	Favourable	Two separate grid connection All options (Options 1a, 1b, 1c and 1d) underlain by similar bedrock All routes traverse drainage features / small rivers From an engineering perspective, all options will have similar founding conditions

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS AND ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
		This route traverses more mountainous / hilly topography than corridor Options 2 and 3. Therefore, the corridor Option 1 has more risk of slope instability, possibly more talus deposits, higher chance of soil erosion, possibly higher construction cost.
Grid Connection Option 1d	Favourable	Two separate grid connection All options (Options 1a, 1b, 1c and 1d) underlain by similar bedrock All routes traverse drainage features / small rivers From an engineering perspective, all options will have similar founding conditions This route traverses more mountainous / hilly topography than corridor Options 2 and 3. Therefore, the corridor Option 1 has more risk of slope instability, possibly more talus deposits, higher chance of soil erosion, possibly higher construction cost.
Grid Connection Option 2a	Preferred	Shorter route; similar impacts for Options 2a and 2b. Both options are underlain by similar bedrock Both routes traverse drainage features / small rivers From an engineering perspective, both options will have similar founding conditions Smaller section of this route traverses near / over more mountainous / hilly topography than corridor Option 1.

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS AND ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
		Therefore, the corridor Option 2 has less risk of slope instability, possibly less talus deposits, less chance of soil erosion, possibly lower construction cost.
Grid Connection Option 2b	Preferred	Shorter route; similar impacts for Options 2a and 2b. Both options are underlain by similar bedrock Both routes traverse drainage features / small rivers From an engineering perspective, both options will have similar founding conditions Smaller section of this route traverses near / over more mountainous / hilly topography than corridor Option 1. Therefore, the corridor Option 2 has less risk of slope instability, possibly less talus deposits, less chance of soil erosion, possibly lower construction cost.
Grid Connection Option 3	Preferred	Slightly longer route than Option 2. Route traverses by similar bedrock as Option 2 It traverses drainage features / small rivers From an engineering perspective, this option will have similar founding conditions Smaller section of this route traverses near / over more mountainous / hilly topography than corridor Option 1. Therefore, the corridor Option 3 has less risk of slope instability, possibly less talus deposits, less chance of soil

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS AND ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
		erosion, possibly lower construction cost.
PAARDE VALLEY SOLAR PV FACILITY:		
Grid Connection Option 1a	Preferred	Shorter Route Both options, Option 1a and 1b, are underlain by similar bedrock Both routes traverse drainage features / small rivers From an engineering perspective, both options will have similar founding conditions From an engineering perspective, all options will have similar founding conditions
Grid Connection Option 1b	Preferred	Shorter Route Both options, Option 1a and 1b, are underlain by similar bedrock Both routes traverse drainage features / small rivers From an engineering perspective, both options will have similar founding conditions From an engineering perspective, all options will have similar founding conditions
Grid Connection Option 1c	Preferred	Slightly longer route. Both options, Option 1c and 1d, are underlain by similar bedrock Both routes traverse drainage features / small rivers From an engineering perspective, both options will have similar founding conditions From an engineering perspective, all options will have similar founding conditions

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS AND ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
Grid Connection Option 1d	Preferred	Slightly longer route. Both options, Option 1c and 1d, are underlain by similar bedrock Both routes traverse drainage features / small rivers From an engineering perspective, both options will have similar founding conditions
Grid Connection Option 2a	Favourable	Longer route All options, Option 2a, 2b, 2c and 2d are underlain by similar bedrock all routes traverse drainage features / small rivers From an engineering perspective, all options will have similar founding conditions
Grid Connection Option 2b	Favourable	Longer route All options, Option 2a, 2b, 2c and 2d are underlain by similar bedrock all routes traverse drainage features / small rivers From an engineering perspective, all options will have similar founding conditions
Grid Connection Option 2c	Favourable	Longer route All options, Option 2a, 2b, 2c and 2d are underlain by similar bedrock all routes traverse drainage features / small rivers From an engineering perspective, all options will have similar founding conditions
Grid Connection Option 2d	Favourable	Longer route All options, Option 2a, 2b, 2c and 2d are underlain by similar bedrock

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS AND ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
		all routes traverse drainage features / small rivers From an engineering perspective, all options will have similar founding conditions

9 CONCLUSIONS

The desktop geotechnical assessment did not identify any fatal flaws that, from a geological and geotechnical perspective, would prevent the construction of the proposed Usombomvu PV Energy Facilities.

The potential impacts the project may have on the geology, relate to soils that could be impacted by the construction activities. There may be a potential for soil erosion, due to removal of vegetation and exposure of the soils to the elements, during construction. The impacts were found to be of "***negative low impact***".

Various corridor options were studied for each PV facility. While all options are considered suitable for development, the following options were found to be preferable from a geological and geotechnical perspective:

- Mooi Plaats PV Facility – Grid Option 1
- Wonderheuven PV Facility – Grid Option 2 and 3
- Paarde Valley PV Facility – Grid Option 1

The geological impacts will be similar.

Due the very similar bedrock geology, similar geotechnical conditions are expected across all options.

From a geological and geotechnical perspective, based on the minimal negative impacts on the geology and soils and the recommendations for mitigation measures, it is recommended that the **Usombomvu PV Energy Facilities** project receives the go ahead from the Competent Authority.

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10 REFERENCES

1. Brink, A.B.A. (1983). *Engineering Geology of South Africa Volume 1-4*. Building Publications Pretoria.
2. Johnson, C.R., Anhaeusser, C.R. and Thomas, R.J. (2006). *The Geology of South Africa*. Council for Geoscience.

Annexure A: Impact Assessment 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:

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

Annexure B: Specialist's Curriculum Vitae

CECILIA CANAHAI

Profession	*Engineering Geologist / Scientist*
Position in Firm	*Technical Director*
Area of Specialisation	*Geotechnical, Environmental, Waste Management*
Qualifications	*Pr.Sci.Nat., MSc (Eng Geol), BSc (Eng Geology)*
Years of Experience	*31 Years*
Years with Firm	*20 Years*

SUMMARY OF EXPERIENCE

Cecilia Canahai gained her first site experience working as a site geologist for oil and gas exploration, in Romania, in 1988. She completed drilling supervision, sampling, gas chromatography, borehole logging and interpretation, report writing and made recommendations for drilling parameters.

Cecilia joined Moore Spence Jones (Pty) Ltd in 1997 as an engineering geologist, where she completed numerous geotechnical investigations for township and industrial development, sports facility developments, private residential properties and pipeline investigations. She has completed slope stability analyses with recommendations for rehabilitation. Other aspects of her experience include dam and tunnel geotechnical investigations. She acquired her first experience as an environmentalist while carrying out groundwater pollution monitoring, at SAPREF.

All projects have included fieldwork, on site testing, site supervision of works, material sampling, interpretation of laboratory results, client liaison, and reporting.

Cecilia joined JG Afrika (Pty) Ltd in 1999 as an environmentalist / engineering geologist.

As an engineering geologist she has worked on various projects, inter alia, geotechnical investigations for rural water supply schemes, housing developments, roads investigations, materials investigations, lateral support design and geotechnical investigations for dams and tunnels.

As an environmental practitioner she has successfully completed numerous Environmental Impact Assessment Scoping and EIA reports, Solid Waste Management, Environmental Management Programme Reports and Closure Reports for various mines/ borrow pits and Environmental Audits. She was also involved in other aspects of the environmental field such as scoping and public participation, impact assessment, mitigation and monitoring and preparation of environmental management plans (EMP).

Cecilia was the Pietermaritzburg Branch Quality System Manager, involved in the maintaining the office' quality standard in terms of ISO 9001 (JG Afrika is ISO 9001 certified) between 2002 and 2007, when work commitments required her to hand over this particular task to someone else.

Cecilia became a shareholder in 2010 and a partner in 2012. Since 2010 her duties are business development and marketing in the fields of engineering geology geotechnical engineering; waste management; environmental science, aquatic health and water resources management, as well as managing various multi- disciplinary projects.

SIKHULISA SONKE

PROFESSIONAL REGISTRATIONS & INSTITUTE MEMBERSHIPS

Pr.Sci.Nat. - Registered with the South African Council for Natural Scientific Professions - Registration No 400011/00: Environmental Science & Geological Science

SAIEG - Member of the South African Institute for Engineering and Environmental Geologists - Membership No 03/211

IAIA - Member of the International Association of Impact Assessment; Membership No 1686

EDUCATION

1983 – Certificate of Baccalaureate – Pitesti, Romania
1987 – BSc (Hons) (Eng Geol) – University of Bucharest, Romania
1988 – MSc (Eng Geol) – University of Bucharest, Romania

SPECIFIC EXPERIENCE

JG Afrika (Pty) Ltd (Previously Jeffares & Green (Pty) Ltd)

2010 - 2019
Position – Technical Director

Sicello Bulk Water Main: EIA & EMPR for water main al Sicello

Kumba Iron Ore Biomonitoring Programme for aquatic health

Kriel Power Station – Geotechnical Investigation for ash dam complex stability and stability monitoring for a period of 11 months

New Ash Facility at Tutuka Power Station for Eskom detail design for water return dams and appurtenant structure and infrastructure as part of an ADF team

New Ash Facility at Kusile Power Station for Eskom detail design for water return dams and appurtenant structure and infrastructure as part of an ADF team

Camden New Ash Dam Facility detail design, encompassing geotechnical investigation for the new ADF, water return dams and appurtenant structure and infrastructure

New Ash Facility at Kendal Power Station for Eskom

Hendrina Step-In and Go-Higher Ash Dam Facility detail design, encompassing geotechnical investigation for the extension of the existing ADF

Mathjabeng Solar Park

Atlas Substation EIA for Closure and Risk Assessment and Due Diligence

Gauteng Department of Roads and Transportation: Environmental assessment for 15 Intersection upgrades

Geotechnical Investigation in support of the Feasibility Study for a **5 GW power Solar Park** in the Northern Cape Province of South Africa (presidential project)

Feasibility Study for the potential sources of water for the **Tikwa Wind Farm**

N11 Sections 6 & 7 Borrow Pit Closure

Various **Water Use Licence Applications**

Basic Assessment for the installation of **Fibre Optic Cable between Aliwal North and George**

Baseline study for Eskom WTW and WWTW for readiness for Blue Drop / Green Drop Certification

Basic Assessment for the installation of **Fibre Optic Cable between Johannesburg and Cape Town**

Various Geotechnical Investigations for Rand Water Pipelines

Various **Environmental Basic Assessments** for Rand Water Pipelines

Various **Geotechnical Investigations** for various Eskom towers (3 year Contract)

2009 – 2010
Position –Executive Associate

N4 Rustenburg to Swartruggens: Geotechnical investigation for N4 road rehabilitation

Pikitup OSH Legal Audits

Dumbe Coalline Geotechnical investigation for Transnet (stability of proposed cuttings)

Various **Geotechnical Investigations** for Rand Water Pipelines

Various **Environmental Basic Assessments** for Rand Water Pipelines

Various **Geotechnical Investigations** for various Eskom towers (3 year Contract)

Basic Assessment for the installation of **Fibre Optic Cable** between Pretoria and Rustenburg

Materials recovery facility in **Ekandustria Waste Licence Application** and Basic assessment

2008 – 2009
Position – Associate

Pikitup Environmental Compliance

Rand Water G25 Pipeline Basic Assessment study downgraded to and Environmental Management Plan; Saved the Client R100 000,00 in fees.

Pikitup Garden sites and Depot sites Application for Waste Licences & Basic Assessment studies

Pretoria North Modal Interchange: full Environmental Impact Assessment for intermodal facility

N11 Section 4: Environmental services for obtaining Authorization for road rehabilitation and borrow pits

Various Geotechnical Investigations for Eskom towers (3 year Contract)

N6: Environmental services and Applications for Borrow Pits Closures

N12 Section 12: Environmental Auditing for road construction

2007 – 2008
Position – Associate

N6 Section 8 Closure Documentation for quarry and borrow pits for Road Rehabilitation

Lesotho Lowlands Water Supply Scheme: Geotechnical Investigation

Lusikisiki Police Station Geotechnical Investigation

Toscana Ridge Geotechnical Investigation for Housing development

Phinda Game Reserve: Geotechnical investigation for Housing development

Lusikisiki Police Station: Geotechnical Investigation.

Pretoria North Station Modal Interchange: full Environmental Impact Assessment for various road realignments, modal interchange and railway refurbishment in Pretoria.

N1 Section 14: Full Environmental Impact Assessment for the N1 rehabilitation.

Mt Ayliff & Mt Frere Access Roads – Environmental services for obtaining authorization from DEAET and DME for 12 access roads and associated borrow pits.

N2 Pongola Borrow pits: Application for borrow pits Closure

N2 Section 32: environmental services for obtaining Authorization for road rehabilitation and borrow pits

Umzimkhulu Municipality: Various environmental services for the upgrade of roads in Umzimkhulu

Environmental Management Plan for the rehabilitation of Dorpspruit River, Pietermaritzburg

Kwamashu Police Station Basic Assessment Report

2006 – 2007
Position – Associate

Elliottdale Landfill Site Classification and Permitting

Impendle Housing Development (1500 units): Geotechnical Investigation.

Lesotho Lowlands Bulk Water Supply Scheme: Geotechnical Investigation

Environmental Impact Assessment for various access roads in the Mt Frere and Mt Ayliff areas for the Umzimvubu Municipality.

Bubu Access Road : Geotechnical and materials investigation

Erf 3 Bishopstowe: Geotechnical Investigation for housing development

Willowton Proposed Shopping Centre: Geotechnical Investigation

Black Umfolozi River Bridge: Basic Assessment for environmental authorization

Mtwalume River sand mining Environmental Management Plan

Vulindlela Access Road: Environmental Management Plan for construction

Inhlazuka CWSS Environmental Management Plan for construction

Ladysmith Development: Preliminary Geotechnical & Environmental assessments

Black Umfolozi River Bridge - Basic Assessment Report as per NEMA Regulations 386.

Erf 3 Bishopstowe Geotechnical investigation for housing development

Vulindlela Access Roads – Environmental services for road rehabilitation.

2005 – 2006
Position – Engineering & Environmental Geologist

Closure of Landfill Site Hluhluwe & Identification of new Landfill Site to replace the old Landfill Site

N11 Sections 6 and 7 Borrow Pits and Quarry Permitting: environmental services (EIA & EMPR's) 10 borrow pits and one quarry

N12 Section 12 Borrow Pits & Quarry Permitting: environmental services (EIA & EMPR's) for 8 borrow pits and one quarry

Impendle Community Water Supply Schemes – Environmental services for obtaining authorization from DAEA for the construction of a community pipeline and associated structures.

Masomonco Community Water Supply Scheme - Environmental services for obtaining authorization from DAEA for the construction of a community pipeline and associated structure.

KwaNovuka Community Water Supply Scheme - Environmental services for obtaining authorization from DAEA for the construction of a community pipeline and associated structure.

Umtshezi Municipality Land Use Management System – Broad Environmental Scan

Vryheid Housing Development – Geotechnical Investigation

Illovo River Mining Right – environmental services for a sand mining operation on the Illovo River

Kwa Gqugquma Community Water Supply Scheme - Environmental services for obtaining authorization from DAEA for the construction of a community pipeline and associated structure.

2004 – 2005
Position – Engineering & Environmental Geologist

Georgedale development – environmental services for sand mining

God's Haven Housing Development – Geotechnical Investigation

Kwa Senge Clinic – Geotechnical Investigation

Umdoni Municipality Cemetery – Geotechnical & Environmental Assessments

N6 Borrow Pits and Quarry Permitting: environmental services (EIA & EMPR's) 10 borrow pits and one quarry

Umkomaas River Mining Right – environmental services for sand mining operations on the Umkomaas River

Umkomaas River Footbridge – Geotechnical Investigation

Marburg Prison – Geotechnical Investigation

Enkanyezini Community Water Supply Scheme - Environmental services for obtaining authorization from DAEA for the construction of a community pipeline and associated structures.

Shemula Community Water Supply Scheme - Environmental services for obtaining authorization from DAEA for the construction of a community pipeline and associated structures.

Mtwalume River Mining Permit – environmental services for sand mining operation on the Mtwalume River.

Umzimkulu River Mining Right – environmental services for sand mining operations on the Umzimkulu River

Umvoti River Mining Rights and Permits – environmental services for various sand mining operations on the Umvoti River

N2 Pongola quarry – Geotechnical Investigation

Rugged Glen - Environmental services for upgrading and construction of new structures.

2003 – 2004
Position – Engineering & Environmental Geologist

Kwa Mpande Geotechnical Investigation for school

St Ives Environmental Scoping for tourism development on the Midlands Meander

Ladysmith Petrol Station – Geotechnical Investigation and Scoping report

Kwa Ngwanase Community Water Supply Scheme – Geotechnical investigation for pipeline and associated structures.

Kwa Ngwanase Community Water Supply Scheme Environmental Scoping for proposed pipeline and associated structures.

Emkhuzeni & Mhlangana Community Water Supply Schemes – Geotechnical investigation for pipelines and associated structures.

Emkhuzeni & Mhlangana Community Water Supply Schemes Environmental Scoping for proposed pipelines and associated structures.

Inanda Dam Mining Permit – environmental services for a sand mining operation on the Inanda Dam.

Mdloti River Mining Conversion of old right to Mining Right.

Edwin Swales – Environmental Managemnt Plan compilation and Auditing.

Estcourt Prison – Geotechnical Investigation

Kombuzi Environmental Management Programme report for mining

Umhlumayo Community Water Supply Scheme – Geotechnical Investigation

2002 – 2003
Position – Engineering & Environmental Geologist

Dumbe Housing Development – Geotechnical Investigation.

Clouds oh Hope – Children's Home – Geotechnical Investigation

C4 Water Pipeline – Johennesburg – Geotechnical Investigation.

Kombuzi Community Water Supply Scheme – Geotechnical investigation for pipeline and associated structures.

Hlahlindlela Community Water Supply Scheme – Geotechnical investigation for pipeline and associated structures.

Shemula Community Water Supply Scheme – Geotechnical investigation for pipeline and associated structures.

Mt Frere rehabilitation of 3 roads – Geotechnical Investigation

Mbono Community Water Supply Scheme – Geotechnical investigation for pipeline and associated structures.

Camperdown Spar - Geotechnical Investigation for failed pavement.

Thokoza Community Water Supply Scheme – Geotechnical investigation for pipeline and associated structures.

Nqutu Community Water Supply Scheme – Geotechnical investigation for pipeline and associated structures.

Taxi Rank at Lusikisiki – Geotechnical Investigation

Kwa Hlope Community Water Supply Scheme – Geotechnical investigation for pipeline and associated structures.

Mbazwane Community Water Supply Scheme – Geotechnical investigation for pipeline and associated structures.

2001 – 2002
Position – Engineering & Environmental Geologist

Amangwe Community Water supply Scheme Enviornmental Scoping for Pipeline and associated structure

Black Umfolozi River Bridge - Basic Assessment Report as per NEMA Regulations 386.

Mt Ayliff & Mt Frere Access Roads – Environmental services for obtaining authorization from DEAET and DME for access roads and associated borrow pits.

Erf 3 Bishopstowe Geotechnical investigation for housing development

2000 – 2001
Position – Engineering & Environmental Geologist

Black Umfolozi River Bridge - Basic Assessment Report as per NEMA Regulations 386.

Mt Ayliff & Mt Frere Access Roads – Environmental services for obtaining authorization from DEAET and DME for access roads and associated borrow pits.

Erf 3 Bishopstowe Geotechnical investigation for housing development

1999 – 2000
Position – Engineering & Environmental Geologist

Nzinga and Langkloof CWSS: Geotechnical Investigation for pipeline and reservoirs, Environmental Scoping: & Environmental Management Programme reports for mining

Mbazwana CWSS: Geotechnical Investigation for pipeline and reservoirs, & Environmental Scoping

Nhlangano to Sicunusa Road: Geotechnical & Materials Investigation

Edendale Hospital New Wing: Geotechnical Investigation

Spandikroon, Dival & Mhlabathini CWSS: Geotechnical Investigations for pipeline and reservoirs, Environmental Scoping: reports

Tugela Estates CWSS: Geotechnical Investigations for pipeline and reservoirs

Debep Quarry Drilling Investigation for materials for road Construction

N2 Road Rehabilitation at Kei River Geotechnical investigation for road rehabilitation

Moore Spence Jones (Pty) Ltd

1998 – 1999
Position – Engineering & Environmental Geologist

Indian Ocean Fertilizers (Richards Bay): Geotechnical Investigation for new plant

Housing Development at Hammarsdale: Geotechnical investigation for foundations, earthworks, suitability of materials for road construction, etc.

Zimbali Housing Development: Geotechnical investigation for foundations, earthworks, suitability of materials for road construction, etc.

Cato Manor: Stability Investigation of platform cuttings

Mpophomeni Housing Development: Geotechnical investigation for foundations, earthworks, suitability of materials for road construction, etc.

Fleetguard Pmb: Geotechnical investigation for warehouse foundations, earthworks, suitability of materials for road construction, etc.

Stukenberg Water Pipeline: Geotechnical investigation for slope stability, pipeline re-routing and tunnel investigation, etc.

Booth Road Housing Development: Geotechnical investigation for foundations, earthworks, suitability of materials for road construction, etc.

1996 – 1998
Position – Engineering & Environmental Geologist

Gateway Development: Geotechnical Investigation for founding conditions, Assessment of waste, Site stability, etc.

Azalea Housing Development Geotechnical investigation for foundations, earthworks, suitability of materials for road construction, etc.

Matatiele Housing Development Geotechnical investigation for foundations, earthworks, suitability of materials for road construction, etc.

Kwa Dabeka Housing Development Geotechnical investigation for foundations, earthworks, suitability of materials for road construction, etc.

Newlands West: Geotechnical Investigation at cracked houses

AECI: Geotechnical Investigation into the stability of the slimes dams at AECI

SAPREF: Groundwater Pollution monitoring

Craiova Drilling Company Romania

1988 – 1992
Position – Site Geologist

Site geologist - Responsible for Drilling supervision at various oil & gas exploration & exploitation boreholes. Main duties included sample and core analysis and description, data logging and interpretation, down-the-hole logging and on site interpretation, gas chromatography and geo-service logging, compilation of reports and recommendations for drilling parameters.

A major project Mrs Canahai was involved in, was the drilling supervision of a 6000 m deep exploration hole. Responsibilities included liaison with design engineers and contractors, gas chromatography and geo-service logging, compilation of reports and recommendations for drilling parameters.

CONTINUED PROFESSIONAL DEVELOPMENT

Courses

2000 - Integrated Environmental Management Course – (University of KwaZulu Natal)
2001 - Environmental Auditing Course - (University of KwaZulu Natal)
2003 - ISO 9001:2000; Registered Internal and Suppliers Auditors Course - (Wynleigh International)
2003 - Waste Management Course – (University of Pretoria)
2005 SHEQMAN Course – (Advance A.C.T.)

2017 Resource Efficiency Cleaner Production - 2-Day End User Training CSIR Pretoria
2018 Energy Management Systems Implementation - End User Training CSIR Pretoria

Published Papers

1988 - "Mineralogical Study of Devonian Deposits of the Hercinic Orogen, Dobrogea", *MSc Thesis*, University of Bucharest (Engineering Geology), 1988.

PERSONAL DETAILS

Nationality – South African
Date of Birth – 1965-03-30
Domicile – Johannesburg, South Africa

Languages
English – Very Good
Romanian – Excellent

Appendix 6D

Heritage Assessment

MOOI PLAATS, WONDERHEUVEL, PAARDE VALLEY SOLAR POWER (PTY) LTD

PROPOSED UMSOBOMVU SOLAR PV ENERGY FACILITIES

Heritage Impact Report

Issue Date: 11 November 2019
Revision No.: 1
Project No.: 15324

Date:	11 11 2019
Document Title:	Heritage Impact Report
Author:	Wouter Fourie
Revision Number:	1
Checked by:	Stephan Jacobs
For:	SiVEST Environmental Division

The heritage impact assessment report has been compiled considering the NEMA Appendix 6 requirements for specialist reports as indicated in the table below.

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	**Relevant section in report**
1.(1) (a) (i) Details of the specialist who prepared the report	Page 2 of Report – Contact details and company
(ii) The expertise of that person to compile a specialist report including a curriculum vita	Section 1.2 – refer to **Appendix D**
(b) A declaration that the person is independent in a form as may be specified by the competent authority	Page ii of the report
(c) An indication of the scope of, and the purpose for which, the report was prepared	Section 1.1
(cA) An indication of the quality and age of base data used for the specialist report	Section 3.1
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 5.1
(d) The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 3.1
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 3.1 and **Appendix B**
(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;	Section 5
(g) An identification of any areas to be avoided, including buffers	Section 5
(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;	Section 5
(i) A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 1.3
(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	Section 5 and 6
(k) Any mitigation measures for inclusion in the EMPr	Interim Section 7
(l) Any conditions for inclusion in the environmental authorisation	Interim Section 7
(m) Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Interim Section 7
(n)(i) A reasoned opinion as to whether the proposed activity, activities or portions thereof should be authorised and	Interim Section 7
(n)(iA) A reasoned opinion regarding the acceptability of the proposed activity or activities; and	
(n)(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	Interim Section 7
(o) A description of any consultation process that was undertaken during the course of carrying out the study	Not applicable. A public consultation process was handled as part of the EIA and EMP process.
(p) A summary and copies if any comments that were received during any consultation process	Not applicable. To date not comments regarding heritage resources that require input from a specialist have been raised.

(q) Any other information requested by the competent authority.	Not applicable.
(2) Where a government notice 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.	No protocols or minimum standards for HIAs or PIAs promulgated through a governmental notice.

EXECUTIVE SUMMARY

PGS Heritage (Pty) Ltd was appointed by SiVEST Environmental Division to undertake a Heritage Impact Assessment Report that forms part of the Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) for the Umsombomvu Solar Energy Facilities close to Noupoort in the Northern Cape Province.

The HIA consisted of a scoping phase during which background information and landscape analysis was done to determine the heritage resources that can potentially occur within the study area. Thisi was followed up with fieldwork by a team of archaeologist and a palaeontologist with the aim of identifying heritage resources in the development footprint areas and t make recommendation on the management of these resources and the possible chance finds during construction activities.

The field work identified a total of 10 areas of heritage significance. Adjustments to the project layouts based on the various specialist input resulted in the total avoidance of 3 heritage areas that was excluded from the reporting. The remaining seven site consist of three large, low to medium density scatters of later stone age sites (**UMS005,008 and 009**). These three sites were avoided by slight adjustments in the PV array layouts in the Paarde Valley as well as Wonderheuvel PV facilities. **UMS004, 006 and 007** are all round stone packed enclosure. **UMS007** situated in the Mooi Plaats facility was excluded from direct impact by design changes. UMS004 and 006 will need to be avoided during construction of the power grid through the implementation of a 30-meter buffer.

UMS010 was identified as a fossil find spot and a 50-meter buffer around the fossil bearing material must be implemented. Any construction in the demarcated area must be monitored by a palaeontologist.

The impact rating on the heritage resources indicated that per-mitigation a negative high impact is projected but with the implementation of the recommended management measures this impact rating will be reduced to low negative.

A comparative assessment of the alternative provided for the PV and grid options is summarised in Table 18 and Table 19 below. The palaeontological sensitive area at UMS010 is the only heritage resources that influence the Options assessment, but those options affected is still favourable with the implementation of the recommended management measures.

Table E 1: Key for comparative assessment

PREFERRED	The alternative will result in a low impact / reduce the impact
FAVOURABLE	The impact will be relatively insignificant
LEAST PREFERRED	The alternative will result in a high impact / increase the impact
NO PREFERENCE	The alternative will result in equal impacts

Table E 2: PV infrastructure alternatives (laydown areas and O&M buildings)

PV INFRASTRUCTURE ALTERNATIVES (LAYDOWN AREAS AND O&M BUILDINGS)	Preference	Reasons (incl. potential issues)
MOOI PLAATS SOLAR PV FACILITY:		
Laydown Area and O&M Building Site Option 1	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 2	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 3	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 4	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 5	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 6	**NO PREFERENCE**	No heritage issue identified for this footprint
WONDERHEUVEL SOLAR PV FACILITY:		
Laydown Area and O&M Building Site Option 1	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 2	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 3	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 4	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 5	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 6	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 7	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 8	**NO PREFERENCE**	No heritage issue identified for this footprint
PAARDE VALLEY SOLAR PV FACILITY:		
Laydown Area and O&M Building Site Option 1	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 2	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 3	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 4	**NO PREFERENCE**	No heritage issue identified for this footprint

PV INFRASTRUCTURE ALTERNATIVES (LAYDOWN AREAS AND O&M BUILDINGS)	Preference	Reasons (incl. potential issues)
Laydown Area and O&M Building Site Option 5	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 6	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 7	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 8	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 9	**NO PREFERENCE**	No heritage issue identified for this footprint

Table E 3: Grid connection infrastructure alternatives (power line corridors and associated substations)

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS AND ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
MOOI PLAATS SOLAR PV FACILITY:		
Grid Connection Option 1a	**NO PREFERENCE**	No heritage issue identified for this footprint
Grid Connection Option 1b	**NO PREFERENCE**	No heritage issue identified for this footprint
Grid Connection Option 2a	**NO PREFERENCE**	No heritage issue identified for this footprint
Grid Connection Option 2a	**NO PREFERENCE**	No heritage issue identified for this footprint
WONDERHEUVEL SOLAR PV FACILITY:		
Grid Connection Option 1a	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 1b	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS AND ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
Grid Connection Option 1c	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 1d	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 2a	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 2b	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 3	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
PAARDE VALLEY SOLAR PV FACILITY:		
Grid Connection Option 1a	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 1b	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS AND ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
		construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 1c	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 1d	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 2a	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 2b	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 2c	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 2d	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS AND ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
		substation 3a, but still a favourable option

It is my considered opinion, based on the current data available, that with the consideration of the position of heritage sensitivities during the layout design and the implementation of the proposed management measures, the project will have an acceptable low impact on heritage resources and can continue.

Contents Page

EXECUTIVE SUMMARY

Appendices

1 INTRODUCTION

PGS Heritage (Pty) Ltd was appointed by SiVEST Environmental Division to undertake a Heritage Impact Assessment Report(HIA) that forms part of the respective Environmental Impact Assessments (EIAs) and Environmental Management Programmes (EMPrs) for the Umsombomvu Solar Energy Facilities close to Noupoort and Middelburg in the Northern and Eastern Cape Provinces.

1.1 Scope of the Study

The aim of the study is to identify possible heritage resources, finds and sensitive areas that may occur in the study area to be investigated in the EIA study. The HIA aims to inform the Environmental Impact Assessment (EIA) in the development of a comprehensive Environmental Management Programme (EMPr) to assist the developer in managing the discovered heritage resources in a responsible manner, in order to protect, preserve, and develop them within the framework provided by the National Heritage Resources Act of 1999 (Act 25 of 1999) (NHRA).

1.2 Assumptions and Limitations

Not detracting in any way from the comprehensiveness of the fieldwork undertaken, it is necessary to realise that the heritage resources located during the fieldwork do not necessarily represent all the possible heritage resources present within the development area. Various factors account for this, including the subterranean nature of some archaeological sites. As such, should any heritage features and/or objects not included in the present inventory be located or observed, a heritage specialist must immediately be contacted.

The accuracy of Palaeontological Impact Assessments, that is included as part of the HIA, is reduced by several factors which may include the following: the databases of institutions are not always up to date and relevant locality and geological information was not accurately documented in the past. Various remote areas of South Africa have not been assessed by palaeontologists and data is based on aerial photographs alone. Geological maps concentre on the geology of an area and the sheet explanations were never intended to focus on palaeontological heritage.

Similar Assemblage Zones, but in different areas are used to provide information on the presence of fossil heritage in an unmapped area. Desktop studies of similar geological formations and Assemblage Zones generally assume that exposed fossil heritage is present within the development area. The accuracy of the Palaeontological Impact Assessment is thus improved considerably by conducting a field-assessment.

Due to the prohibitive size of the application area it was agreed that fieldwork related to the heritage assessment will only be done in the EIA phase when the footprint areas have been determined and significantly reduced, based on environmental sensitive areas determined by the other specialists. After the completion of the fieldwork the proposed grid corridors were

redefined based on the information from various specialist. The final power line corridor will then be walked down during the EMP implementation as required in the proposed management measures related to heritage resources.

1.3 Specialist Qualifications

PGS Heritage (PGS) compiled this HIA.

The staff at PGS has a combined experience of nearly 80 years in the heritage consulting industry. PGS and its staff have extensive experience in managing the HIA processes. PGS will only undertake heritage assessment work where they have the relevant expertise and experience to undertake that work competently.

Wouter Fourie, author and project manager for this project, holds a BA (Hon) in Archaeology and is registered as a Professional Archaeologist with the Association of Southern African Professional Archaeologists (ASAPA) and has CRM accreditation within the said organisation, as well as being accredited as a Professional Heritage Practitioner with the Association of Professional Heritage Practitioners – Western Cape (APHP).

Marko Hutten, field archaeologist this project, holds a BA (Hon) in Archaeology and is registered as a Professional Archaeologist with the Association of Southern African Professional Archaeologists (ASAPA) and has CRM accreditation within the said organisation.

Thomas Mulaudzi, archaeological field technician this project, is registered as an Archaeological Field technician with the Association of Southern African Professional Archaeologists (ASAPA).

Elize Butler has an MSc in Palaeontology from the University of the Free State, Bloemfontein, South Africa. She has been working in Palaeontology for more than twenty-four years. She has extensive experience in locating, collecting and curating fossils, including exploration field trips in search of new localities in the Karoo Basin. She has been a member of the Palaeontological Society of South Africa for 12 years. She has been conducting PIAs since 2014.

1.4 Legislative Context

The identification, evaluation and assessment of any cultural heritage site, artefact or find in the South African context is required and governed by the following legislation:

- National Environmental Management Act (NEMA), Act 107 of 1998
- National Heritage Resources Act (NHRA), Act 25 of 1999
- Mineral and Petroleum Resources Development Act (MPRDA), Act 28 of 2002

The following sections in each Act refer directly to the identification, evaluation and assessment of cultural heritage resources.

National Environmental Management Act (NEMA) Act 107 of 1998

- Basic Environmental Assessment (BEA) – Section (23)(2)(d)
- Environmental Scoping Report (ESR) – Section (29)(1)(d)
- Environmental Impact Assessment (EIA) – Section (32)(2)(d)
- Environmental Management Plan (EMP) – Section (34)(b)

National Heritage Resources Act (NHRA) Act 25 of 1999

- Protection of Heritage Resources – Sections 34 to 36; and
- Heritage Resources Management – Section 38

Mineral and Petroleum Resources Development Act (MPRDA) Act 28 of 2002

- Section 39(3)

The NHRA stipulates that cultural heritage resources may not be disturbed without authorization from the relevant heritage authority. Section 34(1) of the NHRA states that, "no person may alter or demolish any structure or part of a structure which is older than 60 years without a permit issued by the relevant provincial heritage resources authority…" The NHRA is utilized as the basis for the identification, evaluation and management of heritage resources and in the case of CRM those resources specifically impacted on by development as stipulated in Section 38 of NHRA. This study falls under s38(8) and requires comment from the relevant heritage resources authority.

Refer to **Appendix A** for further discussions on heritage management and legislative frameworks

Table 1: Terminology

Acronyms	Description
AIA	Archaeological Impact Assessment
ASAPA	Association of South African Professional Archaeologists
CI	Cumulative Impacts
CRM	Cultural Resource Management
DEA	Department of Environmental Affairs
EIA practitioner	Environmental Impact Assessment Practitioner
EIA	Environmental Impact Assessment
ESA	Earlier Stone Age
GPS	Global Positioning System
HIA	Heritage Impact Assessment
I&AP	Interested & Affected Party
LSA	Later Stone Age
LIA	Late Iron Age
MSA	Middle Stone Age
MIA	Middle Iron Age
NEMA	National Environmental Management Act
NHRA	National Heritage Resources Act
PHRA	Provincial Heritage Resources Agency
PSSA	Palaeontological Society of South Africa
ROD	Record of Decision

Acronyms	Description
SADC	Southern African Development Community
SAHRA	South African Heritage Resources Agency
WEF	Wind Energy Facility

Archaeological resources

This includes:

i. material remains resulting from human activity which are in a state of disuse and are in or on land and which are older than 100 years including artefacts, human and hominid remains and artificial features and structures;
ii. rock art, being any form of painting, engraving or other graphic representation on a fixed rock surface or loose rock or stone, which was executed by human agency and which is older than 100 years, including any area within 10m of such representation;
iii. wrecks, being any vessel or aircraft, or any part thereof, which was wrecked in South Africa, whether on land, in the internal waters, the territorial waters or in the maritime culture zone of the republic as defined in the Maritimes Zones Act, and any cargo, debris or artefacts found or associated therewith, which is older than 60 years or which SAHRA considers to be worthy of conservation;
iv. features, structures and artefacts associated with military history which are older than 75 years and the site on which they are found.

Cultural significance

This means aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance

Development

This means any physical intervention, excavation, or action, other than those caused by natural forces, which may in the opinion of the heritage authority in any way result in a change to the nature, appearance or physical nature of a place or influence its stability and future well-being, including:

i. construction, alteration, demolition, removal or change in use of a place or a structure at a place;
ii. carrying out any works on or over or under a place;
iii. subdivision or consolidation of land comprising a place, including the structures or airspace of a place;
iv. constructing or putting up for display signs or boards;
v. any change to the natural or existing condition or topography of land; and
vi. any removal or destruction of trees, or removal of vegetation or topsoil

Earlier Stone Age

The archaeology of the Stone Age, between 700 000 and 2 500 000 years ago.

Fossil

Mineralised bones of animals, shellfish, plants and marine animals. A trace fossil is the track or footprint of a fossil animal that is preserved in stone or consolidated sediment.

Heritage
That which is inherited and forms part of the National Estate (historical places, objects, fossils as defined by the National Heritage Resources Act 25 of 1999).

Heritage resources
This means any place or object of cultural significance, such as the caves with archaeological deposits identified close to both development sites for this study.

Holocene
The most recent geological time period which commenced 10 000 years ago.

Later Stone Age
The archaeology of the last 30 000 years associated with fully modern people.

Late Iron Age (Early Farming Communities)
The archaeology of the last 1000 years up to the 1800's, associated with iron-working and farming activities such as herding and agriculture.

Middle Stone Age
The archaeology of the Stone Age between 30 000-300 000 years ago, associated with early modern humans.

Palaeontology
Any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or trace.

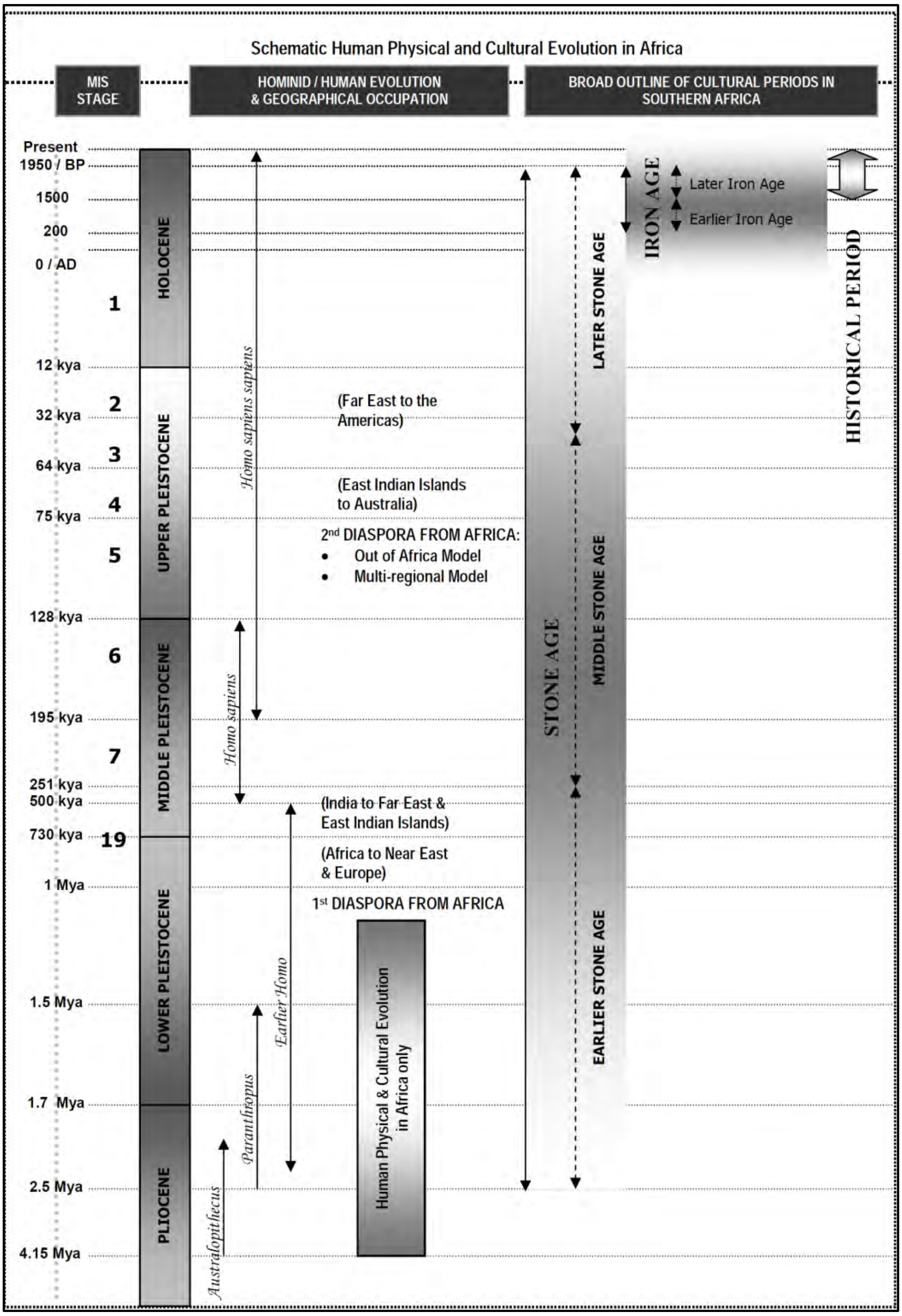

Figure 1: Human and Cultural Timeline in Africa (Morris, 2008)

2 TECHNICAL DETAILS OF THE PROJECT

It is proposed that three (3) Solar Photovoltaic (PV) Energy Facilities, with associated grid connection infrastructure, will be developed, these being:

- ***Mooi Plaats Solar PV Facility***, on an application site of approximately 5 303ha, comprising the following farm portions:
  - Portion 1 of Leuwe Kop No 120
  - Remainder of Mooi Plaats No 121

- ***Wonderheuvel Solar PV Facility***, on an application site of approximately 5 652ha, comprising the following farm portions:
  - Remainder of Mooi Plaats No 121
  - Portion 3 of Wonder Heuvel No 140
  - Portion 5 of Holle Fountain No 133

- ***Paarde Valley Solar PV Facility***, on an application site of approximately 3 695ha, comprising the following farm portion:
  - Portion 2 of Paarde Valley No 62: and
  - Portion 7 of the Farm Leeuw Hoek No. 61.

2.1 SOLAR PV COMPONENTS

2.1.1 Mooi Plaats Solar PV Energy Facility

The proposed Mooi Plaats Solar PV Energy Facility will include the following components:

- Three (3) PV array areas, occupying a combined total area of approximately 777 hectares (ha).
- The proposed solar PV energy facility will have a maximum total generation capacity of approximately **400MW** and will comprise approximately **1 142 857** PV modules. The final number of modules as well as their configuration will only be determined in the detailed design phase.
- PV modules will be either fixed tilt mounting or single axis tracking mounting, and the modules will be either crystalline silicon or thin film technology. Each module will be approximately 2m wide and between 1m and 4m in height, depending on the mounting type.
- Internal roads, between 4m and 10m wide, will provide access to the PV arrays. Existing site roads will be used wherever possible, although new site roads will be constructed where necessary.
- Up to three (3) temporary construction laydown / staging areas of approximately 4ha each.
- Operation and maintenance (O&M) buildings will be provided for each PV array area, occupying a site of approximately 1ha each. Up to a maximum of three (3) O&M buildings will thus be constructed.
- Medium voltage cabling will link the solar PV energy facility to the grid connection infrastructure. These cables will be laid underground wherever technically feasible.

2.1.2 Wonderheuvel Solar PV Energy Facility

The proposed Wonderheuvel Solar PV Energy Facility will include the following components:

- Six (6) PV array areas, occupying a combined total area of approximately 864ha.
- The proposed solar PV energy facility will have a maximum total generation capacity of approximately **480MW** and will comprise approximately **1 371 429** PV modules. The final number of modules as well as their configuration will only be determined in the detailed design phase.
- PV modules will be either fixed tilt mounting or single axis tracking mounting, and the modules will be either crystalline silicon or thin film technology. Each module will be approximately 2m wide and between 1m and 4m in height, depending on the mounting type.
- Internal roads, between 4m and 10m wide, will provide access to the PV arrays. Existing site roads will be used wherever possible, although new site roads will be constructed where necessary.
- Up to a maximum of four (4) temporary construction laydown / staging areas of approximately 4ha each.
- Operation and maintenance (O&M) buildings will be provided for each PV array area, occupying a site of approximately 1ha each. However, certain PV array areas will share O&M buildings. Up to a maximum of four (4) O&M buildings will thus be constructed.
- Medium voltage cabling will link the solar PV energy facility to the grid connection infrastructure. These cables will be laid underground wherever technically feasible.

2.1.3 Paarde Valley Solar PV Energy Facility

The proposed Paarde Valley Solar PV Energy Facility will include the following components:

- Five (5) PV array areas, occupying a combined total area of approximately 1 337ha.
- The proposed solar PV energy facility will have a maximum total generation capacity of approximately **700MW** and will comprise approximately **2 000 000** PV modules. The final number of modules as well as their configuration will only be determined in the detailed design phase.
- PV modules will be either fixed tilt mounting or single axis tracking mounting, and the modules will be either crystalline silicon or thin film technology. Each module will be approximately 2m wide and between 1m and 4m in height, depending on the mounting type.
- Internal roads, between 4m and 10m wide, will provide access to the PV arrays. Existing site roads will be used wherever possible, although new site roads will be constructed where necessary.
- Up to five (5) temporary construction laydown / staging areas of approximately 4ha each.
- Operation and maintenance (O&M) buildings will be provided for each PV array area, occupying a site of approximately 1ha each. Up to a maximum of five (5) O&M buildings will thus be constructed.

- Medium voltage cabling will link the solar PV energy facility to the grid connection infrastructure. These cables will be laid underground wherever technically feasible.

2.2 Grid Connection Infrastructure

The proposed grid connection infrastructure will include the following components:

- New on-site substations and collector substations to serve each solar PV energy facility, each occupying an area of up to approximately 4ha.
- A new 132kV overhead power line connecting the on-site substations and/or collector substations to either the Hydra D Main Transmission Substation (MTS) or the proposed Coleskop Wind Energy Facility (WEF) substation, from where the electricity will be fed into the national grid. The type of power line towers being considered at this stage to include both lattice and monopole towers which will be up to 25m in height.

Grid connection infrastructure alternatives have been provided for each PV project. These alternatives essentially provide for different route alignments with associated substations contained within an assessment corridor between approximately 400m and 900m wide. This is to allow for flexibility to route the power line on either side of the existing high voltage Eskom power lines. The respective alternatives are as follows:

2.2.1 Mooi Plaats Solar PV Grid Connection

The alternatives essentially provide for two (2) different route alignments with associated substations contained within an assessment corridor between approximately 400m and 900m wide. The alternatives are as follows:

OPTION 1:

- **Corridor Option 1a** - links Substation 2 and Substation 1a to the Hydra D MTS.
- **Corridor Option 1b** - links Substation 2 and Substation 1b to the Hydra D MTS.

OPTION 2:

- **Corridor Option 2a** - links Substation 2 and Substation 1a to the Hydra D MTS via the proposed Central Collector substation located on the Wonderheuvel PV project application site.
- **Corridor Option 2b** - links Substation 2 and Substation 1b to the Hydra D MTS via the proposed Central Collector substation located on the Wonderheuvel PV project application site.

2.2.2 Wonderheuvel Solar PV Grid Connection

The alternatives essentially provide for three (3) different route alignments with associated substations contained within an assessment corridor between approximately 400m and 900m wide. The alternatives are as follows:

OPTION 1:

- **Corridor Option 1a** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  a. The *northern connection* links the Proposed Substation 3a to the Hydra D MTS via the proposed Northern Collector Substation located on the Mooi Plaats PV project application site.
  b. The *southern connection* links the proposed Substation 4a to the Coleskop WEF Substation via the proposed Southern Collector Substation located on the Paarde Valley PV Project application site.

- **Corridor Option 1b** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  a. The *northern* connection links the Proposed Substation 3a to the Hydra D MTS via the proposed Northern Collector Substation located on the Mooi Plaats PV project application site.
  b. The *southern connection* links the proposed Substation 4b to the Coleskop WEF Substation via the proposed Southern Collector Substation located on the Paarde Valley PV Project application site.

- **Corridor Option 1c** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  a. The *northern* connection links the Proposed Substation 3b to the Hydra D MTS via the proposed Northern Collector Substation located on the Mooi Plaats PV project application site.
  b. The *southern connection* links the proposed Substation 4a to the Coleskop WEF Substation via the proposed Southern Collector Substation located on the Paarde Valley PV Project application site.

- **Corridor Option 1d** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  a. The *northern connection* links the Proposed Substation 3b to Hydra D MTS via the proposed Northern Collector Substation located on the Mooi Plaats PV project application site.
  b. The *southern connection* links the proposed Substation 4b to the Coleskop WEF Substation via the proposed Southern Collector Substation located on the Paarde Valley PV Project application site.

OPTION 2:

- **Corridor Option 2a** - links Substation 3a to the Hydra D MTS via the proposed Central Collector Substation.

- **Corridor Option 2b** - Option 2b links Substation 3b to Hydra D MTS via the proposed Central Collector Substation.

OPTION 3:

- **Corridor Option 3** links Substation 4b to Hydra D MTS via the proposed Central Collector Substation.

2.2.3 Paarde Valley Solar PV Grid Connection

The alternatives essentially provide for two (2) different route alignments with associated substations contained within an assessment corridor between approximately 400m and 900m wide. The alternatives are as follows:

OPTION 1:

- Corridor **Option 1a** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  - i. The *northern connection* links Substation 5 to Coleskop Substation via the proposed Southern Collector Sub (Substation 6a will act as Central Collector for this option).
  - ii. The *southern connection* links Substation 7a to the Coleskop Substation via the proposed Southern Collector Substation (Substation 6a will act as Southern Collector for this option).

- Corridor **Option 1b** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  - i. The *northern connection* links Substation 5 to Coleskop Substation via the proposed Southern Collector Sub (Substation 6b will act as Southern Collector for this option).
  - ii. The *southern connection* links Substation 7a to the Coleskop Substation via the proposed Southern Collector Substation (Substation 6b will act as Southern Collector for this option).

- Corridor **Option 1c** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  - i. The *northern connection* links Substation 5 to Coleskop Substation via the proposed Southern Collector Sub (Substation 6a will act as Southern Collector for this option).
  - ii. The *southern connection* links Substation 7b to the Coleskop Substation via the proposed Southern Collector Substation (Substation 6a will act as Southern Collector for this option).

- Corridor **Option 1d** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
    i. The *northern connection* links Substation 5 to Coleskop Substation via the proposed Southern Collector Sub (<u>Substation 6b will act as Southern Collector for this option</u>).
    ii. The *southern connection* links Substation 7b to the Coleskop Substation via the proposed Southern Collector Substation (<u>Substation 6b will act as Southern Collector for this option</u>).

<u>OPTION 2:</u>

- Corridor **Option 2a** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
    i. The *northern connection* links Substation 5 to Hydra D MTS via the proposed Central Collector Sub located on the Wonderveuvel PV Project application site.
    ii. The *southern connection* links Substation 6a and 7a to the Hydra D MTS via the proposed Central Collector Substation located on the Wonderheuvel PV Project application site.

- Corridor **Option 2b** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
    i. The *northern connection* links Substation 5 to Hydra D MTS via the proposed Central Collector Sub located on the Wonderheuvel PV Project application site.
    ii. The *southern connection* links Substation 6b and 7b to the Hydra D MTS via the proposed Central Collector Substation located on the Wonderheuvel PV Project application site.

- Corridor **Option 2c** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
    i. The *northern connection* links Substation 5 to Hydra D MTS via the proposed Central Collector Sub located on the Wonderheuvel PV Project application site.
    ii. The *southern connection* links Substation 6a and 7b to the Hydra D MTS via the proposed Central Collector Substation located on the Wonderheuvel PV Project application site.

- Corridor **Option 2d** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
    i. The *northern connection* links Substation 5 to Hydra D MTS via the proposed Central Collector Sub located on the Wonderheuvel PV Project application site.
    ii. The *southern connection* links Substation 6b and 7a to the Hydra D MTS via the proposed Central Collector Substation located on the Wonderheuvel PV Project application site.

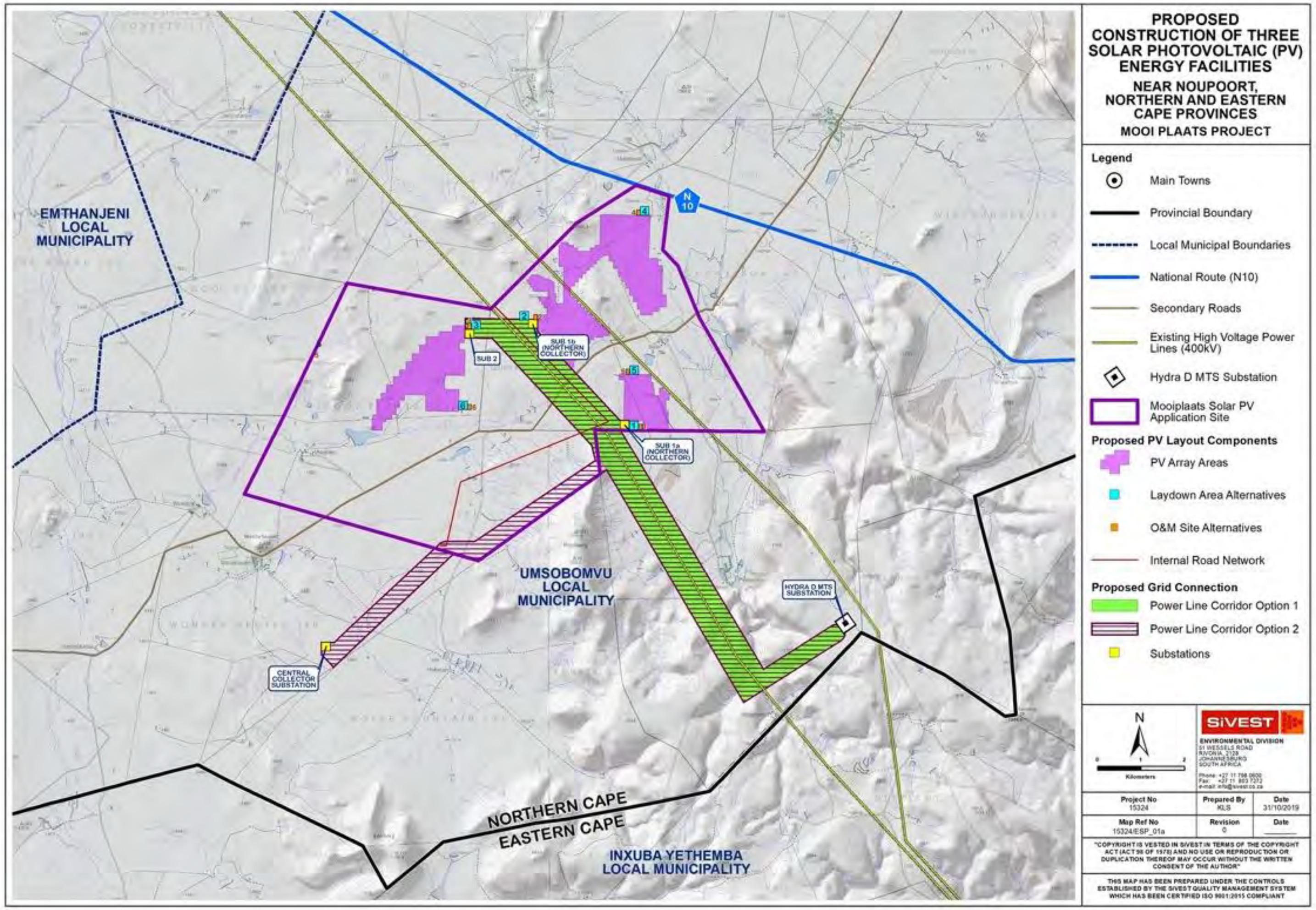

Figure 2: Mooi Plaats Solar PV Facility

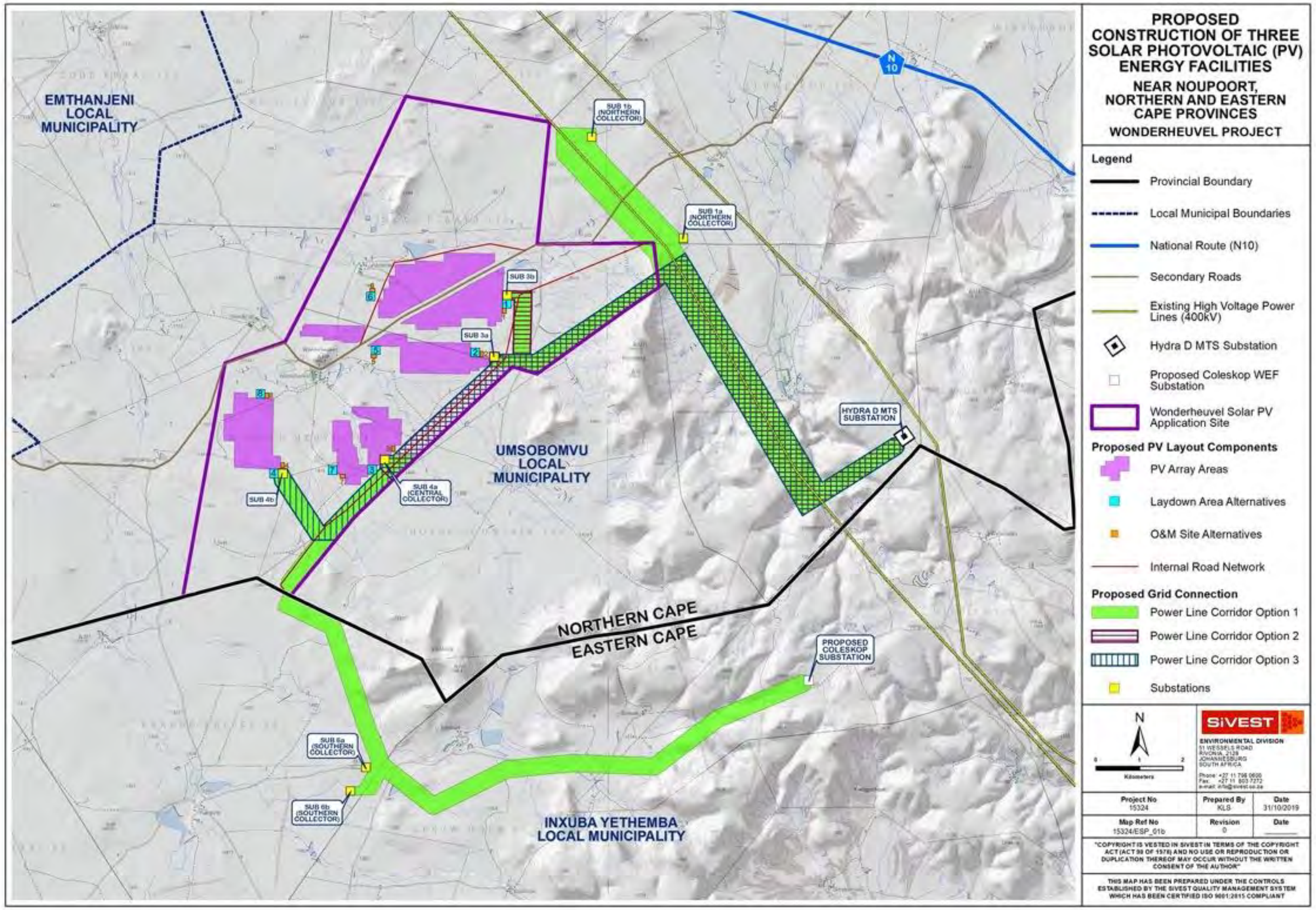

Figure 3: Wonderheuvel Solar PV Facility

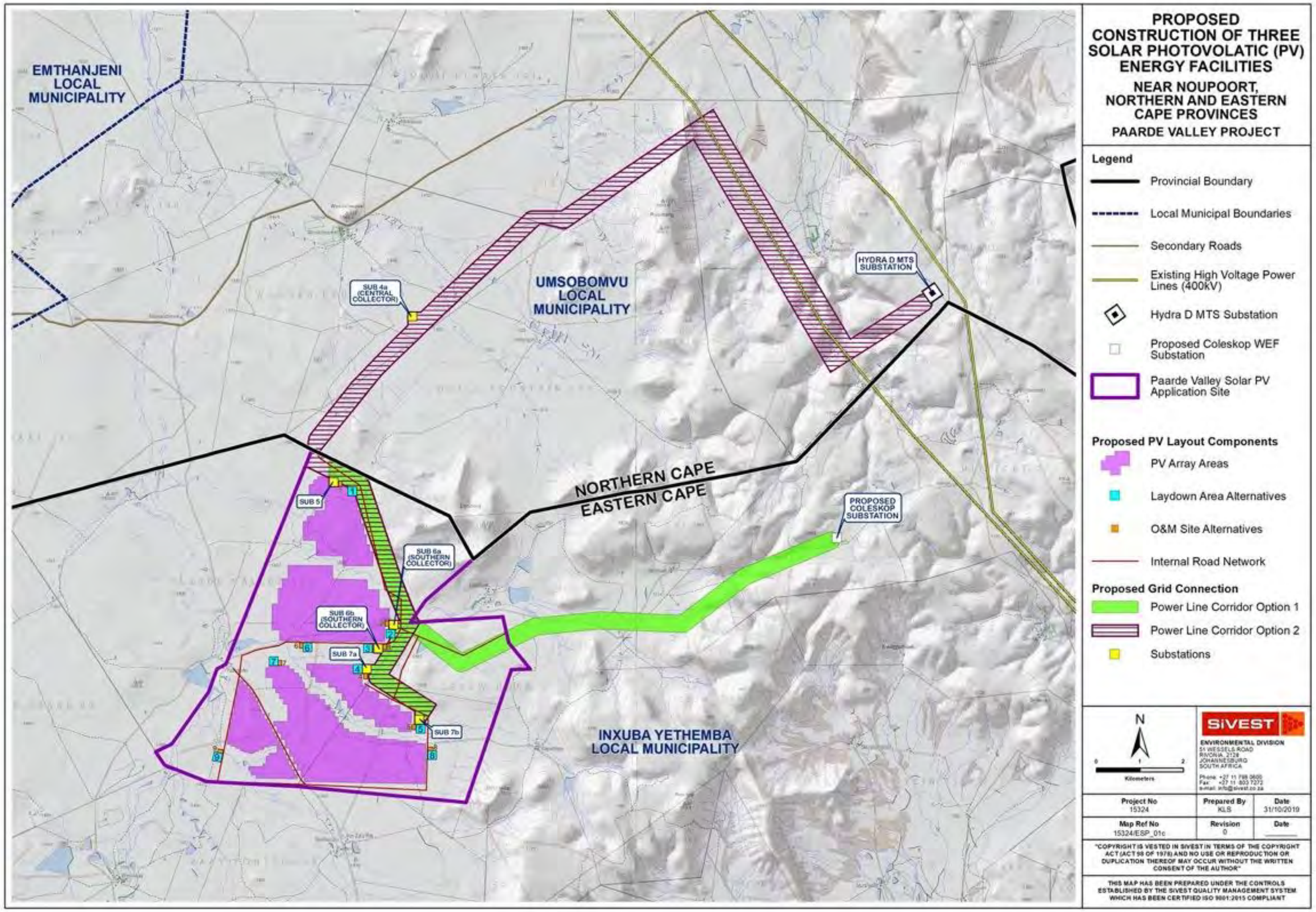

Figure 4: Paarde Valley Solar PV Energy Facility.

3 ASSESSMENT METHODOLOGY

The section below outlines the assessment methodologies utilised in the study.

3.1 Methodology for Assessing Heritage Site significance

This HIAreport was compiled by PGS for the Proposed Umsobomvu Solar PV Energy Facilities. The applicable maps, tables and figures, are included as stipulated in the NHRA (no 25 of 1999), the National Environmental Management Act (NEMA) (no 107 of 1998). The HIA process consisted of three steps:

3.1.1 Scoping Phase

Step I – Literature Review: The background information to the field survey relies greatly on the Heritage Background Research.

3.1.2 Impact Assessment Phase

Step II – Physical Survey: A physical survey was conducted on foot and by vehicle through the proposed project area by two qualified archaeologists and two field assistants, which aimed at locating and documenting sites falling within and adjacent to the proposed development footprint. *Completed 26-29 August 2019*.

Step III – The final step involved the recording and documentation of relevant archaeological resources, the assessment of resources in terms of the HIA criteria and report writing, as well as mapping and constructive recommendations.

Appendix B, outlines the Heritage Impact Assessment methodology, while **Appendix C** provides the guidelines for the impact assessment evaluation that were utilised during this EIA phase of the project.

4 BACKGROUND RESEARCH

4.1 Previous Studies

Researching the SAHRA APM Report Mapping Project records and the SAHRIS online database (http://www.sahra.org.za/sahris), it was determined that a number of other archaeological or historical studies have been performed within the wider vicinity of the study area. Previous studies listed for the area in the APM Report Mapping Project included a number of surveys within the area listed in chronological order below:

- Binneman, Booth & Higgitt (2010). A phase 1 Archaeological Impact Assessment (AIA) for the proposed Skietkuil quarries 1 and 2 on the farm Skietkuil no. 3, Victoria West, central Karoo District, Western Cape Province ≈20 kms SW of study area. This study located stone artefacts as well as a lower grind stone, ceramics as well as kraals.

- Booth (2011) A phase 1 archaeological impact assessment (AIA) for the proposed Kleinfontein solar energy facility on the farm Kleinfontein, portion 4 of 167, situated near Noupoort, Northern Cape Province ≈130 kms E from study area. Isolated occurrences of very weathered and patinated Middle Stone Age (MSA) stone artefacts were observed within the proposed area.
- Booth, 2011 (b) A phase 1 Archaeological Impact Assessment (AIA) for the proposed solar facility on the farm Toitdale, portion 1 of 167, situated near Noupoort, Northern Cape Province ≈ 130 kms from the study area. MSA scatters.
- Fourie (2010) Phase 2 Heritage Impact Assessment for the Gamma-Kappa 765kV Transmission line. Various heritage resources were identified including rock engravings 5km south of the Kappa substation.
- Fourie (2016) Basic Assessment for the proposed construction of supporting electrical infrastructure for the Victoria West wind farm, Victoria West, Northern Cape Province ≈Kim form the study area. A MSA scatter was located as well as a colonial structure/farmstead
- Hart (2015) Heritage Impact Assessment for the proposed Umsinde Emoyeni wind energy facility. ≈40 kms from study area. This study located ESA, MSA and LSA scatters, ceramics, rock paintings and rock engravings pre-colonial kraals and historic buildings and graves.
- Halkett &Webley (2011) Heritage Impact Assessment: proposed Victoria West mini renewable energy facility on the farm Bultfontein 217, northern cape province. ≈30 kms W of the study area. The author found a wide scatter of stone artefactual material including some concentrations, which suggest spatial integrity. Most of the material observed can be ascribed to the Middle Stone Age (MSA).
- Morris (2012) Wildebeest Vlakte Karoo PV solar energy project. Specialist input for the Environmental Impact Assessment for the proposed Wildebeest Vakte Karoo PV solar energy project, Richmond registration division, Northern Cape Province ≈30 kms NW of the study area. Small scatter of MSA artefacts were located as well as two colonial structures of interest, a ruin of a stone dwelling with included ash heap containing porcelain and a small dry stone fortification, part of a blockhouse line developed to defend the railway during the Anglo Boer war.
- Murimbika (2014) Proposed Gamma-Kappa 2nd 765kv Eskom Transmission Powerline and Substations Upgrade Development in Western Cape, Phase 1 heritage impact assessment study. This study runs west of the study area through Victoria West. Findings include ESA, MSA and LSA scatters.
- Van Schalkwyk &Wahl (2007). Heritage Impact Assessment of the Gamma Grassridge Powerlines and substation, Eastern, Western, and Northern Cape Provinces South Africa. Numerous heritage resources were identified, including buildings and structures; an historical settlement; the landscape of the Camdeboo Karoo and the Springbokvlakte, archaeological sites, graves and traditional building techniques.

4.2 Findings from the studies

The aim of a desktop study is to create a compendium of the heritage resources in a selected area. These processes provide a good indication of the type of heritage sites to be expected in the area of concern. The area of concern in this case is between Victoria West and Richmond in the upper Karoo area of the Northern Cape, South Africa.

Sources of data include scientific literature on the topic, scientific journals and previous heritage reports that have been conducted in the surrounding area.

People have occupied the Karoo for hundreds of thousands of years (Hart, 2015). This information is borne out by solid scientific studies by researchers both local and international that have worked in the central interior of the country since the early years of the 20th century. Virtually the entire full range of material evidence of human evolution is manifested in the archaeological sites of this area (Hart, 2015).

The available data indicates that heritage resources are varied and widely distributed throughout the general vicinity. The heritage features include Stone Age sites, rock art sites, historical buildings associated with villages and farmsteads, cemeteries, and potential cultural landscapes (Prins, 2011).

One of the most complete archaeological research surveys in South Africa was conducted by Professor Garth Sampson over a 30-year period, in the Agter Sneeuberg region (northern side of the Sneeuberg) in the central and upper Seacow River Area that covered an area of 734 square kilometers between Hanover, Richmond and Noupoort in the Northern Cape (Sampson, 1985; Booth, 2011). Sampson (1985) stated that one of the many reasons for him choosing to undertake archaeological research in to the Karoo was that it was that the heritage was intact and untouched by ploughing and recent intervention (Hart, 2015). The pre-colonial archaeology of the Karoo was not only visible, but also prolific and in exceptionally good condition.

The valley occurs north east to south east of the present study area and has revealed the presence of some 10 000 archaeological sites representing a history of human occupation that dates back at least 250 000 years (Hart, 2015). Since 1980 the headwaters of the Seacow River have been the focus of intensive archaeological survey where more than 16 000 Stone Age sites were recorded during this period (Sampson, 1985) and in depth ceramic distributional studies were conducted where later Stone Age Lithics and rare Khoekhoe pottery sherds were uncovered during systematic surveys of the area (Sadr & Sampson, 1999)

The Seacow River Valley covers an area of about 2000 sq. kms and was formerly known to its first trek-boer settlers as the Agter-Sneeuberg (Van der Merwe, 1937). Prior to the arrival of the trek-boers in the 1760's Bushman hunter-foragers who were believed to have been without livestock inhabited the area. Sampson (1989) describes the environment of the upper valley as large, flat, treeless basins on shale bedrock with thin topsoil. Dolerite ridges separate them and hill swarms supporting sparse bushes together with the typical Karoo scrub that also covers the flats (Sampson, 1989:3). It is believed that the carrying capacity of the area was high and was swarming with game at the time of colonial contact with the Bushman. Key resources for hunter-forager survival, such as springs, firewood, hyrax colonies, plant foods, hornfels for stone tools and rare rock shelters were all concentrated on dolerites.

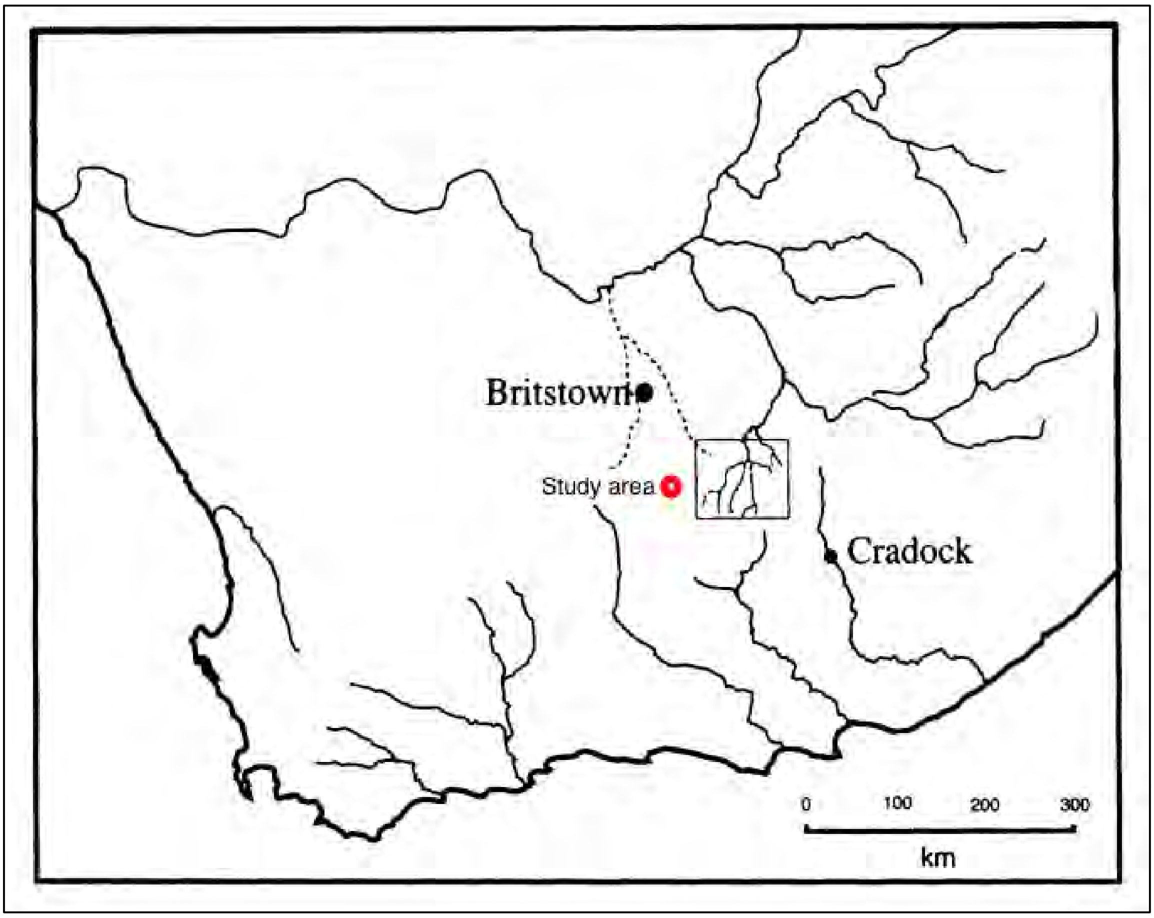

Figure 5: Position of the Seacow River Valley. Adapted from Close & Sampson, 1999

Prins (2011) and Sampson (1985) state that at about 1200 0 1400 AD, a global climatic fluctuation (The Little Ice Age) may well have caused an increase in rainfall in the central Karoo resulting in the area being more suitable than at present for the grazing by cattle and occupation by Khoekhoen pastoralists. It is further stated that archaeology of pastoralist occupation of vast areas in the Karoo are indicated by various stone kraal complexes of which several hundred have been recorded in the Seacow River Valley.

4.2.1 Pre-Colonial Past

- *Early Stone Age: 2.5 million to 250 000 years ago*

Early Stone Age stone artefacts endure for long periods and generally occur as open-air surface scatters either as isolated occurrences or in large quantities and very rarely in association with other archaeological heritage, plant and material remains (Booth, 2011).

The Earlier Stone Age is the first and oldest phase identified in South Africa's archaeological history and comprises two technological phases. The earliest of these is known as Oldowan and is associated with crude flakes and hammer stones. It dates to approximately 2 million years ago. The second technological phase is the Acheulean and comprises more refined and better made stone artefacts such as the cleaver and bifacial hand axe. The Acheulean dates back to approximately 1.5 million years ago.

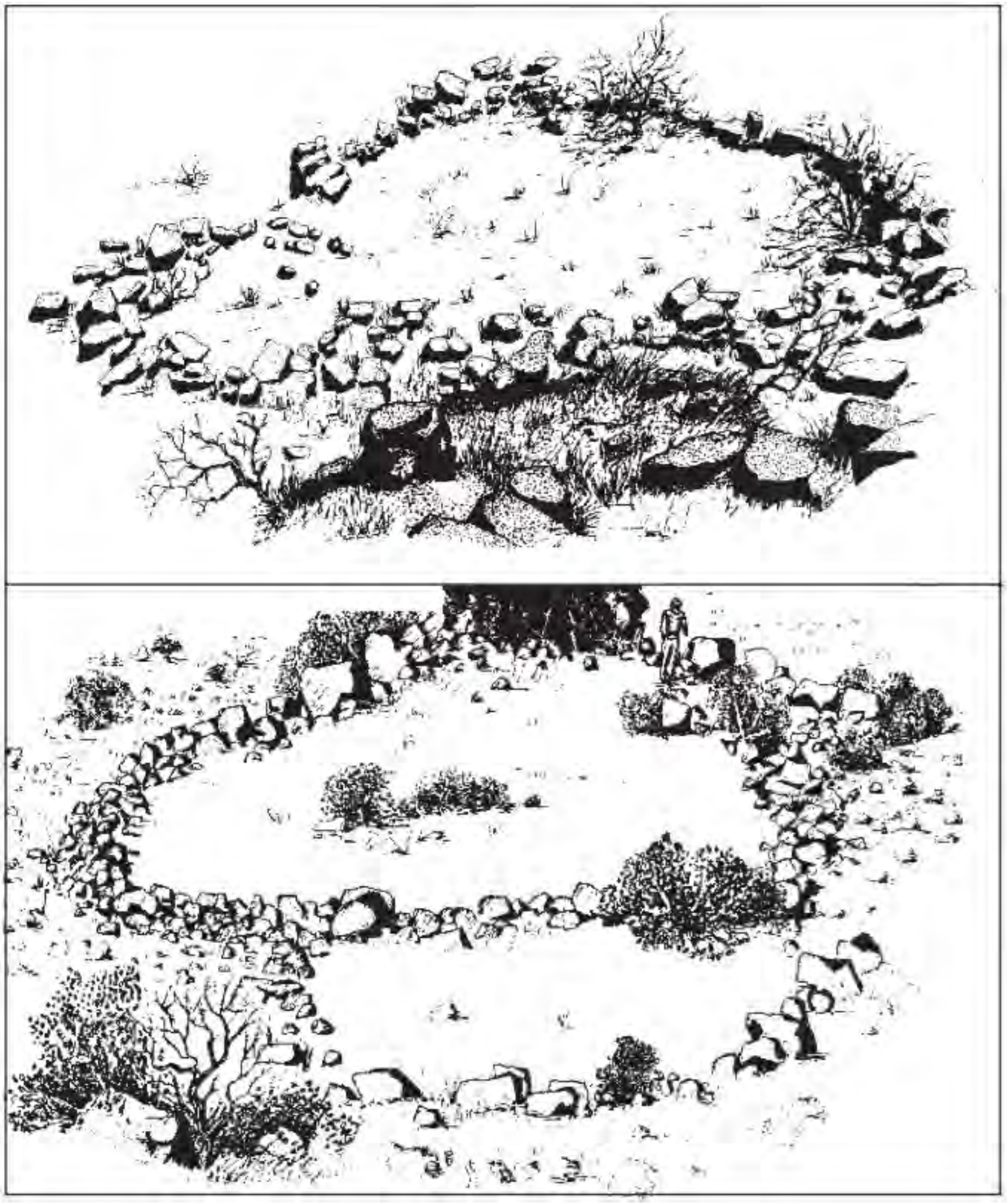

Figure 6: Field sketches from large, collapsed circles of low, dry-stone walling which is typical of the Seacow River Valley. (From Sampson unpublished article)

The Albany Museum database includes records of occurrences of Acheulean handaxes between Middelburg and the Kamdeboo National Park near Graaff Reinet, as well as a collection of stone artefacts from the Cradock area. Sampson (1985) located a large number of sites within the Seacow River Valley (Booth, 2011).

Victoria West lent its name to the so-called Victoria West Industry, a component of the Early Stone Age period (ESA), of which distinctive prepared cores are the most recognizable element (Inskeep, 1978 in Mitchell, 2002), this is considered a transitional between the ESA and MSA. Binneman *et al* (2010) mentions that during the 1920's, A.H.J. Goodwin (1926, 1946) identified the Victoria West Industry which occurred in the Karoo and along the Vaal River, It is was thought that the Victoria West cores are the 'evolutionary step' before the Levallois or the prepared core industry, indicating an outward spread of this technological change (Lycett, 2009: 175).

- *Middle Stone Age: 250 000 to 40 000 years ago*

The Middle Stone Age is the second oldest phase identified in South Africa's archaeological history. This phase is associated with flakes, points and blades manufactured by means of the so-called 'prepared core' technique.

The MSA focuses on the emergence of modern humans by the change in technology, behaviour, physical appearance, art, and symbolism (Booth, 2011). Surface scatters of these flake and blade industries occur widespread across southern Africa although rarely with any associated botanical and faunal remains (Booth, 2011). It is also common for these stone artefacts to be found between the surface and approximately 50-80cm below ground. Fossil bone may be associated with Middle Stone Age occurrences. According to Booth (2011), the Albany Museum database holds records of the occurrence of Middle Stone Age stone artefacts around the Cradock area. Sampson has reported many open-air MSA sites which he assigned to the Orangian Industry (dating between 128 000 - 75 000 years old), Florisbad and Zeekoegat Industries dating between 64 000 and 32 000 years old (Booth, 2011).

- *Late Stone Age: 40 000 years ago to the historic past*

The Later Stone Age is the third archaeological phase identified and is associated with an abundance of very small artefacts known as microliths, and is associated with the archaeology of San hunter-gatherers. It is a very important layer on the Karoo landscape as this represents the heritage of the Khoekhoen (historically known as "Hottentot" by early writers) and San (popularly known as Bushman) people of South Africa (Hart, 2015). The direct descendants of these groups make up a significant proportion of the population today. This heritage is represented by two industries (phases). These are the Interior Wilton which is characterised by a microlithic stone artefact industry characterised by lightly patinated hornfels (indurated shale stone) and the later Smithfield industry characterised by specific classes of stone artefacts and the presence of grass tempered ceramics (Hart, 2015).

The majority of archaeological sites date from the past 10 000 years where San hunter-gatherers inhabited the landscape living in rock shelters and caves as well as on the open landscape, inland and along the coast (Booth, 2011). Booth (2011) mentions that the open sites are difficult to locate because they are in the open veld. The preservation of these sites is poor and it is not always possible to date them (Deacon & Deacon, 1999; Booth, 2011). Caves and rock shelters, however, in most cases, provide a more substantial preservation record of pre-colonial human occupation (Booth, 2011).

The Later Stone Age archaeology of the Karoo region is described as rich and varied. Various studies (Beaumont & Morris, 1990; Beaumont & Vogel, 1984, and Sampson, 1985) have shown that the general area has been relatively marginal regarding pre-colonial human settlement, but is in fact exceptionally rich in archaeological sites and rock art (Booth, 2011). Bifacial and tanged barbed arrowheads made on very fine-grained dark or black chalcedony are distributed over the Kimberly area in the west, Lesotho in the east and as far south as Britstown and Steynsburg (Humphreys, 1991).

About 2 000 years ago Khoekhoen pastoralists entered into the region and lived mainly in small settlements. They were the first food producers in South Africa and introduced domesticated animals (sheep, goats and cattle) and ceramic vessels to southern Africa (Booth, 2011). Often, these archaeological sites are found close to the banks of large streams and rivers and along the coast. Large piles of freshwater mussel shell (called freshwater middens) usually mark the large stream and river sites and large piles of marine shellfish middens mark the coastal sites.
According to Hart (2015), it was after 1000 years BP people who were herding sheep/goats and possibly cattle, made an incursion into Karoo and established a new economic order based on transhumant pastoralism (Hart, 1989; Sampson *et al,* 1989; Sampson, 2010). The presence of herding people is represented by stone walled structures that occur throughout the Karoo. They have been recorded within the Zeekoei River Valley, between De Aar and Victoria West and even in the inhospitable high Karoo near Sutherland (Hart, 2005) and on the West Coast (Sadr, 2007).
The spatial distribution of Late Stone Archaeological sites in the Karoo is quite patterned. People needed to be close to water so rivers, pans and springs played an important role in influencing where people lived. As previously mentioned the climate of the Karoo also played a key role. The winters can be extremely cold with temperatures dropping well below zero, made worse by freezing winds (Hart, 2015).

- *Ceramics*

A study done by Sampson *et al* (1989) discusses to importance of ceramic studies. Eight shallow rock shelters deposits were excavated in the headwaters of the Seacow River. In this case it is explained how depositional sequences can be reconstructed from rare, diagnostic potsherds used as fossil markers. The sherd contexts were examined on a case by case basis, revealing a valley-wide sequence.

Sampson *et al* (1989) discuss the findings; Grass-tempered plain wares first appear in the area at AD 900 together with rare Khoi vessels. The latter disappear from the record for c. 500 years, and then reappear in numbers. Various stamp-decorated wares, forming localized concentrations on the landscape, which suggest social groupings, then replace Khoi ceramics. Following this, these are replaced, apparently abruptly, by a single, valley wide ubiquitous rocker-stamp wares again rapidly replace motif of double puncture rows, and this. Sampson *et al* (1989) suggest that this final motif appears at the same time as the first European items, therefor suggesting that its arrival must date close to AD 1770. Rocker-stamp motifs continued to be made by the parahistoric Bushmen well into the post contact era. This research presents evidence of at least five stylistic upheavals in a single millennium.

Sadr & Sampson (1999) conducted a further study on the ceramics in the Upper Seacow Valley area, they stated that Khoekhoe pottery on surface sites in the upper Seacow River Valley is remarkably like the more abundant, well- stratified Later Stone Age ceramics found some 500-600 **km** away in the south-western Western Cape Province. They believe that pastoralists introduced both. Sadr and Sampson (1999) further state that there appears to have been a steadily expanding herder presence in the upper Seacow Valley with the expansion front moving from north-west to south-east across the study area. Whether this means that some later phases have their origins in the regions *between* the two areas compared here, remains to be seen.

- *Rock art*

Heritage resources such as rock art have been identified by Van Schalkwyk and Wahl (2007) in the Kamdeboo mountains, which occur near Graaff Reinet (≈ 115 Kms from the study area). Rock engravings are known to exist on dolerite koppies in the region, and occur in hills along the Ongers River (Morris, 2012). Such koppies occur as a major feature in the area (Morris, 2012)

The SARADA database of rock art indicates that rock paintings and engravings occur sporadically within the surrounding area. These include rock art found on four farms near Beafort West (≈118 kms SW from study area), sixteen localities in the Richmond area (≈35 kms NE from study area), two farms near Murraysburg (≈50 kms S from study area), two farms near Nieu Bethesda (≈100 kms SE from study area) and one near Victoria west (≈40 kms NW from study area)(Van Riet-Lowe, 1941). Some of the most well-known rock engraving site occurs at Nelspoort, at near Beaufort West (Prins, 2011).

4.2.2 Colonial Archaeology

Hart (2015) states that the indigenous people of Karoo waged a bitter war against colonial expansion as they gradually lost control of their traditional land. Penn (2005) notes the most determined indigenous resistance to trekboer expansion occurred when they entered the harsh environment of the escarpment of the interior plateau (namely Hantam, Roggeveld and Nieuweveld Mountains).

During the first quarter of the nineteenth century the Seacow River valley, between the Sneeuberg range and the Orange River, was on the far northeastern border of the Cape Colony. Dutch stock farmers (trekboers) were present in small numbers from the 1770s and rapidly filled up the valley between 1800-1820 (Neville *et al,* 1994).

The frontier history of the Upper Seacow Valley is one on changing interactions between resident Bushman, Hunter-Gatherers and Dutch trekboer pastoralists (Saitowitz & Sampson, 1992). The early direct contact phase spans from 1765-1770 and their direct contact phase is covered by the Bushman/Boer war for the Sneeuberg between 1770-1800. It was believed that the San launched an almost successful campaign to drive the trekboers out. Numerous place names throughout the Karoo such as Oorlogspoort and Oorlogskloof are testimony the skirmishes of the late 18th century (Hart, 2015). The situation became so desperate that the colonists fought back by establishing the "Kommando" system – the "hunting" of San was officially sanctioned in 1777 (Dooling, 2007) and in some instances bounties were obtainable from the local landrost (on presentation of body parts).

The Drosdy of Graaff Reinett played a significant role in this long and bitter war, which eventually saw the almost complete destruction of the Karoo San.

The settlement phase covers Earl Macartney's pacification programme of 1800-1825 (Saitowitz & Sampson, 1992; Thompson & Lamar, 1981). There was also an advanced settlement sub-phase during 1826-1850 where surviving pockets of 'wild' Bushmen suffered increasing ecological and social stress. During the Consolidation phase 1850-1890, the upper valley was surrounded by towns and entered the cash economy, with most remaining Bushman becoming servants (Sampson, 1993).

- *Glass beads*

Sampson (1993) discusses how surviving documents indicate that among the first European items acquired by the Seacow River Bushmen were glass beads, clay pipes and copper wire. During the pacification programme, Bushmen were encouraged to settle at the farmsteads, flint-and-steel sets, tinderboxes and knives were handed out during this time. Muskets were also given to Bushmen shepherds and farm guards. Other items such as household utensils and European clothing only became common among farm Bushmen in early Consolidation times (Saitowitz & Sampson, 1992). Increased use of building materials like window glass, nails, screws, box strapping and especially fencing wire by the Bushman occurred after 1880.

Saitowitz & Sampson (1992) excavated eight rock shelters in the upper Seacow valley, the superficial deposits contained fragments of nearly all the above-mentioned items among dwindling numbers of indigenous Smithfield artefacts. In six of these excavations, small assemblages of glass beads were found in association with other European items, many of which have can be dated to the nearest quarter century (Saitowitz & Sampson, 1992). Although very small samples, these bead assemblages, together with those from three shelters in the adjacent middle Orange River, offer rare insights into glass bead chronology for the semi-arid interior of South Africa.
Saitowitz & Sampson (1992) state that although all the upper Karoo rock shelters were still in use at the end of the nineteenth century, glass beads were not found reliably associated with any of these dated superficial deposits. Presumably the farm Bushmen responsible for such residues had by this time adopted European dress, and glass beads no longer played any part in the frontier exchange system.

- *Guns*

Westbury and Sampson (1993) conducted a study, which observed the acquisition of guns by Bushman in the Seacow Valley, the purpose being to provide a timetable of changes in firearm technology throughout the valley. They state that records suggest that Bushman began to use firearms as early as 1770, however material traces only appear from 1825. According to Westbury & Sampson (1993) the earliest that musketry could have been introduced to the upper Seacow Valley would have been the 1770s. During that decade firearms and ammunition were supplied heavily into what was to become the Graaff-Reinet region, and particularly into the Sneeuberg Mountains immediately to the south of the upper valley. The newly arrived Dutch farmers in the area were believed to be arming themselves and their Khoi servants against marauding Bushman, also mentioned above (Westbury & Sampson, 1993)

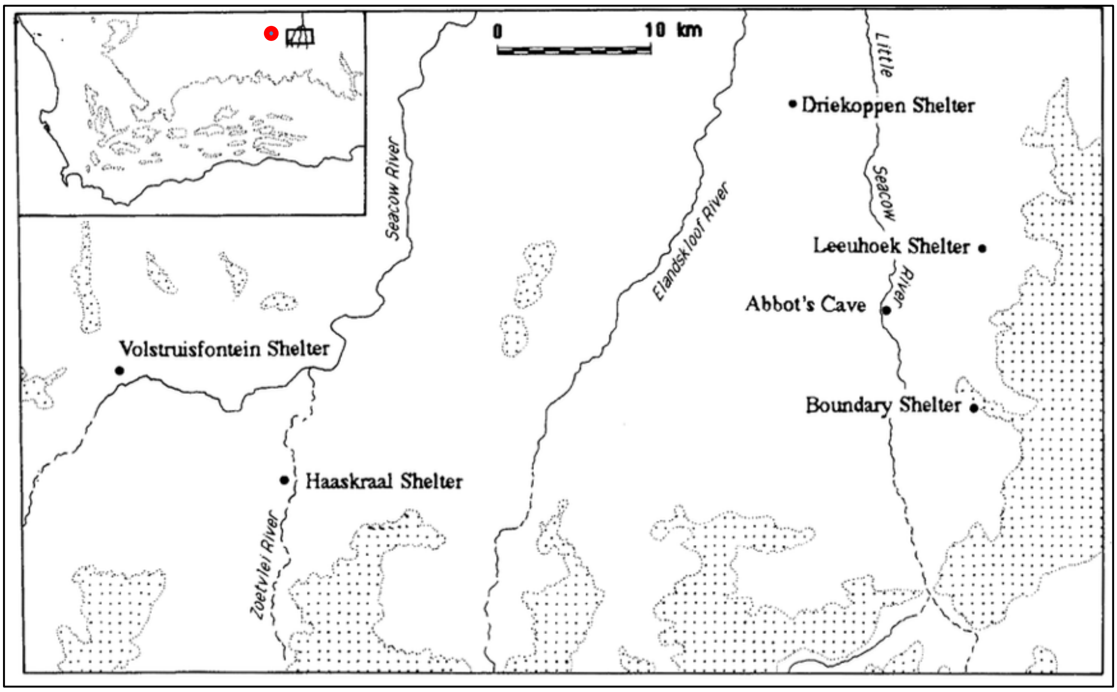

Figure 7: Map of the upper Seacow valley, showing mountains (stippled) main tributaries and locations of rock shelters containing glass trade beads. From Saitowitz & Sampson 1992:94. (red dot current study area)

The Dutch authorities at the Cape heavily supplemented Trekboer weaponry, as shown by a resolution of the Governor's Council dated 1774, in which an ammunition wagon was ordered to be sent to the Sneeuberg with "90 firelocks, 900 lbs of gunpowder, 1,800 lbs of lead, 3,000 flints" (Moodie, 1960). In 1977 the situation got more severe between farmers and Bushman, and more ammunition was requested. By 1779 a further request to the Cape authorities, this time for 1000 lbs gunpowder and 2000 lbs lead (Westbury & Sampson, 1993). During these years there were many opportunities for ammunition to be stolen from farmers or acquired by run-away servants.
By 1809 Strife had substantially subsided after the enforcement of Earl Macartney's pacification programme by the Landdrost, and guns had become common throughout the landscape. Farmers and herders were using the weapons at this stage alike, for protection against wild animals.

The introduction of weapons by expanding colonization had an impact on the archaeological record. Westbury & Sampson excavated nine rock shelters in the Upper Seacow valley of which all revealed shallow post-Contact horizons containing a wide variety of European items found among dwindling numbers of artefacts, fauna and indigenous pottery.

4.2.3 Findings from the studies

Palaeontology

The following is extracted from the Palaeontological Impact Assessment (PIA) completed by Butler (2019) – Refer to **Appendix E** for the full PIA.

*The proposed development includes three PV facilities as well as grid connections and infrastructure. These proposed developments are underlain by the continental sediments of the Latest Permian sediments of the Balfour Formation (Upper Beaufort Group, Adelaide Subgroup) and earliest Triassic sediments of the Katberg Formation (Upper Beaufort Group, Tarkastad Subgroup, Karoo Supergroup) as well as Jurassic Karoo Dolerite. These sediments are generally mantled by a thick layer of Quaternary to Recent colluvium and alluvium. The uppermost Balfour and Katberg Formations are of extraordinary interest in that they provide some of the best existing information on ecologically-complex terrestrial ecosystems during the catastrophic end-Permian mass extinction. According to the PalaeoMap of South African Heritage Resources Information System the Palaeontological Sensitivity of the Tarkastad and Adelaide Subgroups has a Very High Palaeontological Sensitivity, while that of the Quaternary superficial deposits of the Central interior is high and the Karoo dolerite (igneous rocks) is insignificant and rated as zero (***Figure 8** ***to*** **Figure 10***).*

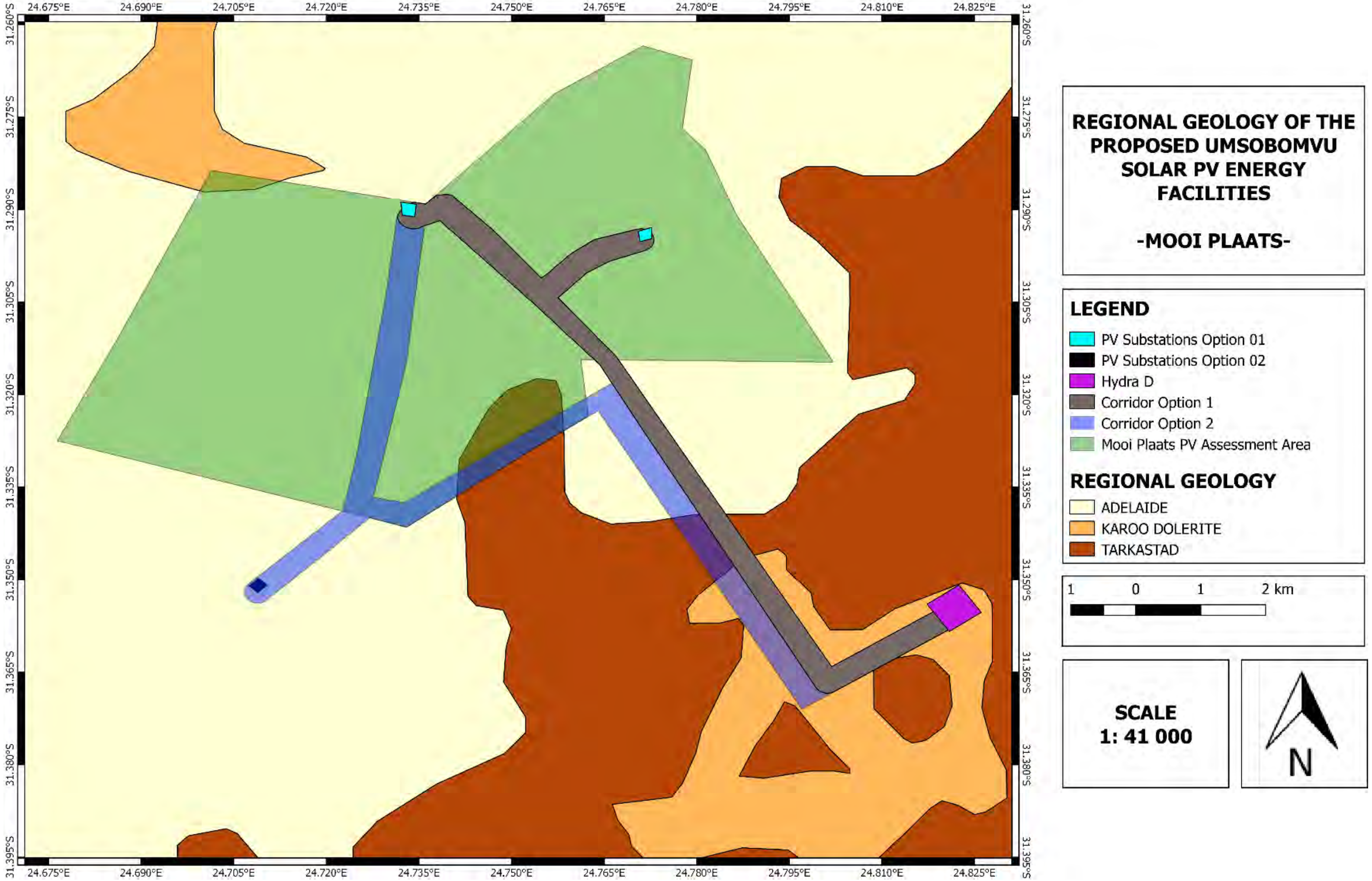

Figure 8: Surface geology of the proposed Umsobomvu Solar PV Energy Facilities: Mooi Plaats. The proposed development is underlain by the Adelaide and Tarkastad Subgroup, Beaufort Group, Karoo Supergroup) as well as Jurassic Karoo Dolerite. Map drawn QGIS Desktop 2.18.1. Map drawn QGIS Desktop 2.18.1

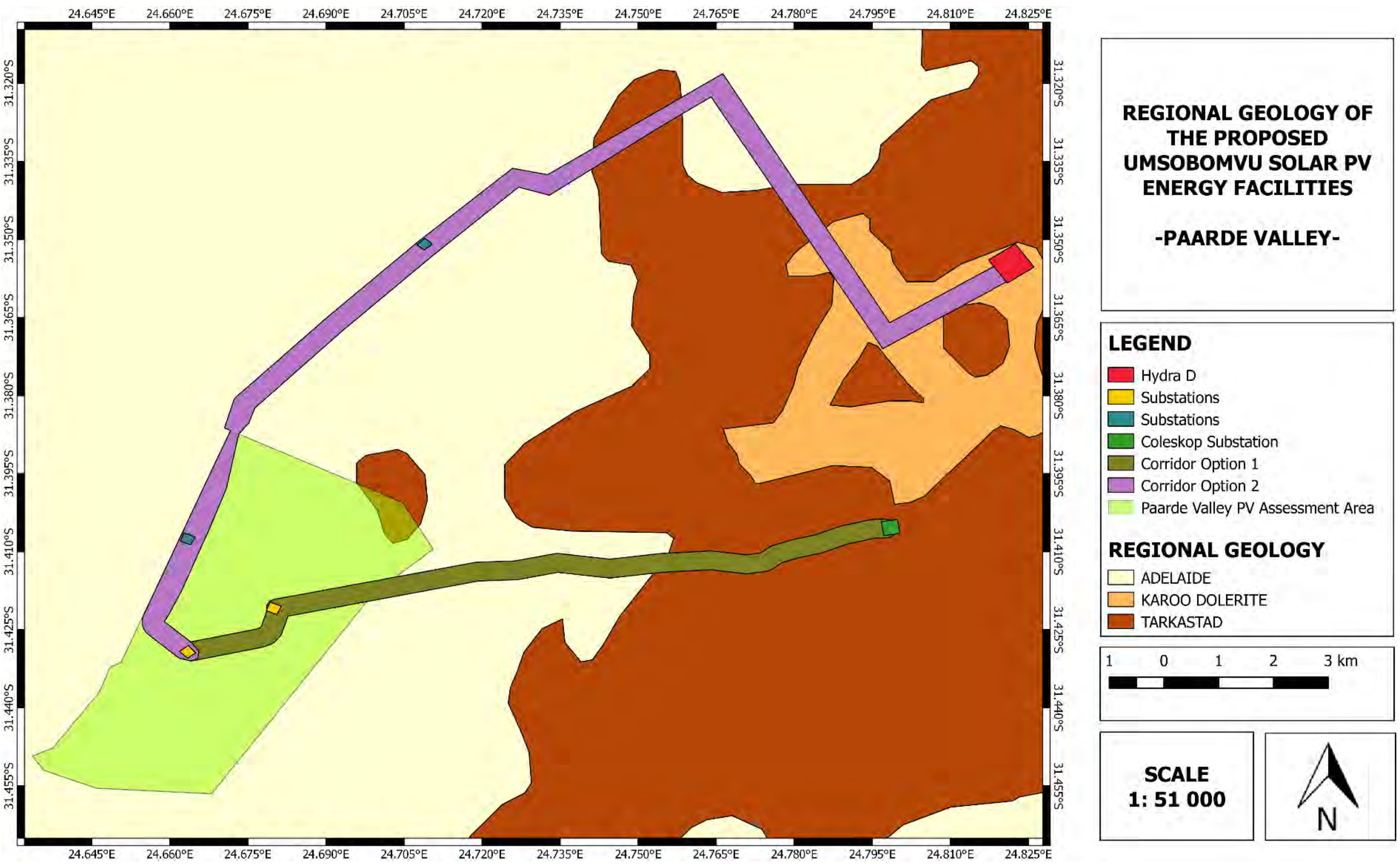

Figure 9: Surface geology of the proposed Umsobomvu Solar PV Energy Facilities: Paarde Valley. The proposed development is underlain by the Adelaide and Tarkastad Subgroup, Beaufort Group, Karoo Supergroup) as well as Jurassic Karoo Dolerite. Map drawn QGIS Desktop 2.18.1

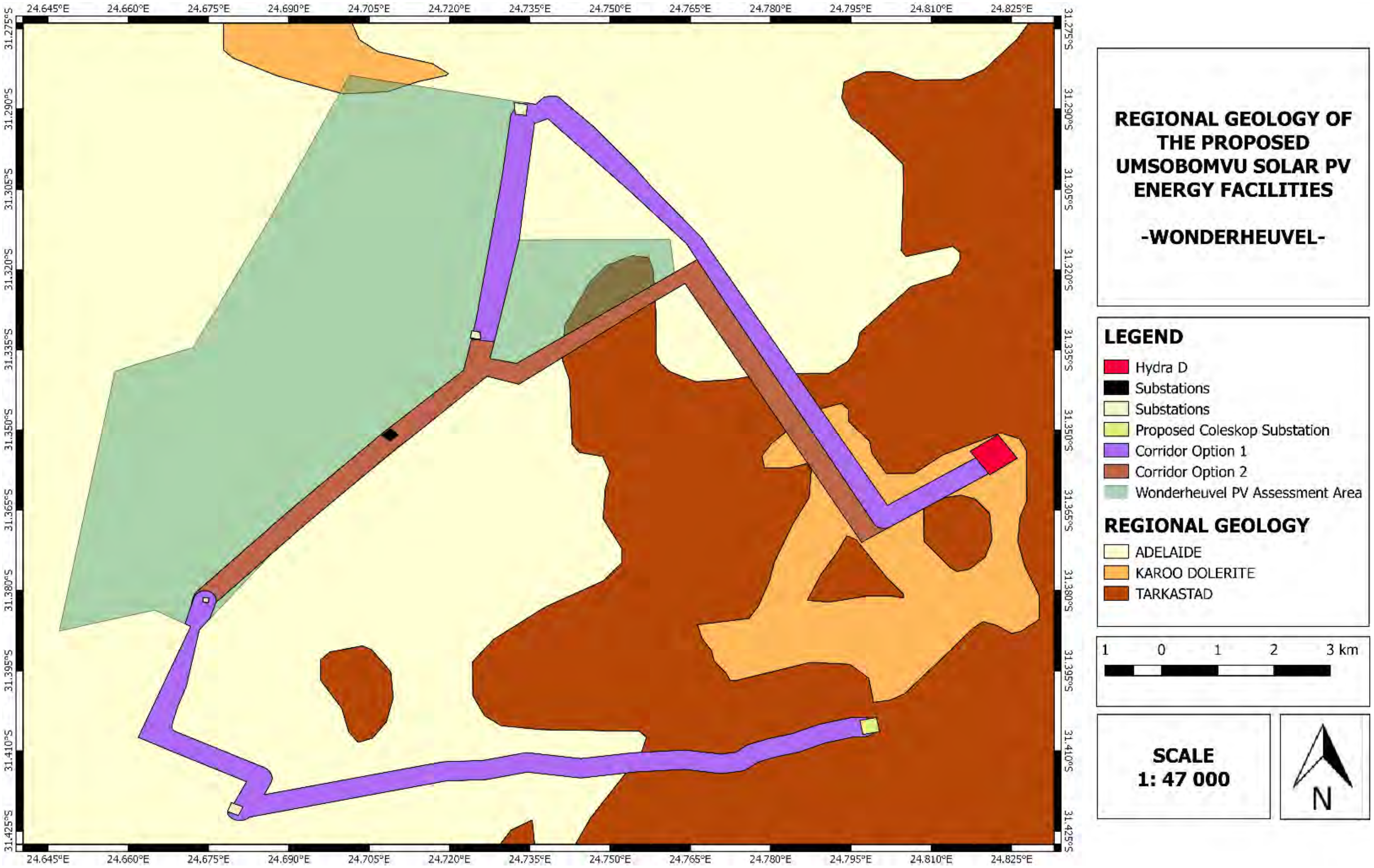

Figure 10: Surface geology of the proposed Umsobomvu Solar PV Energy Facilities: Wonderheuvel. The proposed development is underlain by the Adelaide and Tarkastad Subgroup, Beaufort Group, Karoo Supergroup) as well as Jurassic Karoo Dolerite. Map drawn QGIS Desktop 2.18.1

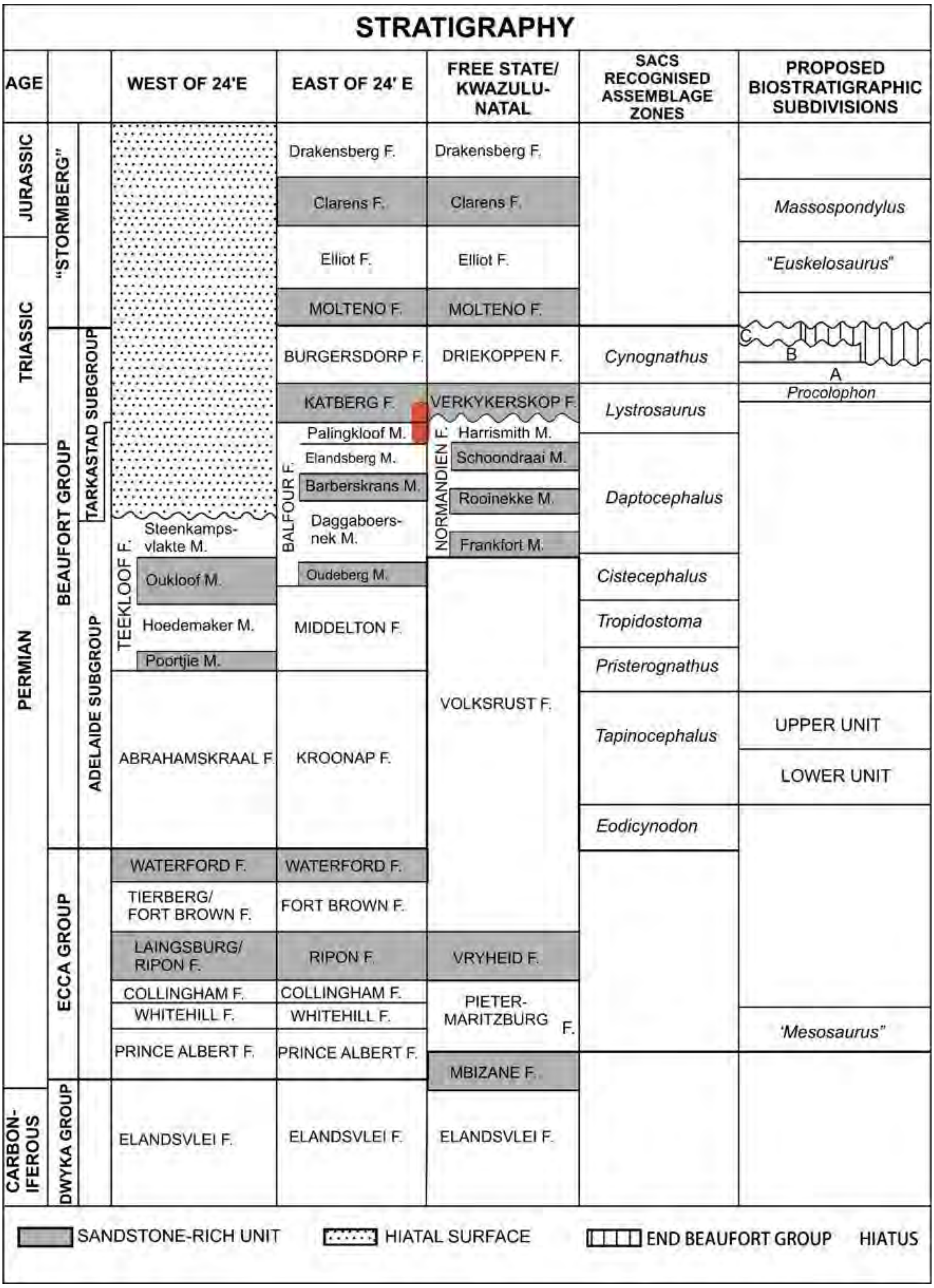

Figure 11: Lithostratigraphic (rock-based) and biostratigraphic (fossil-based) subdivisions Beaufort Group of the Karoo Supergroup with rock units and fossil assemblage zones relevant to the present study marked in red (Modified from Rubidge, 1995). Abbreviations: F. = Formation, M. = Member

The proposed development includes three PV facilities as well as grid connections and infrastructure. These proposed developments are underlain by the continental sediments of the Latest Permian sediments of the Balfour Formation (Upper Beaufort Group, Adelaide Subgroup) and earliest Triassic sediments of the Katberg Formation (Upper Beaufort Group, Tarkastad Subgroup, Karoo Supergroup) as well as Jurassic Karoo Dolerite. These sediments are generally mantled by a thick layer of Quaternary to Recent colluvium and alluvium. The uppermost Balfour and Katberg Formations are of extraordinary interest in that they provide some of the best existing information on ecologically-complex terrestrial ecosystems during the catastrophic end-Permian mass extinction. According to the PalaeoMap of South African Heritage Resources Information System the Palaeontological Sensitivity of the Tarkastad and Adelaide Subgroups has a Very High Palaeontological Sensitivity, while that of the Quaternary superficial deposits of the Central interior is high and the Karoo dolerite (igneous rocks) is insignificant and rated as zero.

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle from the 24^{tht} – 28th January 2019. Elsewhere in the Karoo Basin numerous fossils have been uncovered in these geological sediments but only two sites on koppies with fossiliferous outcrops were identified. These fossiliferous sites have been identified as Highly Sensitive and No-go areas. It is recommended that a 50 m buffer will be placed around these areas. In the event that construction is necessary in these sensitive areas it is recommended that the fossils will be collected by a professional palaeontologist. Preceding excavation of any fossil material, the specialist would need to apply for a collection permit from SAHRA. Fossil material must be curated in an accredited collection (museum or university collection), while all fieldwork and reports should meet the minimum standards for palaeontological impact studies suggested by SAHRA.

4.2.4 Heritage sensitivities

The evaluation of the possible heritage resource finds, and their heritage significance linked to mitigation requirements was linked to types of landscape. The heritage sensitivity rating does not indicate no-go areas but the possibility of finding heritage significant site that could require mitigation work.

4.2.5 Possible finds

Evaluation of aerial photography has indicated that certain areas may be sensitive from an archaeological perspective. The analysis of the studies conducted in the area assisted in the development of the following landform type to heritage find matrix in Table 2**.**

Table 2:Landform to heritage matrix

LAND FROM TYPE	HERITAGE TYPE
Crest and foot hill	LSA and MSA scatters
Crest of small hills	Small LSA sites – scatters of stone artefacts, ostrich eggshell, pottery and beads
Pans	Dense LSA sites

LAND FROM TYPE	HERITAGE TYPE
Outcrops	Occupation sites dating to LSA
Farmsteads	Historical archaeological material

5 FIELWORK FINDINGS

Due to the nature of cultural remains, a systematic controlled-exclusive surface survey was conducted on foot and in a vehicle, over a period of four days by an archaeologist and archaeological technician from PGS. The fieldwork was conducted on the 26-29 August 2019.

The area is characterized by typical Karoo landscape with low vegetation cover and vast open spaces. The PV localities are situated in the flat low lying areas (**Figure 12** and **Figure 13**) while the southern power line corridors travers mountainous areas (**Figure 14** and **Figure 15**).

Figure 12: View of open Karoo veld in study area

Figure 13: Characteristic view of the study area

Figure 14: View of one of the power lien corridors

Figure 15: Mountainous areas within study area

The following section describes the heritage resource identified during the fieldwork and is divided per PV facility.

5.1 Mooi Plaats

The Mooi Plaats PV and corridor areas revealed a single heritage resource point (**UMS007**) within the development footprint (refer to **Table 3**). As noted in section 1.2 of this report the focus of the field work was on the PV footprints as well as the power line corridor centre lines. Track logs (in orange) for the survey and heritage resources in red are indicated in **Figure 18**.

Table 3 – Heritage Resources for Mooi Plaats

Site[1] number	Lat	Lon	Description	Heritage Significance	Heritage Rating
UMS007	S 31,28607	E 24,74903°	A small, circular shaped, stone walled enclosure was identified at this location. The enclosure measures approximately 4m x 5m in size and the walls were approximately 1m high and approximately 0.75m wide. It was overgrown and collapsed in several places. The small enclosure was most probably used during the herding of sheep and goats on the farm.	Medium	IIIB

Figure 16: View of stone packed wall at site UMS007

Figure 17: View of stone packed wall at site UMS007

[1] *Site in this context refers to a place where a heritage resource is located and not a proclaimed heritage site as contemplated under s27 of the NHRA.*

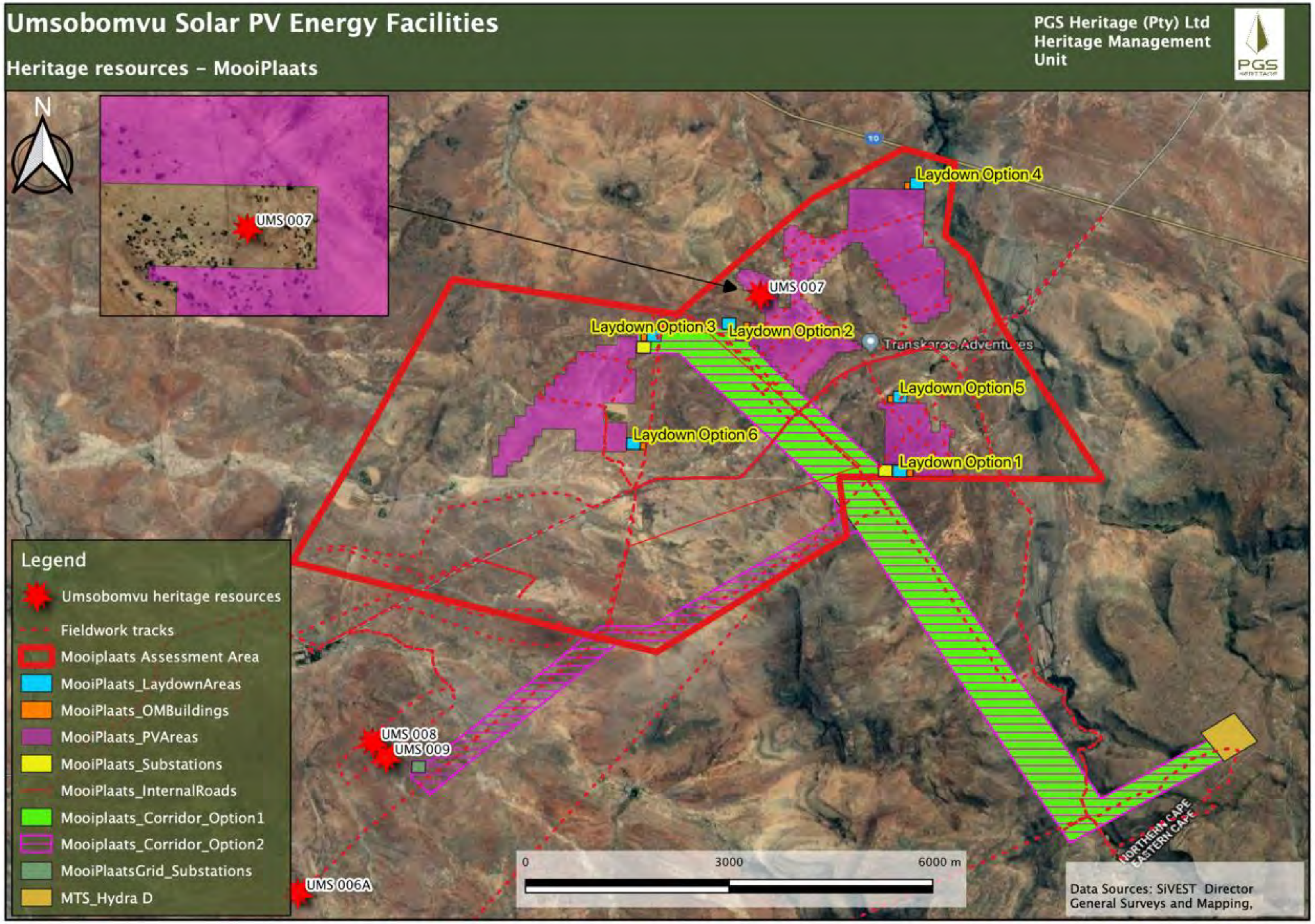

Figure 18: Heritage resources and tracklogs - Mooi Plaats

5.2 Paarde Valley

The Paarde Valley PV and corridor areas revealed tree heritage resource points (**UMS004, UMS005 & 005B and UMS006A**) within the development footprint (refer to **Table 4**). As noted in section 1.2 of this report the focus of the field work was on the PV footprints as well as the power line corridor centre lines. Track logs (in orange) for the survey and heritage resources in red are indicated in **Figure 25**.

Table 4 – Heritage Resources for Paarde Valley

Site number	Lat	Lon	Description	Heritage Significance	Heritage Rating
UMS004	S 31,41905°	E 24,69405°	A small, circular shaped, stone walled enclosure was identified at this location. The enclosure measures approximately 8m x 10m in size and the walls were approximately 1m high and approximately 0.75m wide. It was overgrown and collapsed in several places. The small enclosure was most probably used during the herding of sheep and goats on the farm. Three unknown stone mounds are situated approximately 15m to the south of the stone walled enclosure. The origin or function of these stone mounds is not known as yet. **Site extent**: 20x20m.	Medium	IIIB

Figure 19: Stone circle at UMS004

Figure 20: One of the stone mounds at UMS004

Site number	Lat	Lon	Description	Heritage Significance	Heritage Rating
UMS005 &005B	S 31,41926°	E 24,69005°	A low/medium density scatter (5-10 artefacts/10m²) of Late Stone Age artefacts was identified at this location. The scatter is situated on the northern slopes of an elongated rise which overlooks a water course approximately 80m further to the north. The scatter of artefacts follows the slope of the rise all along the water course to the north. It extents for approximately 400m along this water course further to the north and measures approximately 200m wide across the slope of the rise. The artefacts are exposed due to some sheet erosion which occurs across the slope. The artefacts occur in concentrations along this eroded or exposed area. The artefacts consist mostly of debitage (waste material such as flakes, chips and chunks) which were produced from fine- grained and weathered dolerite, quarts and rare CCS (Crypto-crystalline silicates). Some cores and blade fragments were also recognized.	Low	IIIC

Figure 21: View of site UMS005 and 005B

Figure 22: Dolerite core (left), some side and end scrapers collected on the site

Site number	Lat	Lon	Description	Heritage Significance	Heritage Rating
UMS006A	S 31,37868°	E 24,67732°	A small, circular shaped, stone walled enclosure was identified at this location. The enclosure measures approximately 5m x 6m in size and the walls were approximately 1m high and approximately 0.75m wide. It was overgrown and collapsed in several places. The small enclosure was most probably used during the herding of sheep and goats on the farm.	Medium	IIIB

Figure 23: Stone circle at UMS006A

Figure 24: Low stone walling

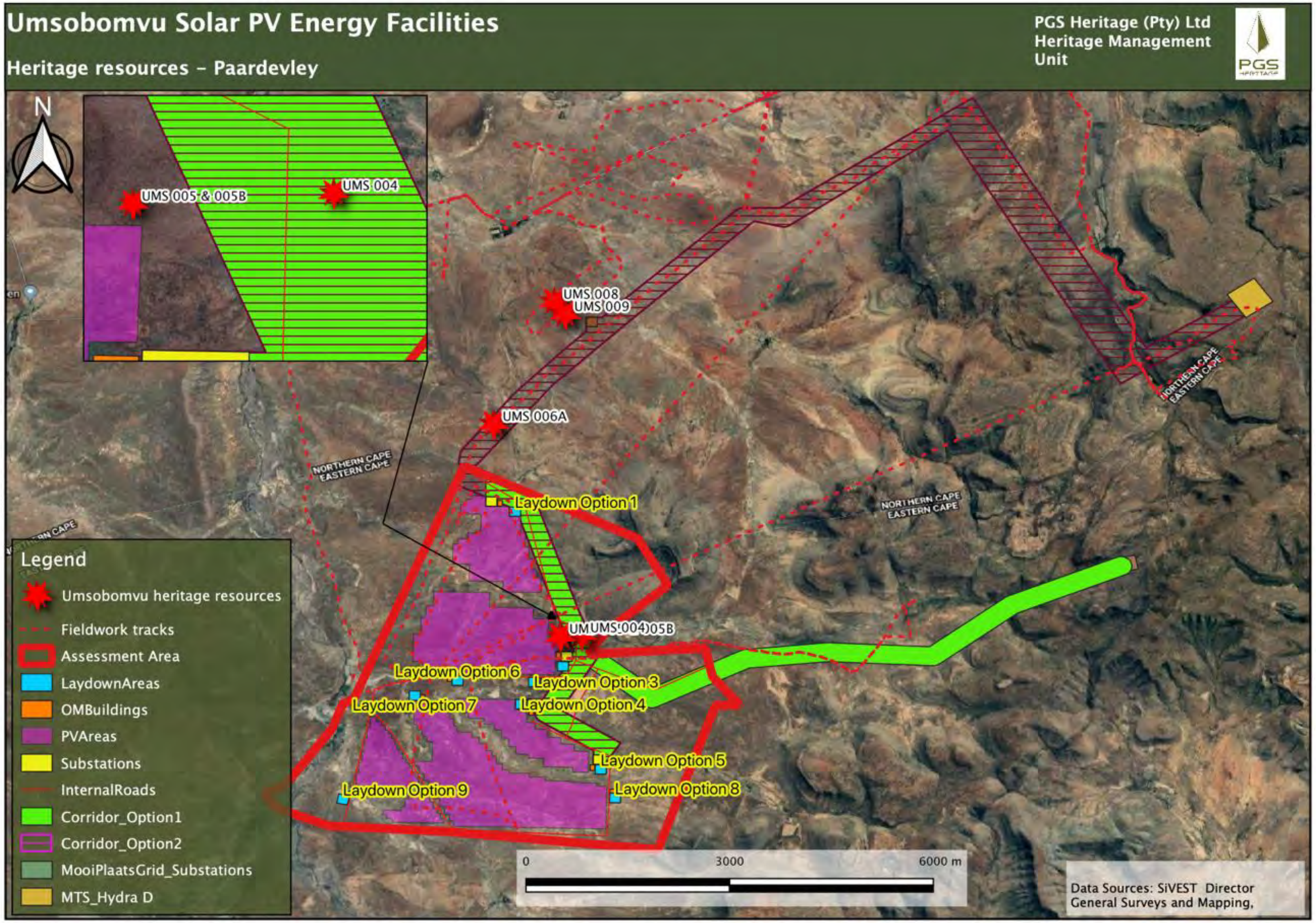

Figure 25: Heritage resources and tracklogs – Paarde Valley

5.3 Wonderheuvel

The Wonderheuvel PV and corridor areas revealed tree heritage resource points (**UMS004, UMS005 & 005B, UMS006A, UMS007-010**) within the development footprint (refer to **Table 5**). As noted in section 1.2 of this report the focus of the field work was on the PV footprints as well as the power line corridor centre lines. Track logs (in orange) for the survey and heritage resources in red are indicated in **Figure 37**.

Table 5: List of heritage finds in the Wonderheuvel PV footprint

Site number	Lat	Lon	Description	Heritage Significance	Heritage Rating
UMS004	S 31,41905°	E 24,69405°	A small, circular shaped, stone walled enclosure was identified at this location. The enclosure measures approximately 8m x 10m in size and the walls were approximately 1m high and approximately 0.75m wide. It was overgrown and collapsed in several places. The small enclosure was most probably used during the herding of sheep and goats on the farm. Three unknown stone mounds are situated approximately 15m to the south of the stone walled enclosure. The origin or function of these stone mounds is not known as yet. **Site extent**: 20x20m.	Medium	IIIB

Figure 26 – Stone circle at UMS004

Figure 27 – One of the stone mounds at UMS004

Site number	Lat	Lon	Description	Heritage Significance	Heritage Rating
UMS005 &005B	S 31,41926°	E 24,69005°	A low/medium density scatter (5-10 artefacts/10m²) of Late Stone Age artefacts was identified at this location. The scatter is situated on the northern slopes of an elongated rise which overlooks a water course approximately 80m further to the north. The scatter of artefacts follows the slope of the rise all along the water course to the north. It extents for approximately 400m along this water course further to the north and measures approximately 200m wide across the slope of the rise. The artefacts are exposed due to some sheet erosion which occurs across the slope. The artefacts occur in concentrations along this eroded or exposed area. The artefacts consist mostly of debitage (waste material such as flakes, chips and chunks) which were produced from fine- grained and weathered dolerite, quarts and rare CCS (Crypto-crystalline silicates). Some cores and blade fragments were also recognized.	Low	IIIC

Figure 28 – View of site UMS005 and 005B

Figure 29 – Dolerite core (left), some side and end scrapers collected on the site

Site number	Lat	Lon	Description	Heritage Significance	Heritage Rating
UMS006A	S 31,37868°	E 24,67732°	A small, circular shaped, stone walled enclosure was identified at this location. The enclosure measures approximately 5m x 6m in size and the walls were approximately 1m high and approximately 0.75m wide. It was overgrown and collapsed in several places. The small enclosure was most probably used during the herding of sheep and goats on the farm.	Medium	IIIB

Figure 30 – Stone circle at UMS006A

Figure 31 – Low stone walling

Site number	Lat	Lon	Description	Heritage Significance	Heritage Rating
UMS008	S 31,35536°	E 24,68892°	Another low density scatter (2-5 artefacts/10m²) of Late Stone Age artefacts was identified at this location. The scatter is situated on the northern slopes of a shallow valley or gully which overlooks a water course approximately 40m further to the north. The scatter of artefacts follows the slope of the valley/gully all along the water course to the north. It extents for approximately 100m along this water course further to the north and measures approximately 50m wide across the slope of the valley. The artefacts are exposed due to some sheet erosion which occurs across the slope. The artefacts occur in concentrations along this eroded or exposed area. The artefacts consist mostly of debitage (waste material such as flakes, chips and chunks) which were produced from fine- grained and weathered dolerite, quarts and rare CCS (Crypto-crystalline silicates). Some cores and blade fragments were also recognized.	Low	IIIC

Figure 32 – Low density scatter visible in grass

Figure 33 – Various blades and side scrapers collected in the area of UMS008

Site number	Lat	Lon	Description	Heritage Significance	Heritage Rating
UMS009	S 31,35536°	E 24,68892°	Another low density scatter (2-5 artefacts/10m²) of Late Stone Age artefacts was identified at this location. The scatter is situated on the slopes of a shallow valley or gully which overlooks a water course approximately 40m further to the south. The scatter of artefacts follows the slope of the valley/gully all along the water course to the south. It also extends across the water course and more artefacts are found on the other side of the water course. The area with artefacts covers approximately 80m x 120m and is situated on both sides of the water course. The artefacts are exposed due to some sheet erosion which occurs across the slopes. The artefacts occur in concentrations along this eroded or exposed area. The artefacts consist mostly of debitage (waste material such as flakes, chips and chunks) which were produced from fine- grained and weathered dolerite, quarts and rare CCS (Crypto-crystalline silicates). Some cores and blade fragments were also recognized.	Low	IIIC

Figure 34 – View of site UMS009

Figure 35 – Various scrapers and roughout flakes found on slope

Site number	Lat	Lon	Description	Heritage Significance	Heritage Rating
UMS010A UMS10B	S31.32807° S31.32813°	24.745946° 24.745929°E	Only two sites with fossiliferous outcrops were identified on the proposed development footprint. As the fossiliferous outcrops was located on a koppies it and should not have an effect on the PV solar plants. Thus, although fossiliferous outcrops have been identified no, No-go areas or highly sensitive fossil sites have been identified as the uncovered fossils were poorly preserved and fragmentary.	Low	IIIC

Figure 36 – In situ Lystrosaurus skull

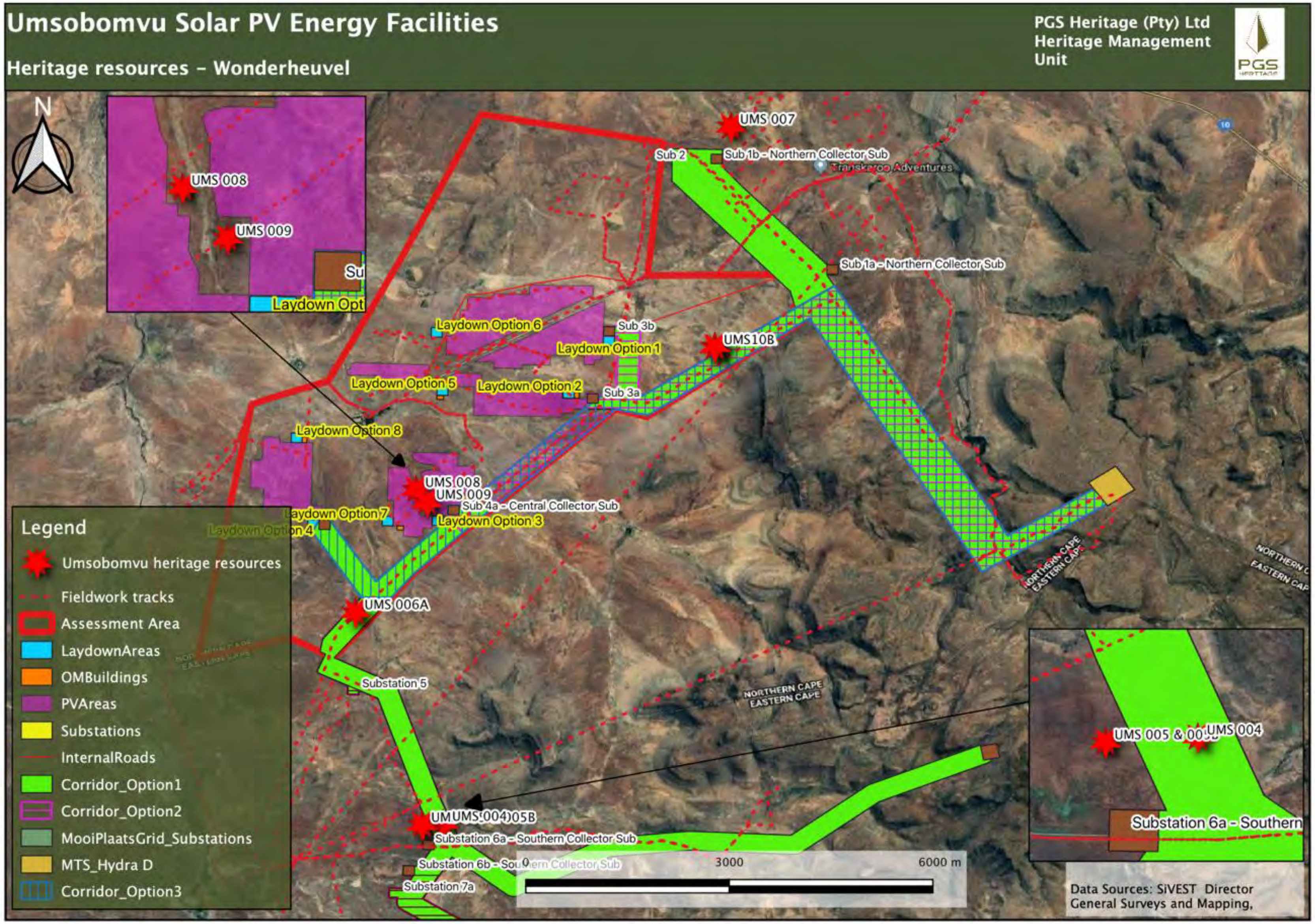

Figure 37: Heritage resources and tracklogs - Wonderheuvel

6 IMPACT RATINGS

After consideration of the proposed layout in relation to the heritage resource the following table provide findings for each of the PV projects inclusive of their corridors. The impact assessment rating is based on the rating scale as contained in **Appendix B** and **Appendix C**.

Table 6: Impact table for the Mooi Plaats PV options

MOOI PLAATS SOLAR PV 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																				
Impact on known Stone Age resources	Impact on stone age resources during earth moving - including trenching, road making, foundation digging	1	2	3	4	4	2	28	-	Medium impact	** Review PV layout to avoid the site **Implementation 30-meter buffer	1	1	3	2	1	2	16	-	Low impact
Impact on chance finds	Impact on stone age resources during earth moving - including trenching, road making, foundation digging	1	1	3	4	4	4	52	-	High impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	3	4	3	2	24	-	Medium impact

MOOI PLAATS SOLAR PV 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
Impact on palaeontological resources	Impact on palaeontological resources during earth moving - including trenching, road making, foundation digging	1	2	3	4	4	2	28	-	Medium impact	**Implement chance finds procedures **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	2	4	4	2	24	-	Medium impact
Operational Phase																				
Impact on heritage resources	Impact on heritage resources during general maintenance	1	1	4	4	4	4	56	-	High impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	4	4	4	1	14	-	Low impact
Decommissioning Phase																				
Impact on heritage resources	Impact on heritage resources during rehabilitation work associated with decommissioning - grading trench filling etc	1	1	4	4	4	4	56	-	High impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request	1	1	4	4	4	1	14	-	Low impact

MOOI PLAATS SOLAR PV 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
											destruction permits from SAHRA									
Cumulative																				
Impact on heritage resources	Additional impact of the development on heritage resources adding to the current cumulative impact of existing or proposed developments in the region	2	2	4	4	4	2	32	-	Medium impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	4	4	4	1	14	-	Low impact
Impact on palaeontological resources	Additional impact of the development on palaeontological resources adding to the current cumulative impact of existing or proposed developments in the region	2	2	4	4	4	2	32	-	Medium impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	4	4	4	1	14	-	Low impact

Table 7: Impact table for the Mooi Plaats grid options

MOOI PLAATS ALIGNMENT																				
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																				
Impact on known Stone Age resources	Impact on stone age resources during earth moving - including trenching, road making, foundation digging	1	2	3	4	4	2	28	-	Medium impact	** Review PV layout to avoid the site **Implementation 30-meter buffer	1	1	3	2	1	2	16	-	Low impact
Impact on chance finds	Impact on stone age resources during earth moving - including trenching, road making, foundation digging	1	1	3	4	4	4	52	-	High impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	3	4	3	2	24	-	Medium impact

MOOI PLAATS ALIGNMENT																				
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
Impact on palaeontological resources	Impact on palaeontological resources during earth moving - including trenching, road making, foundation digging	1	2	3	4	4	2	28	-	Medium impact	**Implement chance finds procedures **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	2	4	4	2	24	-	Medium impact
Operational Phase																				
Impact on heritage resources	Impact on heritage resources during general maintenance	1	1	4	4	4	4	56	-	High impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	4	4	4	1	14	-	Low impact
Decommissioning Phase																				
Impact on heritage resources	Impact on heritage resources during rehabilitation work associated with decommissioning - grading trench filling etc	1	1	4	4	4	4	56	-	High impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request	1	1	4	4	4	1	14	-	Low impact

MOOI PLAATS ALIGNMENT																				
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**
											destruction permits from SAHRA									
Cumulative																				
Impact on heritage resources	Additional impact of the development on heritage resources adding to the current cumulative impact of existing or proposed developments in the region	2	2	4	4	4	2	32	-	Medium impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	4	4	4	1	14	-	Low impact
Impact on palaeontological resources	Additional impact of the development on palaeontological resources adding to the current cumulative impact of existing or proposed developments in the region	2	2	4	4	4	2	32	-	Medium impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	4	4	4	1	14	-	Low impact

Table 8: Impact table for the Paarde Valley PV options

PAARDE VALLEY SOLAR PV 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																				
Impact on known Stone Age resources	Impact on stone age resources during earth moving - including trenching, road making, foundation digging	1	2	3	4	4	2	28	-	Medium impact	** Review PV layout to avoid the site **Implementation 30-meter buffer	1	1	3	2	1	2	16	-	Low impact
Impact on chance finds	Impact on stone age resources during earth moving - including trenching, road making, foundation digging	1	1	3	4	4	4	52	-	High impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	3	4	3	2	24	-	Medium impact
Impact on palaeontological resources	Impact on palaeontological resources during earth moving - including trenching, road making, foundation digging	1	2	3	4	4	2	28	-	Medium impact	**Implement chance finds procedures **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	2	4	4	2	24	-	Medium impact

PAARDE VALLEY SOLAR PV 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
Operational Phase																				
Impact on heritage resources	Impact on heritage resources during general maintenance	1	1	4	4	4	4	56	-	High impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	4	4	4	1	14	-	Low impact
Decommissioning Phase																				
Impact on heritage resources	Impact on heritage resources during rehabilitation work associated with decommissioning - grading trench filling etc	1	1	4	4	4	4	56	-	High impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	4	4	4	1	14	-	Low impact
Cumulative																				

PAARDE VALLEY SOLAR PV 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**
Impact on heritage resources	Additional impact of the development on heritage resources adding to the current cumulative impact of existing or proposed developments in the region	2	2	4	4	4	2	32	-	Medium impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	4	4	4	1	14	-	Low impact
Impact on palaeontological resources	Additional impact of the development on palaeontological resources adding to the current cumulative impact of existing or proposed developments in the region	2	2	4	4	4	2	32	-	Medium impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	4	4	4	1	14	-	Low impact

Table 9: Impact table for the Paarde Valley grid options

PAARDE VALLEY GRID ALIGNMENT																				
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																				
Impact on known Stone Age resources	Impact on stone age resources during earth moving - including trenching, road making, foundation digging	1	2	3	4	4	2	28	-	Medium impact	** Review PV layout to avoid the site **Implementation 30-meter buffer	1	1	3	2	1	2	16	-	Low impact
Impact on chance finds	Impact on stone age resources during earth moving - including trenching, road making, foundation digging	1	1	3	4	4	4	52	-	High impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	3	4	3	2	24	-	Medium impact

PAARDE VALLEY GRID ALIGNMENT																				
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
Impact on palaeontological resources	Impact on palaeontological resources during earth moving - including trenching, road making, foundation digging	1	2	3	4	4	2	28	-	Medium impact	**Implement chance finds procedures **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	2	4	4	2	24	-	Medium impact
Operational Phase																				
Impact on heritage resources	Impact on heritage resources during general maintenance	1	1	4	4	4	4	56	-	High impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	4	4	4	1	14	-	Low impact
Decommissioning Phase																				
Impact on heritage resources	Impact on heritage resources during rehabilitation work associated with decommissioning - grading trench filling etc	1	1	4	4	4	4	56	-	High impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request	1	1	4	4	4	1	14	-	Low impact

PAARDE VALLEY GRID ALIGNMENT																				
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
											destruction permits from SAHRA									
Cumulative																				
Impact on heritage resources	Additional impact of the development on heritage resources adding to the current cumulative impact of existing or proposed developments in the region	2	2	4	4	4	2	32	-	Medium impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	4	4	4	1	14	-	Low impact
Impact on palaeontological resources	Additional impact of the development on palaeontological resources adding to the current cumulative impact of existing or proposed developments in the region	2	2	4	4	4	2	32	-	Medium impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	4	4	4	1	14	-	Low impact

Table 10: Impact table for the Wonderheuvel PV options

WONDERHEUVEL PV 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																				
Impact on known Stone Age resources	Impact on stone age resources during earth moving - including trenching, road making, foundation digging	1	2	3	4	4	2	28	-	Medium impact	** Review PV layout to avoid the site **Implementation 30-meter buffer	1	1	3	2	1	2	16	-	Low impact
Impact on chance finds	Impact on stone age resources during earth moving - including trenching, road making, foundation digging	1	1	3	4	4	4	52	-	High impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	3	4	3	2	24	-	Medium impact
Impact on palaeontological resources	Impact on palaeontological resources during earth moving - including trenching, road making, foundation digging	1	2	3	4	4	2	28	-	Medium impact	**Implement chance finds procedures **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	2	4	4	2	24	-	Medium impact

WONDERHEUVEL PV 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
Operational Phase																				
Impact on heritage resources	Impact on heritage resources during general maintenance	1	1	4	4	4	4	56	-	High impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	4	4	4	1	14	-	Low impact
Decommissioning Phase																				
Impact on heritage resources	Impact on heritage resources during rehabilitation work associated with decommissioning - grading trench filling etc	1	1	4	4	4	4	56	-	High impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	4	4	4	1	14	-	Low impact
Cumulative																				

WONDERHEUVEL PV 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
Impact on heritage resources	Additional impact of the development on heritage resources adding to the current cumulative impact of existing or proposed developments in the region	2	2	4	4	4	2	32	-	Medium impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	4	4	4	1	14	-	Low impact
Impact on palaeontological resources	Additional impact of the development on palaeontological resources adding to the current cumulative impact of existing or proposed developments in the region	2	2	4	4	4	2	32	-	Medium impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	4	4	4	1	14	-	Low impact

Table 11: Impact table for the Wonderheuvel grid options

WONDERHEUVEL GRID ALIGNMENT																				
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																				
Impact on known Stone Age resources	Impact on stone age resources during earth moving - including trenching, road making, foundation digging	1	2	3	4	4	2	28	-	Medium impact	** Review PV layout to avoid the site **Implementation 30-meter buffer	1	1	3	2	1	2	16	-	Low impact
Impact on chance finds	Impact on stone age resources during earth moving - including trenching, road making, foundation digging	1	1	3	4	4	4	52	-	High impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	3	4	3	2	24	-	Medium impact
Impact on palaeontological resources	Impact on palaeontological resources during earth moving - including trenching, road making, foundation digging	1	2	3	4	4	2	28	-	Medium impact	**Implement chance finds procedures **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	2	4	4	2	24	-	Medium impact

WONDERHEUVEL GRID ALIGNMENT																				
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																				
Impact on heritage resources	Impact on heritage resources during general maintenance	1	1	4	4	4	4	56	-	High impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	4	4	4	1	14	-	Low impact
Decommissioning Phase																				
Impact on heritage resources	Impact on heritage resources during rehabilitation work associated with decommissioning - grading trench filling etc	1	1	4	4	4	4	56	-	High impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	4	4	4	1	14	-	Low impact
Cumulative																				

WONDERHEUVEL GRID ALIGNMENT																				
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
Impact on heritage resources	Additional impact of the development on heritage resources adding to the current cumulative impact of existing or proposed developments in the region	2	2	4	4	4	2	32	-	Medium impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	4	4	4	1	14	-	Low impact
Impact on palaeontological resources	Additional impact of the development on palaeontological resources adding to the current cumulative impact of existing or proposed developments in the region	2	2	4	4	4	2	32	-	Medium impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	4	4	4	1	14	-	Low impact

The projected impact significance for the development on heritage resources is MEDIUM to HIGH before mitigation and management and will reduce MEDIUM to LOW.

6.1 Cumulative Impacts (CI)

This section evaluates the Umsombombvu PV Projects. The CI on heritage resources evaluated a 35-kilometer radius (**Figure 38**). It must further be noted that the evaluation is based on available heritage studies (**Table 12**) and cannot take the findings of outstanding studies on current ongoing EIA's in consideration.

The following must be considered in the analysis of the cumulative effect of development on heritage resources:

- **Fixed datum or dataset:** There is no comprehensive heritage data set for the region and thus we cannot quantify how much of a specific cultural heritage element is present in the region. The region has never been covered by a heritage resources study that can account for all heritage resources. Further to this none of the heritage studies conducted can with certainty state that all heritage resources within the study area has been identified and evaluated;
- **Defined thresholds**: The value judgement on the significance of a heritage site will vary from individual to individual and between interest groups. Thus, implicating that heritage resources' significance can and does change over time. And so, will the tipping threshold for impacts on a certain type of heritage resource;
- **Threshold crossing**: In the absence of a comprehensive dataset or heritage inventory of the entire region we will never be able to quantify or set a threshold to determine at what stage the impact from developments on heritage resources has reached or is reaching the danger level or excludes the new development on this basis. (Godwin, 2011)

Keeping the above short comings in mind, the methodology in evaluating cumulative impacts on heritage resources has been as follows.

The analysis of the competed studies as listed in **Table 12**, took in to account the findings and recommendation of each of the seventeen evaluated HIA's. The cumulative impact on the cultural landscape was discounted as the HIA's, in most cases, did not address this and the Visual Impact Assessment covers such analysis in detail.

The overall findings of the 17 studies all concur that the area is characterised by numerous Stone Age findspots and archaeological resources. Many these concentrated around outcrops in a landscape where water, food and shelter came at a premium. The sites around the outcrops where in most cases given a medium to high heritage significance on a local scale and in the majority of the cases were recommended as being no-go areas or extensive mitigation is required.

This cumulative assessment has also not addressed the possible cumulative impacts on the heritage landscape. The evaluated studies have in most cases not addressed or quantified the possible impact on the cultural landscape.

Table 12 provides an analysis of the projected cumulative impact this project will add to impact on heritage resources.

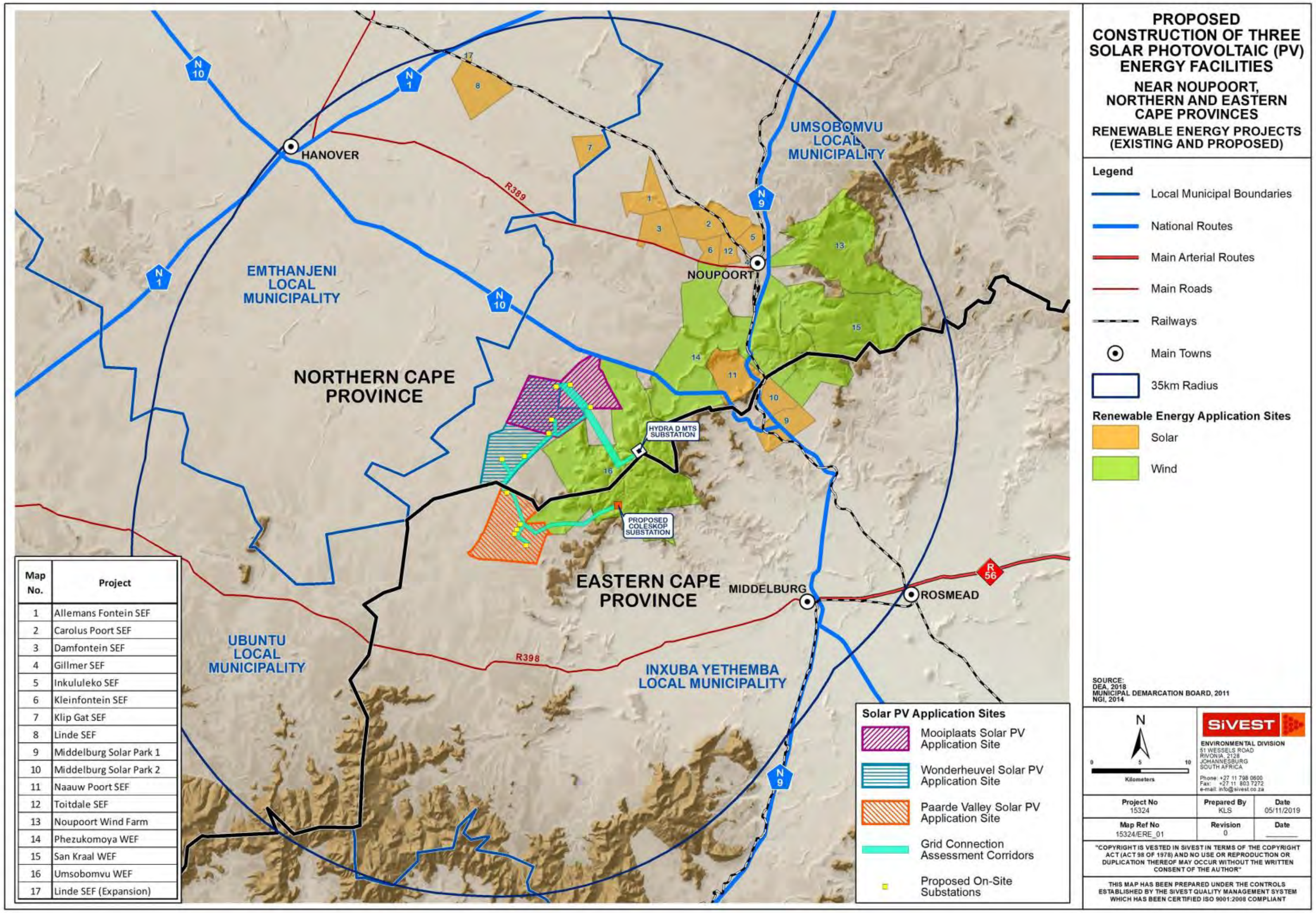

Figure 38: Other Renewable Energy developments in relation to the Umsombombvu PV Projects (SiVEST 2019)

Table 12: Heritage Impact Assessments conducted within 35km from the Umsombombvu PV Projects

Project	DEA Reference No	Findings	Recommendations
Allemans Fontein SEF	14/12/16/3/3/ 1/730	Surface scatters of middle stone age artefacts occurred over the extent of the area. Most were however disturbed and of low heritage value. No although the area was underlain by fossiliferous mudstone and sandstone no palaeontological significant finds were made.	General management measures such as informing SAHRA and chance finds procedure to be put in place.
Carolus Poort SEF	14/12/16/3/3/ 1/729	Surface scatters of middle stone age and later stone age artefacts occurred over the extent of the area. Most were however disturbed and of low heritage value Although the area was underlain by fossiliferous mudstone and sandstone no palaeontological significant finds were made.	General management measures such as informing SAHRA and chance finds procedure to be put in place.
Damfontein SEF	14/12/16/3/3/ 1/728	Surface scatters of middle stone age and later stone age artefacts occurred over the extent of the area. Most were however disturbed and of low heritage value.	General management measures such as informing SAHRA and chance finds procedure to be put in place.
Gillmer SEF	14/12/16/3/3/ 1/735	Surface scatters of middle stone age and later stone age artefacts occurred over the extent of the area. One single collapsed stone structure was discovered. Most were however disturbed and of low heritage value. Although the area was underlain by fossiliferous mudstone and sandstone no palaeontological significant finds were made.	General management measures such as informing SAHRA and chance finds procedure to be put in place.
Inkululeko SEF	14/12/16/3/3/ 1/553	Surface scatters of middle stone age and later stone age artefacts occurred over the extent of the area.	General management measures such as informing SAHRA and chance finds procedure to be put in place.
Kleinfontein SEF	12/12/20/265 4	Surface scatters of middle stone age artefacts occurred over the extent of the area.	General management measures such as informing SAHRA and chance finds procedure to be put in place.
Klip Gat SEF	14/12/16/3/3/ 2/354	Surface scatters of middle stone age and later stone age artefacts occurred over the extent of the area. One single collapsed stone structure was discovered. One area of high significance was demarcated. Although the area was underlain by fossiliferous mudstone and sandstone no palaeontological significant finds were made.	General management measures such as informing SAHRA and chance finds procedure to be put in place. A detailed survey of the demarcated area was recommended.
Linde SEF	12/12/20/225 8	One site was identified with a cultural heritage resource, a stone redoubt emanating from the Second Boer War together with a portion of low gauge railway line. The resource has been excluded from the development footprint on site H, Taaibos.	General management measures such as informing SAHRA and chance finds procedure to be put in place. A detailed survey of the demarcated area was recommended. Buffering of the site was recommended.
Linde SEF (Expansion)	14/12/16/3/3/ 1/1122	One site was identified with a cultural heritage resource, a stone redoubt emanating from the Second Boer War together with a portion of low gauge railway line. The resource has been excluded from the development footprint on site H, Taaibos.	General management measures such as informing SAHRA and chance finds procedure to be put in place. A detailed survey of the demarcated area was recommended. Buffering of the site was recommended.
Middelburg Solar Park 1	12/12/20/246 5/2	Surface scatters of middle stone age and later stone age artefacts occurred over the extent of the area. A few stone outcrops showed higher concentrations of lithics and required buffering.	General management measures such as informing SAHRA and chance finds procedure to be put in place. A detailed survey of the demarcated area was recommended. Buffering some sites were recommended.

Project	DEA Reference No	Findings	Recommendations
Middelburg Solar Park 2	12/12/20/2465/1	Surface scatters of middle stone age and later stone age artefacts occurred over the extent of the area. A few stone outcrops showed higher concentrations of lithics and required buffering.	General management measures such as informing SAHRA and chance finds procedure to be put in place. A detailed survey of the demarcated area was recommended. Buffering some sites were recommended.
Naauw Poort SEF	14/12/16/3/3/2/355	Surface scatters of middle stone age and later stone age artefacts occurred over the extent of the area. A few dry pack stone walls were identified as having a medium heritage significance. One area of high significance was demarcated. Various fossil finds were mad in the Katberg formation during field work.	General management measures such as informing SAHRA and chance finds procedure to be put in place. A detailed survey of the demarcated area was recommended. Further ground truthing of footprint areas were recommended.
Toitdale SEF	12/12/20/2653	Surface scatters of middle stone age artefacts occurred over the extent of the area.	General management measures such as informing SAHRA and chance finds procedure to be put in place.
Noupoort Wind Farm	12/12/20/2319	A rock shelter with rock art was identified. Numerous dry stone walled enclosures were identified. A farmstead and cemetery was also identified during the fieldwork. Various fossil finds were mad in the Katberg formation during field work.	General management measures such as informing SAHRA and chance finds procedure to be put in place. A detailed survey of the demarcated area was recommended. Further ground truthing of footprint areas were recommended
Phezukomoya WEF	14/12/16/3/3/1/1028	Stone Age archaeological sites are sparse in the high suurveld areas and that not very many sites will be physically impacted. Two archaeological sites will require mitigation through avoidance or alternatively systematic collection. Only a few fossil remains were recorded during a four-day field assessment	General management measures such as informing SAHRA and chance finds procedure to be put in place. A detailed survey of the demarcated area was recommended. Buffering some sites were recommended.
San Kraal WEF	14/12/16/3/3/1/1069	The comprehensive survey of the project area, associated infrastructure and power lines has revealed that Stone Age archaeological sites are sparse in the high suurveld areas and that not very many sites will be physically impacted. Fossil finds on site are confined to mostly fragmented river-washed bone fragments. The presence of a number of fossilised vertebrate burrows in a river bed was also noted	General management measures such as informing SAHRA and chance finds procedure to be put in place. A detailed survey of the demarcated area was recommended. Buffering some sites were recommended.
Umsobomvu WEF	14/12/16/3/3/2/730	A total of 41 heritage sites were noted in the study area from in the desktop and field survey. These sites varied from open stone tool scatters, rock art sites in small overhangs, and built structures such as farm buildings and kraals. The historical buildings were the most frequently occurring heritage sites. Three of these early farmsteads have associated cemeteries. There are no fatal flaws in the Umsobomvu WEF development proposal as far as fossil heritage is concerned.	General management measures such as informing SAHRA and chance finds procedure to be put in place. A detailed survey of the demarcated area was recommended. Buffering some sites were recommended.

As the projected impact on heritage resources is seen as the same on all the alternatives, a single impact rating table is provided (**Table 13**) for all three (3) proposed Solar PV Energy Facilities and grid options. The impact assessment rating is based on the rating scale as contained in **Appendix B** and **Appendix C**.

Table 13: Cumulative impact assessment table for all three facilities and grid connections

MOOI PLAATS ALIGNMENT																				
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
Cumulative																				
Impact on heritage resources	Additional impact of the development on heritage resources adding to the current cumulative impact of existing or proposed developments in the region	2	2	4	4	4	2	32	-	Medium impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	4	4	4	1	14	-	Low impact
Impact on palaeontological resources	Additional impact of the development on palaeontological resources adding to the current cumulative impact of existing or proposed developments in the region	2	2	4	4	4	2	32	-	Medium impact	** development of chance finds procedures to be included in the EMP **Implementation of mitigation measures such as buffering, documentation and excavations and request destruction permits from SAHRA	1	1	4	4	4	1	14	-	Low impact

The projected impact significance for the development on heritage resources is MEDIUM before mitigation and management and will reduce to LOW.

6.2 Comparative Assessment of Layout Alternatives

Table 14: Key for comparative assessment

PREFERRED	The alternative will result in a low impact / reduce the impact
FAVOURABLE	The impact will be relatively insignificant
LEAST PREFERRED	The alternative will result in a high impact / increase the impact
NO PREFERENCE	The alternative will result in equal impacts

Table 15: PV infrastructure alternatives (laydown areas and O&M buildings)

PV INFRASTRUCTURE ALTERNATIVES (LAYDOWN AREAS AND O&M BUILDINGS)	Preference	Reasons (incl. potential issues)
MOOI PLAATS SOLAR PV FACILITY:		
Laydown Area and O&M Building Site Option 1	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 2	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 3	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 4	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 5	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 6	**NO PREFERENCE**	No heritage issue identified for this footprint
WONDERHEUVEL SOLAR PV FACILITY:		
Laydown Area and O&M Building Site Option 1	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 2	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 3	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 4	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 5	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 6	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 7	**NO PREFERENCE**	No heritage issue identified for this footprint

PV INFRASTRUCTURE ALTERNATIVES (LAYDOWN AREAS AND O&M BUILDINGS)	Preference	Reasons (incl. potential issues)
Laydown Area and O&M Building Site Option 8	**NO PREFERENCE**	No heritage issue identified for this footprint
PAARDE VALLEY SOLAR PV FACILITY:		
Laydown Area and O&M Building Site Option 1	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 2	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 3	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 4	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 5	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 6	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 7	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 8	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 9	**NO PREFERENCE**	No heritage issue identified for this footprint

Table 16: Grid connection infrastructure alternatives (power line corridors and associated substations)

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS AND ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
MOOI PLAATS SOLAR PV FACILITY:		
Grid Connection Option 1a	**NO PREFERENCE**	No heritage issue identified for this footprint
Grid Connection Option 1b	**NO PREFERENCE**	No heritage issue identified for this footprint
Grid Connection Option 2a	**NO PREFERENCE**	No heritage issue identified for this footprint
Grid Connection Option 2a	**NO PREFERENCE**	No heritage issue identified for this footprint
WONDERHEUVEL SOLAR PV FACILITY:		
Grid Connection Option 1a	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS AND ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
		construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 1b	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 1c	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 1d	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 2a	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 2b	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 3	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS AND ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
PAARDE VALLEY SOLAR PV FACILITY:		
Grid Connection Option 1a	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 1b	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 1c	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 1d	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 2a	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 2b	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 2c	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS AND ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
		northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 2d	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option

7 CONCLUSIONS AND RECOMMENDATIONS

PGS was appointed by SiVEST to undertake a HIA that forms part of the respective EIAs and EMPr for the Umsombomvu Solar Energy Facilities close to Noupoort and Middelburg in the Northern and Eastern Cape Provinces.

The HIA consisted of a scoping phase during which background information and landscape analysis was done to determine the heritage resources that can potentially occur within the study area. This was followed up with fieldwork by a team of archaeologist and a palaeontologist with the aim of identifying heritage resources in the development footprint areas and t make recommendation on the management of these resources and the possible chance finds during construction activities.

The field work identified a total of 10 areas of heritage significance. Adjustments to the project layouts based on the various specialist input resulted in the total avoidance of 3 heritage areas that was excluded from the reporting. The remaining seven site consist of three large, low to medium density scatters of later stone age sites (**UMS005,008 and 009**). These three sites were avoided by slight adjustments in the PV array layouts in the Paarde Valley as well as Wonderheuvel PV facilities. **UMS004, 006 and 007** are all round stone packed enclosure. **UMS007** situated in the Mooi Plaats facility was excluded from direct impact by design changes. UMS004 and 006 will need to be avoided during construction of the power grid through the implementation of a 30-meter buffer.

UMS010 was identified as a fossil find spot and a 50-meter buffer around the fossil bearing material must be implemented. Any construction in the demarcated area must be monitored by a palaeontologist.

The impact rating on the heritage resources indicated that per-mitigation a negative high impact is projected but with the implementation of the recommended management measures this impact rating will be reduced to low negative.

A comparative assessment of the alternative provided for the PV and grid options is summarised in **Table 18** and **Table 19** below. The palaeontological sensitive area at UMS010 is the only heritage resources that influence the Options assessment, but those options affected is still favourable with the implementation of the recommended management measures.

Table 17: Key for comparative assessment

PREFERRED	The alternative will result in a low impact / reduce the impact
FAVOURABLE	The impact will be relatively insignificant
LEAST PREFERRED	The alternative will result in a high impact / increase the impact
NO PREFERENCE	The alternative will result in equal impacts

Table 18: PV infrastructure alternatives (laydown areas and O&M buildings)

PV INFRASTRUCTURE ALTERNATIVES (LAYDOWN AREAS AND O&M BUILDINGS)	Preference	Reasons (incl. potential issues)
MOOI PLAATS SOLAR PV FACILITY:		
Laydown Area and O&M Building Site Option 1	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 2	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 3	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 4	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 5	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 6	**NO PREFERENCE**	No heritage issue identified for this footprint
WONDERHEUVEL SOLAR PV FACILITY:		
Laydown Area and O&M Building Site Option 1	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 2	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 3	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 4	**NO PREFERENCE**	No heritage issue identified for this footprint

PV INFRASTRUCTURE ALTERNATIVES (LAYDOWN AREAS AND O&M BUILDINGS)	Preference	Reasons (incl. potential issues)
Laydown Area and O&M Building Site Option 5	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 6	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 7	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 8	**NO PREFERENCE**	No heritage issue identified for this footprint
PAARDE VALLEY SOLAR PV FACILITY:		
Laydown Area and O&M Building Site Option 1	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 2	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 3	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 4	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 5	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 6	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 7	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 8	**NO PREFERENCE**	No heritage issue identified for this footprint
Laydown Area and O&M Building Site Option 9	**NO PREFERENCE**	No heritage issue identified for this footprint

Table 19: Grid connection infrastructure alternatives (power line corridors and associated substations)

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS AND ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
MOOI PLAATS SOLAR PV FACILITY:		
Grid Connection Option 1a	**NO PREFERENCE**	No heritage issue identified for this footprint
Grid Connection Option 1b	**NO PREFERENCE**	No heritage issue identified for this footprint

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS AND ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
Grid Connection Option 2a	**NO PREFERENCE**	No heritage issue identified for this footprint
Grid Connection Option 2a	**NO PREFERENCE**	No heritage issue identified for this footprint
WONDERHEUVEL SOLAR PV FACILITY:		
Grid Connection Option 1a	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 1b	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 1c	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 1d	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 2a	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 2b	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS AND ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
		substation 3a, but still a favourable option
Grid Connection Option 3	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
PAARDE VALLEY SOLAR PV FACILITY:		
Grid Connection Option 1a	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 1b	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 1c	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 1d	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 2a	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS AND ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
Grid Connection Option 2b	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 2c	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option
Grid Connection Option 2d	**FAVOURABLE**	A paleontological sensitive area that will require monitoring during construction is situated on the northern corridor towards substation 3a, but still a favourable option

It is my considered opinion, based on the current data available, that with the consideration of the position of heritage sensitivities during the layout design and the implementation of the proposed management measures, the project will have an acceptable low impact on heritage resources and can continue.

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Project	**DEA Reference No**
Allemans Fontein SEF	14/12/16/3/3/1/730
Carolus Poort SEF	14/12/16/3/3/1/729
Damfontein SEF	14/12/16/3/3/1/728
Gillmer SEF	14/12/16/3/3/1/735
Inkululeko SEF	14/12/16/3/3/1/553
Kleinfontein SEF	12/12/20/2654
Klip Gat SEF	14/12/16/3/3/2/354
Linde SEF	12/12/20/2258
Linde SEF (Expansion)	14/12/16/3/3/1/1122
Middelburg Solar Park 1	12/12/20/2465/2
Middelburg Solar Park 2	12/12/20/2465/1
Naauw Poort SEF	14/12/16/3/3/2/355
Toitdale SEF	12/12/20/2653
Noupoort Wind Farm	12/12/20/2319
Phezukomoya WEF	14/12/16/3/3/1/1028

Project	DEA Reference No
San Kraal WEF	14/12/16/3/3/1/1069
Umsobomvu WEF	14/12/16/3/3/2/730

Appendix A

LEGISLATIVE PRINCIPLES

LEGISLATIVE REQUIREMENTS – TERMINOLOGY AND ASSESSMENT CRITERIA

3.1 General principles

In areas where there has not yet been a systematic survey to identify conservation worthy places, a permit is required to alter or demolish any structure older than 60 years. This will apply until a survey has been done and identified heritage resources are formally protected.

Archaeological and palaeontological sites, materials, and meteorites are the source of our understanding of the evolution of the earth, life on earth and the history of people. In the new legislation, permits are required to damage, destroy, alter, or disturb them. People who already possess material are required to register it. The management of heritage resources are integrated with environmental resources and this means that before development takes place heritage resources are assessed and, if necessary, rescued.

In addition to the formal protection of culturally significant graves, all graves, which are older than 60 years and are not in a cemetery (such as ancestral graves in rural areas), are protected. The legislation protects the interests of communities that have interest in the graves: they may be consulted before any disturbance takes place. The graves of victims of conflict and those associated with the liberation struggle will be identified, cared for, protected and memorials erected in their honour.

Anyone who intends to undertake a development must notify the heritage resource authority and if there is reason to believe that heritage resources will be affected, an impact assessment report must be compiled at the developer's cost. Thus, developers will be able to proceed without uncertainty about whether work will have to be stopped if an archaeological or heritage resource is discovered.

According to the National Heritage Act (Act 25 of 1999 section 32) it is stated that:
An object or collection of objects, or a type of object or a list of objects, whether specific or generic, that is part of the national estate and the export of which SAHRA deems it necessary to control, may be declared a heritage object, including –

- objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects, meteorites and rare geological specimens;
- visual art objects;
- military objects;
- numismatic objects;
- objects of cultural and historical significance;
- objects to which oral traditions are attached and which are associated with living heritage;
- objects of scientific or technological interest;
- books, records, documents, photographic positives and negatives, graphic material, film or video or sound recordings, excluding those that are public records as defined in section 1 (xiv) of the National Archives of South Africa Act, 1996 (Act No. 43 of 1996), or in a provincial law pertaining to records or archives; and
- any other prescribed category.

Under the National Heritage Resources Act (Act No. 25 of 1999), provisions are made that deal with, and offer protection, to all historic and pre-historic cultural remains, including graves and human remains.

3.2 Graves and cemeteries

Graves younger than 60 years fall under Section 2(1) of the Removal of Graves and Dead Bodies Ordinance (Ordinance no. 7 of 1925) as well as the Human Tissues Act (Act 65 of 1983) and are the jurisdiction of the National Department of Health and the relevant Provincial Department of Health and must be submitted for final approval to the Office of the relevant Provincial Premier. This function is usually delegated to the Provincial MEC for Local Government and Planning, or in some cases the MEC for Housing and Welfare. Authorisation for exhumation and reinterment must also be obtained from the relevant local or regional council where the grave is situated, as well as the relevant local or regional council to where the grave is being relocated. All local and regional provisions, laws and by-laws must also be adhered to. In order to handle and transport human remains the institution conducting the relocation should be authorised under Section 24 of Act 65 of 1983 (Human Tissues Act).

Graves older than 60 years, but younger than 100 years fall under Section 36 of Act 25 of 1999 (National Heritage Resources Act) as well as the Human Tissues Act (Act 65 of 1983) and are the jurisdiction of the South African Heritage Resource Agency (SAHRA). The procedure for Consultation Regarding Burial Grounds and Graves (Section 36(5) of Act 25 of 1999) is applicable to graves older than 60 years that are situated outside a formal cemetery administrated by a local authority. Graves in the category located inside a formal cemetery administrated by a local authority will also require the same authorisation as set out for graves younger than 60 years over and above SAHRA authorisation.

If the grave is not situated inside a formal cemetery but is to be relocated to one, permission from the local authority is required and all regulations, laws and by-laws set by the cemetery authority must be adhered to.

Appendix B

Heritage Assessment Methodology

The section below outlines the assessment methodologies utilised in the study.

The Heritage Impact Assessment (HIA) report to be compiled by PGS Heritage (PGS) for the proposed Umsombombvu PV Projects will assess the heritage resources found on site. This report will contain the applicable maps, tables and figures as stipulated in the NHRA (no 25 of 1999), the National Environmental Management Act (NEMA) (no 107 of 1998) and the Minerals and Petroleum Resources Development Act (MPRDA) (28 of 2002). The HIA process consists of three steps:

Step I – Literature Review: The background information to the field survey leans greatly on the Heritage Scoping Report completed by PGS for this site.

Step II – Physical Survey: A physical survey was conducted on foot and by vehicle through the proposed project area by qualified archaeologists, aimed at locating and documenting sites falling within and adjacent to the proposed development footprint.

Step III – The final step involved the recording and documentation of relevant archaeological resources, as well as the assessment of resources in terms of the heritage impact assessment criteria and report writing, as well as mapping and constructive recommendations

The significance of heritage sites was based on four main criteria:

- **site integrity** (i.e. primary vs. secondary context),
- **amount of deposit, range of features** (e.g., stonewalling, stone tools and enclosures),
    - Density of scatter (dispersed scatter)
        - Low - <10/50m^2
        - Medium - 10-50/50m^2
        - High - >50/50m^2
- uniqueness and
- **potential** to answer present research questions.

Management actions and recommended mitigation, which will result in a reduction in the impact on the sites, will be expressed as follows:

A - No further action necessary;

B - Mapping of the site and controlled sampling required;

C - No-go or relocate pylon position

D - Preserve site, or extensive data collection and mapping of the site; and

E - Preserve site

Site Significance

Site significance classification standards prescribed by the South African Heritage Resources Agency (2006) and approved by the Association for Southern African Professional Archaeologists (ASAPA) for the Southern African Development Community (SADC) region, were used for the purpose of this report.

Table 1: Site significance classification standards as prescribed by SAHRA

FIELD RATING	GRADE	SIGNIFICANCE	RECOMMENDED MITIGATION
National Significance (NS)	Grade 1	-	Conservation; National Site nomination
Provincial Significance (PS)	Grade 2	-	Conservation; Provincial Site nomination
Local Significance (LS)	Grade 3A	High Significance	Conservation; Mitigation not advised
Local Significance (LS)	Grade 3B	High Significance	Mitigation (Part of site should be retained)
Generally Protected A (GP.A)		High / Medium Significance	Mitigation before destruction
Generally Protected B (GP.B)		Medium Significance	Recording before destruction
Generally Protected C (GP.A)		Low Significance	Destruction

Appendix C

Impact Assessment Methodology to be utilised during EIA phase

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 20: 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: **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 21: 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

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																				
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	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**	2	2	2	1	4	2	22	-	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
	by the wind turbines as well.										**be detailed in the EMPr.**									
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	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**	2	2	2	1	2	2	18	-	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
	heavy machinery on the site and the noise generated.										**measures will be detailed in the EMPr.**									
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

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

Appendix D

Project team CV's

WOUTER FOURIE

Professional Heritage Specialist and Professional Archaeologist and Director PGS Heritage

Summary of Experience

Specialised expertise in Archaeological Mitigation and excavations, Cultural Resource Management and Heritage Impact Assessment Management, Archaeology, Anthropology, Applicable survey methods, Fieldwork and project management, Geographic Information Systems, including *inter alia* -

Involvement in various grave relocation projects (some of which relocated up to 1000 graves) and grave "rescue" excavations in the various provinces of South Africa

Involvement with various Heritage Impact Assessments, within South Africa, including -

- Archaeological Walkdowns for various projects
- Phase 2 Heritage Impact Assessments and EMPs for various projects
- Heritage Impact Assessments for various projects
- Iron Age Mitigation Work for various projects, including archaeological excavations and monitoring
- Involvement with various Heritage Impact Assessments, outside South Africa, including -
- Archaeological Studies in Democratic Republic of Congo
- Heritage Impact Assessments in Mozambique, Botswana and DRC
- Grave Relocation project in DRC

Key Qualifications

BA [Hons] (Cum laude) - Archaeology and Geography - 1997

BA - Archaeology, Geography and Anthropology - 1996

Professional Archaeologist - Association of Southern African Professional Archaeologists (ASAPA) - Professional Member

Accredited Professional Heritage Specialist – Association of Professional Heritage Practitioners (APHP)

CRM Accreditation (ASAPA) -

Principal Investigator - Grave Relocations

Field Director – Iron Age

Field Supervisor – Colonial Period and Stone Age

Accredited with Amafa KZN

Key Work Experience

2003- current - Director – PGS Heritage (Pty) Ltd

2007 – 2008 - Project Manager – Matakoma-ARM, Heritage Contracts Unit, University of the Witwatersrand

2005-2007 - Director – Matakoma Heritage Consultants (Pty) Ltd

2000-2004 - CEO– Matakoma Consultants

1998-2000 - Environmental Coordinator – Randfontein Estates Limited. Randfontein, Gauteng

1997-1998 - Environmental Officer – Department of Minerals and Energy. Johannesburg, Gauteng

Worked on various heritage projects in the SADC region including, Botswana, Malawi, Mozambique. Mauritius and the Democratic Republic of the Congo

CURRICULUM VITAE: ELIZE BUTLER

PROFESSION: Palaeontologist

YEARS' EXPERIENCE: 25 years in Palaeontology

EDUCATION:

B.Sc Botany and Zoology, 1988
University of the Orange Free State

B.Sc (Hons) Zoology, 1991
University of the Orange Free State

Management Course, 1991
University of the Orange Free State

M. Sc. *Cum laude* (Zoology), 2009
University of the Free State

Dissertation title: The postcranial skeleton of the Early Triassic non-mammalian Cynodont *Galesaurus planiceps*: implications for biology and lifestyle

Registered as a PhD fellow at the Zoology Department of the UFS 2013 to current

Dissertation title: A new gorgonopsian from the uppermost D*aptocephalus Assemblage Zone*, in the Karoo Basin of South Africa

MEMBERSHIP

Palaeontological Society of South Africa (PSSA) 2006-currently

EMPLOYMENT HISTORY

Part time Laboratory assistant	Department of Zoology & Entomology University of the Free State Zoology 1989-1992
Part time laboratory assistant	Department of Virology

	University of the Free State Zoology 1992
Research Assistant	National Museum, Bloemfontein 1993 – 1997
Principal Research Assistant and Collection Manager	National Museum, Bloemfontein 1998–currently

TECHNICAL REPORTS

Butler, E. 2018. Palaeontological Phase 1 Assessment of the proposed Swaziland-Mozambique border patrol road and Mozambique barrier structure.

Butler, E. 2018. Palaeontological Impact Assessment of the proposed development of the new Mutsho coal-fired power plant and associated infrastructure near Makhado, Limpopo Province.

Butler, E. 2018. Palaeontological Impact Assessment of the proposed diamonds Alluvial & Diamonds General Prospecting Right Application near Christiana on the Remaining Extent of Portion 1 of the Farm Kaffraria 314, Registration Division HO, North West Province.

Butler, E. 2018. Palaeontological Impact Assessment of the authorisation and amendment processes for Manangu mine near Delmas, Victor Khanye local municipality, Mpumalanga. 2018.

Butler, E. 2018. Palaeontological Impact Assessment for the Proposed Landfill Site in Luckhoff, Letsemeng Local Municipality, Xhariep District, Free State.

Butler, E. 2018. Palaeontological field assessment of the proposed construction of the Zonnebloem Switching Station (132/22kV) and two loop-in loop-out power lines (132kV) in the Mpumalanga Province.

Butler, E. 2018. Palaeontological field Assessment of the proposed Villa Rosa development In the Buffalo City Metropolitan Municipality, East London.

Butler, E. 2018. Palaeontological field assessment of the proposed development of the Wildealskloof mixed use development near Bloemfontein, Free State Province.

Butler, E. 2018. Palaeontological Field Assessment of the proposed Megamor Extension, East London.

Butler, E. 2018. Palaeontological Field Assessment for the proposed re-alignment and de-commisioning of the Firham-Platrand 88kv Powerline, near Standerton, Lekwa Local Municipality, Mpumalanga province.

Butler, E. 2018. Palaeontological Desktop Assessment of the proposed Villa Rosa development In the Buffalo City Metropolitan Municipality, East London.

Butler, E. 2018. Palaeontological desktop assessment of the proposed Mookodi – Mahikeng 400kV line, North West Province.

Butler, E. 2018. Palaeontological desktop assessment of the proposed housing development on portion 237 of farm Hartebeestpoort 328.

Butler, E. 2018. Palaeontological desktop assessment of the proposed New Age Chicken layer facility located on holding 75 Endicott near Springs in Gauteng.

Butler, E. 2018. Palaeontological Desktop Assessment for the proposed Mashishing township establishment in Mashishing (Lydenburg), Mpumalanga Province.

Butler, E. 2018. Palaeontological Desktop Assessment for the Proposed Mlonzi Estate Development near Lusikisiki, Ngquza Hill Local Municipality, Eastern Cape.

Butler, E. 2018. Palaeontological Desktop Assessment for the proposed electricity expansion project and Sekgame Switching Station at the Sishen Mine, Northern Cape Province.

Butler, E. 2018. Palaeontological Desktop Assessment for the proposed Thornhill Housing Project, Ndlambe Municipality, Port Alfred, Eastern Cape Province

Butler, E. 2018 Palaeontological Desktop Assessment for the development of the proposed Leslie 1 Mining Project near Leandra, Mpumalanga Province.

Butler, E. 2017. Palaeontological Scoping Report for the Proposed Construction of a Warehouse and Associated Infrastructure at Perseverance in Port Elizabeth, Eastern Cape Province.

Butler, E. 2017. Palaeontological Impact Assessment Of The Proposed Development Of The New Open Cast Mining Operations On The Remaining Portions Of 6, 7, 8 And 10 Of The Farm Kwaggafontein 8 In The Carolina Magisterial District, Mpumalanga Province.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed development of the new open cast mining operations on the remaining portions of 6, 7, 8 and 10 of the farm Kwaggafontein 8 10 in the Albert Luthuli Local Municipality, Gert Sibande District Municipality, Mpumalanga Province.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed mining of the farm Zandvoort 10 in the Albert Luthuli Local Municipality, Gert Sibande District Municipality, Mpumalanga Province.

Butler, E. 2017. Palaeontological impact assessment of the proposed development of the sport precinct and associated infrastructure at Merrifield Preparatory school and college, Amathole Municipality, East London. PGS Heritage.

Butler, E. 2017. Palaeontological impact assessment of the proposed construction of the Lehae training and fire station, Lenasia, Gauteng Province.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed construction of a 132KV powerline from the Tweespruit distribution substation (in the Mantsopa local municipality) to the Driedorp rural substation (within the Naledi local municipality), Free State province.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed construction of Tina Falls Hydropower and associated power lines near Cumbu, Mthlontlo Local Municipality, Eastern Cape.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed Belvoir aggregate quarry II on portion 7 of the farm Maidenhead 169, Enoch Mgijima Municipality, division of Queenstown, Eastern Cape.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed construction of the Melkspruit-Rouxville 132KV Power line.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed consolidation of the proposed Ilima Colliery in the Albert Luthuli local municipality, Gert Sibande District Municipality, Mpumalanga Province.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed development of the H2 Energy Power Station and associated infrastructure on Portions 21; 22 And 23 of the farm Hartebeestspruit in the Thembisile Hani Local Municipality, Nkangala District near Kwamhlanga, Mpumalanga Province.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed upgrade of the Sandriver Canal and Klippan Pump station in Welkom, Free State Province.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed upgrade of the 132kv and 11kv power line into a dual circuit above ground power line feeding into the Urania substation in Welkom, Free State Province.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed diamonds alluvial & diamonds general prospecting right application near Christiana on the remaining extent of portion 1 of the farm Kaffraria 314, registration division HO, North West Province.

Butler, E. 2017. Palaeontological impact assessment for the proposed development of a new cemetery, near Kathu, Gamogara local municipality and John Taolo Gaetsewe district municipality, Northern Cape.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed development of open pit mining at Pit 36W (New Pit) and 62E (Dishaba) Amandelbult Mine Complex, Thabazimbi, Limpopo Province.

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Appendix E

Palaeontological Impact Assessment

Appendix 6E

Paleontology Assessment

PALAEONTOLOGICAL FIELD ASSESSMENT FOR THE PROPOSED UMSOBOMVU SOLAR PV ENERGY FACILITIES, NORTHERN AND EASTERN CAPE

Issue Date:	**03 November 2019**
Revision No.:	v0.1
Client:	SiVEST
PGS Project No:	15324PIA

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Directors: HS Steyn, PD Birkholtz, W Fourie

Declaration of Independence

I, Elize Butler, declare that –

General declaration:

- I act as the independent palaeontological 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 favorable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting palaeontological impact assessments, 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 will take into account, to the extent possible, the matters listed in section 38 of the NHRA when preparing the application and any report relating to the application;
- 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;
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application;
- I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favorable to the applicant or not
- All the particulars furnished by me in this form are true and correct;
- I will perform all other obligations as expected a palaeontological specialist in terms of the Act and the constitutions of my affiliated professional bodies; and
- I realize that a false declaration is an offense in terms of regulation 71 of the Regulations and is punishable in terms of section 24F of the NEMA.

Disclosure of Vested Interest

I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Regulations;

PALAEONTOLOGICAL CONSULTANT: Banzai Environmental (Pty) Ltd

CONTACT PERSON: Elize Butler

Tel: +27 844478759

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SIGNATURE:

ACKNOWLEDGMENT OF RECEIPT

Report Title	**Palaeontological Field Assessment for the proposed Umsobomvu Solar PV Energy Facilities**		
Control	**Name**	**Signature**	**Designation**
Author	Elize Butler		Palaeontologist
Reviewed	Wouter Fourie		Principal Heritage Specialist
Client			

CLIENT: SiVEST

CONTACT PERSON: Stephan Jacobs, E-mail: StephanJ@sivest.co.za

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The heritage impact assessment report has been compiled taking into account the National Environmental Management Act 1998 (NEMA) and Environmental Impact Regulations 2014 as amended, requirements for specialist reports, Appendix 6, as indicated in the table below.

NEMA Regs (2014) - Appendix 6	**Relevant section in report**
1. (1) A specialist report prepared in terms of these Regulations must contain- a) details of- i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	Page ii of Report – Contact details and company and Appendix A
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Page ii
c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 2 – Objective
(cA) an indication of the quality and age of base data used for the specialist report;	Section 5 – Geological and Palaeontological history
(B) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 12
d) the date, duration and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 1 and 10
e) a description of the methodology adopted in preparing the report or carrying out the specialized process inclusive of equipment and modeling used;	Section 7 Approach and Methodology
f) details of an assessment of the specifically 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;	Section 1 and 10
g) an identification of any areas to be avoided, including buffers;	Section 1 and 10
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;	Section 5 – Geological and Palaeontological history

NEMA Regs (2014) - Appendix 6	Relevant section in report
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 7.1 – Assumptions and Limitation
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;	Section 1 and 10
k) any mitigation measures for inclusion in the EMPr;	Section 1 and 10
l) any conditions for inclusion in the environmental authorization;	Section 1 and 11
m) any monitoring requirements for inclusion in the EMPr or environmental authorization;	Section 1 and 11
n) a reasoned opinion- i. as to whether the proposed activity, activities or portions thereof should be authorized; (iA) regarding the acceptability of the proposed activity or activities; and ii. if the opinion is that the proposed activity, activities or portions thereof should be authorized, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 11
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	Not applicable.
q) any other information requested by the competent authority.	Not applicable.
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.	Section 3 compliance with SAHRA guidelines

EXECUTIVE SUMMARY

Banzai Environmental was appointed by PGS Heritage (Pty) Ltd to conduct the Palaeontological Impact Assessment to assess the proposed Umsobomvu Solar PV Energy Facilities near Noupoort, Northern and Eastern Cape Provinces. The National Heritage Resources Act (No 25 of 1999, section 38) (NHRA), states that a Palaeontological Impact Assessment (PIA) is key to detect the presence of fossil material within the planned development footprint. This PIA is thus necessary to evaluate the potential effect of the construction on the palaeontological resources.

The proposed development includes three PV facilities as well as grid connections and infrastructure. These proposed developments are underlain by the continental sediments of the Latest Permian sediments of the Balfour Formation (Upper Beaufort Group, Adelaide Subgroup) and earliest Triassic sediments of the Katberg Formation (Upper Beaufort Group, Tarkastad Subgroup, Karoo Supergroup) as well as Jurassic Karoo Dolerite. These sediments are generally mantled by a thick layer of Quaternary to Recent colluvium and alluvium. The uppermost Balfour and Katberg Formations are of extraordinary interest in that they provide some of the best existing information on ecologically complex terrestrial ecosystems during the catastrophic end-Permian mass extinction. According to the PalaeoMap of South African Heritage Resources Information System the Palaeontological Sensitivity of the Tarkastad and Adelaide Subgroups has a Very High Palaeontological Sensitivity, while that of the Quaternary superficial deposits of the Central interior is high and the Karoo dolerite (igneous rocks) is insignificant and rated as zero.

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle from the 24^{tht} – 28th January 2019. Elsewhere in the Karoo Basin numerous fossils have been uncovered in these geological sediments but only two sites on koppies with fossiliferous outcrops were identified. Although these localities do not currently fall in the proposed development sites, these fossiliferous sites have been identified as Highly Sensitive and No-go areas and it is recommended that a 50 m buffer will be placed around these areas. In the event that construction is necessity in these sensitive areas it is recommended that the fossils will be collected by a professional palaeontologist. Preceding excavation of any fossil material, the specialist would need to apply for a collection permit from SAHRA. Fossil material must be curated in an accredited collection (museum or university collection), while all fieldwork and reports should meet the minimum standards for palaeontological impact studies suggested by SAHRA.

With the above mentioned in consideration, the proposed development, as well as all alternatives have a similar geology and therefore there is no preferences on the grounds of palaeontological fossil heritage for any specific layout among the different options under consideration. As impacts on fossil heritage usually only occur during the excavation

phase and no further impacts on fossil heritage are expected during the operation and decommissioning phases of the SEF.

The impact of development on fossil heritage are usually negative but it could also have a positive impact due to the discovery of newly uncovered fossil material that would have been unavailable for scientific research. The SEF could also provide a long-term benefit to the country by supplying renewable energy to the electricity grid.

In the event that fossil remains are discovered during any phase of construction, either on the surface or exposed by fresh excavations the **Chance Find Protocol** must be implemented by the ECO in charge of these developments. These discoveries ought to be protected (if possible *in situ*) and the ECO must report to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za) so that correct mitigation (*e.g.* recording and collection) can be carry out by a paleontologist.

It is consequently recommended that no further palaeontological heritage studies, ground truthing and/or specialist mitigation are required pending the discovery of newly discovered fossils. From a Palaeontological Heritage view there are no fatal floors in the proposed SEF development project. However, it is recommended that the mitigation measures are included in the EMPr and fully implemented.

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TERMINOLOGY AND ABBREVIATIONS

Archaeological resources

This includes:

- material remains resulting from human activity which are in a state of disuse and are in or on land and which are older than 100 years including artifacts, human and hominid remains, and artificial features and structures;
- rock art is any form of painting, engraving or other graphic representation on a fixed rock surface or loose rock or stone, which was executed by human agency and which is older than 100 years, including any area within 10m of such representation;
- wrecks, being any vessel or aircraft, or any part thereof, which was wrecked in South Africa, whether on land, in the internal waters, the territorial waters or in the maritime culture zone of the Republic as defined in the Maritimes Zones Act, and any cargo, debris or artefacts found or associated therewith, which is older than 60 years or which SAHRA considers to be worthy of conservation;
- features, structures, and artifacts associated with a military history which are older than 75 years and the site on which they are found.

Cultural significance

This means aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance

Development

This means any physical intervention, excavation, or action, other than those caused by natural forces, which may in the opinion of the heritage authority in any way result in a change to the nature, appearance or physical nature of a place or influences its stability and future well-being, including:

- construction, alteration, demolition, removal or change in use of a place or a structure at a place;
- carrying out any works on or over or under a place;
- subdivision or consolidation of land comprising a place, including the structures or airspace of a place;
- constructing or putting up for display signs or boards;
- any change to the natural or existing condition or topography of land; and
- any removal or destruction of trees, or removal of vegetation or topsoil

Fossil

Mineralized bones of animals, shellfish, plants, and marine animals. A trace fossil is the track or footprint of a fossil animal that is preserved in stone or consolidated sediment.

Heritage

That which is inherited and forms part of the National Estate (historical places, objects, fossils as defined by the National Heritage Resources Act 25 of 1999).

Heritage resources

This means any place or object of cultural significance and can include (but not limited to) as stated under Section 3 of the NHRA,

- places, buildings, structures, and equipment of cultural significance;
- places to which oral traditions are attached or which are associated with living heritage;
- historical settlements and townscapes;
- landscapes and natural features of cultural significance;
- geological sites of scientific or cultural importance;
- archaeological and palaeontological sites;
- graves and burial grounds, and
- sites of significance relating to the history of slavery in South Africa;

Holocene

The most recent geological time period which commenced 10 000 years ago.

Palaeontology

Any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or trace.

Table 1: Abbreviations

Abbreviations	Description
ASAP	Association of South African Professional Archaeologists
BRMO	Black Rock Mining operations
CRM	Cultural Resource Management
DEA	Department of Environmental Affairs
DIA	Desktop Impact Assessment
ECO	Environmental Control Officer
EIA practitioner	Environmental Impact Assessment Practitioner
EIA	Environmental Impact Assessment
ESA	Early Stone Age
GPS	Global Positioning System
HIA	Heritage Impact Assessment
I&AP	Interested & Affected Party
LSA	Late Stone Age
LIA	Late Iron Age

Abbreviations	Description
MSA	Middle Stone Age
MIA	Middle Iron Age
NEMA	National Environmental Management Act
NHRA	National Heritage Resources Act
PIA	Palaeontological Impact Assessment
PHRA	Provincial Heritage Resources Authority
PSSA	Palaeontological Society of South Africa
SADC	Southern African Development Community
SAHRA	South African Heritage Resources Agency

1 INTRODUCTION

SiVEST has been appointed to undertake the EIA process for the Umsobomvu PV Energy Facilities and associated infrastructure (including Grid Connection) near Middelburg and Noupoort in the Eastern and Northern Cape Provinces. PGS Heritage was commissioned by SiVEST SA (Pty) Ltd to conduct the Heritage Impact Assessment. In turn Banzai Environmental was appointed by PGS Heritage (Pty) Ltd to conduct the Palaeontological Impact Assessment (PIA). According to the National Heritage Resources Act (NHRA) (No 25 of 1999, section 38), a PIA is key to detect the presence of fossil material within the proposed development footprint and it is thus necessary to evaluate the impact of the construction on the palaeontological resources. This Palaeontological Impact Assessment report serves to fulfil the requirement and form part of the EIA.

1.1 PROPOSED UMSOBOMVU SOLAR PV ENERGY FACILITIES

1.1.1 PROJECT DESCRIPTION

It is proposed that three (3) Solar Photovoltaic (PV) Energy Facilities, with associated grid connection infrastructure, will be developed, these being:

- ***Mooi Plaats Solar PV Facility***, on an application site of approximately 5 303ha, comprising the following farm portions:
    - Portion 1 of Leuwe Kop No 120
    - Remainder of Mooi Plaats No 121

- ***Wonderheuvel Solar PV Facility***, on an application site of approximately 5 652ha, comprising the following farm portions:
    - Remainder of Mooi Plaats No 121
    - Portion 3 of Wonder Heuvel No 140
    - Portion 5 of Holle Fountain No 133

- ***Paarde Valley Solar PV Facility***, on an application site of approximately 3 695ha, comprising the following farm portion:
    - Portion 2 of Paarde Valley No 62: and
    - Portion 7 of the Farm Leeuw Hoek No. 61[1].

1.2 Grid Connection

1.2.1 Mooi Plaats Solar PV Solar Grid Connection Explanation

<u>Option 1:</u>

- Corridor **Option 1a** links **substation 2** and **substation 1a** to Hydra D MTS; and
- Corridor **Option 1b** links **substation 2** and **substation 1b** to Hydra D MTS.

Option 2:

- Corridor **Option 2a** links **Substation 2** and **Substation 1a** to Hydra D MTS via the proposed Central Collector substation (substation 4a acts as Central Collector) located on the Wonderheuvel PV project application site.
- Corridor **Option 2b** links **Substation 2** and **Substation 1b** to Hydra D MTS via the proposed Central Collector substation (substation 4a acts as Central Collector) located on the Wonderheuvel PV project application site[1].

1.2.2 Wonderheuvel Solar PV Grid Connection

Option 1:

- Corridor **Option 1a** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  - The *northern connection* links the Proposed **Substation 3a** to Hydra D MTS via the proposed Northern Collector Substation (either substation 1a or substation 1b will act as Northern Collector, depending on which grid routing option is preferred from an environmental perspective for Mooi Plaats) located on the Mooi Plaats PV project application site.
  - The *southern connection* links the proposed **Substation 4a** to the Coleskop WEF Substation via the proposed Southern Collector Substation (either substation 6a or substation 6b will act as Southern Collector, depending on which grid routing option is preferred from an environmental perspective for Paarde Valley) located on the Paarde Valley PV Project application site.

- Corridor **Option 1b** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  - The *northern connection* links the Proposed **Substation 3a** to Hydra D MTS via the proposed Northern Collector Substation (either substation 1a or substation 1b will act as Northern Collector, depending on which grid routing option is preferred from an environmental perspective for Mooi Plaats) located on the Mooi Plaats PV project application site.
  - The *southern connection* links the proposed **Substation 4b** to the Coleskop WEF Substation via the proposed Southern Collector Substation (either substation 6a or substation 6b will act as Southern Collector, depending on which grid routing option is preferred from an environmental perspective for Paarde Valley) located on the Paarde Valley PV Project application site.

- Corridor **Option 1c** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
    - The *northern connection* links the Proposed **Substation 3b** to Hydra D MTS via the proposed Northern Collector Substation (either substation 1a or substation 1b will act as Northern Collector, depending on which grid routing option is preferred from an environmental perspective for Mooi Plaats) located on the Mooi Plaats PV project application site.
    - The *southern connection* links the proposed **Substation 4a** to the Coleskop WEF Substation via the proposed Southern Collector Substation (either substation 6a or substation 6b will act as Southern Collector, depending on which grid routing option is preferred from an environmental perspective for Paarde Valley) located on the Paarde Valley PV Project application site.

- Corridor **Option 1d** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
    - The *northern connection* links the Proposed **Substation 3b** to Hydra D MTS via the proposed Northern Collector Substation (either substation 1a or substation 1b will act as Northern Collector, depending on which grid routing option is preferred from an environmental perspective for Mooi Plaats) located on the Mooi Plaats PV project application site.
    - The *southern connection* links the proposed **Substation 4b** to the Coleskop WEF Substation via the proposed Southern Collector Substation (either substation 6a or substation 6b will act as Southern Collector, depending on which grid routing option is preferred from an environmental perspective for Paarde Valley) located on the Paarde Valley PV Project application site.

Option 2:

- Corridor **Option 2a** links **Substation 3a** to Hydra D MTS via the proposed Central Collector Substation (substation 4a acts as Central Collector).
- Corridor **Option 2b** links **Substation 3b** to Hydra D MTS via the proposed Central Collector Substation (substation 4a acts as Central Collector).

Option 3:

- Corridor **Option 3** links **Substation 4b** to Hydra D MTS via the proposed Central Collector Substation (substation 4a acts as Central Collector) [1].

1.2.3 *Paarde Valley Solar PV Grid Connection*

Option 1:

- Corridor **Option 1a** involves two (2) separate grid connections to serve the northern and southern sections of the application site.

- The *northern connection* links **Substation 5** to Coleskop Substation via the proposed Southern Collector Sub (Substation 6a will act as Central Collector for this option).
- The *southern connection* links **Substation 7a** to the Coleskop Substation via the proposed Southern Collector Substation (Substation 6a will act as Southern Collector for this option).

- Corridor **Option 1b** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  - The *northern connection* links **Substation 5** to Coleskop Substation via the proposed Southern Collector Sub (Substation 6b will act as Southern Collector for this option).
  - The *southern connection* links **Substation 7a** to the Coleskop Substation via the proposed Southern Collector Substation (Substation 6b will act as Southern Collector for this option).

- Corridor **Option 1c** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  - The *northern connection* links **Substation 5** to Coleskop Substation via the proposed Southern Collector Sub (Substation 6a will act as Southern Collector for this option).
  - The *southern connection* links **Substation 7b** to the Coleskop Substation via the proposed Southern Collector Substation (Substation 6a will act as Southern Collector for this option).

- Corridor **Option 1d** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  - The *northern connection* links **Substation 5** to Coleskop Substation via the proposed Southern Collector Sub (Substation 6b will act as Southern Collector for this option).
  - The *southern connection* links **Substation 7b** to the Coleskop Substation via the proposed Southern Collector Substation (Substation 6b will act as Southern Collector for this option).

Option 2:

- Corridor **Option 2a** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
  - The *northern connection* links **Substation 5** to Hydra D MTS via the proposed Central Collector Sub (substation 4a acts as Central Collector) located on the Wonderveuvel PV Project application site.

    - The *southern connection* links **Substation 6a and 7a** to the Hydra D MTS via the proposed Central Collector Substation (substation 4a acts as Central Collector) located on the Wonderheuvel PV Project application site.

- Corridor **Option 2b** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
    - The *northern connection* links **Substation 5** to Hydra D MTS via the proposed Central Collector Sub (substation 4a acts as Central Collector) located on the Wonderheuvel PV Project application site.
    - The *southern connection* links **Substation 6b and 7b** to the Hydra D MTS via the proposed Central Collector Substation (substation 4a acts as Central Collector) located on the Wonderheuvel PV Project application site.

- Corridor **Option 2c** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
    - The *northern connection* links **Substation 5** to Hydra D MTS via the proposed Central Collector Sub (substation 4a acts as Central Collector) located on the Wonderheuvel PV Project application site.
    - The *southern connection* links **Substation 6a and 7b** to the Hydra D MTS via the proposed Central Collector Substation (substation 4a acts as Central Collector) located on the Wonderheuvel PV Project application site.

- Corridor **Option 2d** involves two (2) separate grid connections to serve the northern and southern sections of the application site.
    - The *northern connection* links **Substation 5** to Hydra D MTS via the proposed Central Collector Sub (substation 4a acts as Central Collector) located on the Wonderheuvel PV Project application site.
    - The *southern connection* links **Substation 6b and 7a** to the Hydra D MTS via the proposed Central Collector Substation (substation 4a acts as Central Collector) located on the Wonderheuvel PV Project application site[1].

[1] Information provided by SiVEST

2 OBJECTIVE

The terms of reference of a Palaeontological Impact Assessment are as follows:

The objective of a Palaeontological Desktop Assessment is to determine the impact of the development on potential palaeontological material at the site.

According to the "SAHRA APM Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports" the aims of the PIA are: 1) to **identify** the palaeontological status of the exposed as well as rock formations just below the surface in the development footprint 2) to assess the **palaeontological importance** of the formations 3) to determine the **impact** on fossil heritage, and 4) to **recommend** how the developer ought to protect or mitigate damage to fossil heritage.

General Requirements:

- Adherence to the content requirements for specialist reports in accordance with Appendix 6 of the EIA Regulations 2014, as amended;
- Adherence to all appropriate best practice guidelines, relevant legislation and authority requirements;
- Provide a thorough overview of all applicable legislation, guidelines;
- Cumulative impact identification and assessment as a result of other renewable energy (RE) developments in the area (including; a cumulative environmental impact table(s) and statement, review of the specialist reports undertaken for other Renewable Energy developments and an indication of how the recommendations, mitigation measures and conclusion of the studies have been considered);
- Identification sensitive areas to be avoided (including providing shapefiles/kmls);
- Assessment of the significance of the proposed development during the Pre-construction, Construction, Operation, Decommissioning Phases and Cumulative impacts. Potential impacts should be rated in terms of the direct, indirect and cumulative:
    - Direct impacts are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity. These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable.
    - Indirect impacts of an activity are indirect or induced changes that may occur as a result of the activity. These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken, or which occur at a different place as a result of the activity.
    - Cumulative impacts are impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities. Cumulative impacts can occur from the collective

impacts of individual minor actions over a period of time and can include both direct and indirect impacts.

- Comparative assessment of alternatives (infrastructure alternatives have been provided):
- Recommend mitigation measures in order to minimise the impact of the proposed development; and
- Implications of specialist findings for the proposed development (e.g. permits, licenses etc.).

Specific Requirements:

- Describe and map the palaeontological heritage features of the site and surrounding area. This is to be based on desk-top reviews, fieldwork, available databases, findings from other palaeontological heritage studies in the area, where relevant. Include reference to the grade of heritage feature and any heritage status the feature may have been awarded.
- Assess the impacts and provide mitigation measures to include in the environmental management plan.
- Map palaeontological heritage sensitivity for the site. Clearly show any "no-go" areas in terms of heritage (i.e. "very high" sensitivity) and provide recommended buffers or set-back distances.
- Identify and assess potential impacts from the project on palaeontology, as required by heritage legislation (including cumulative impacts from other wind farms within a radius of 50 km).
- Provide an updated sensitivity map for the Umsobomvu PV project site.
- Assess the project alternatives provided, including the no-go alternative

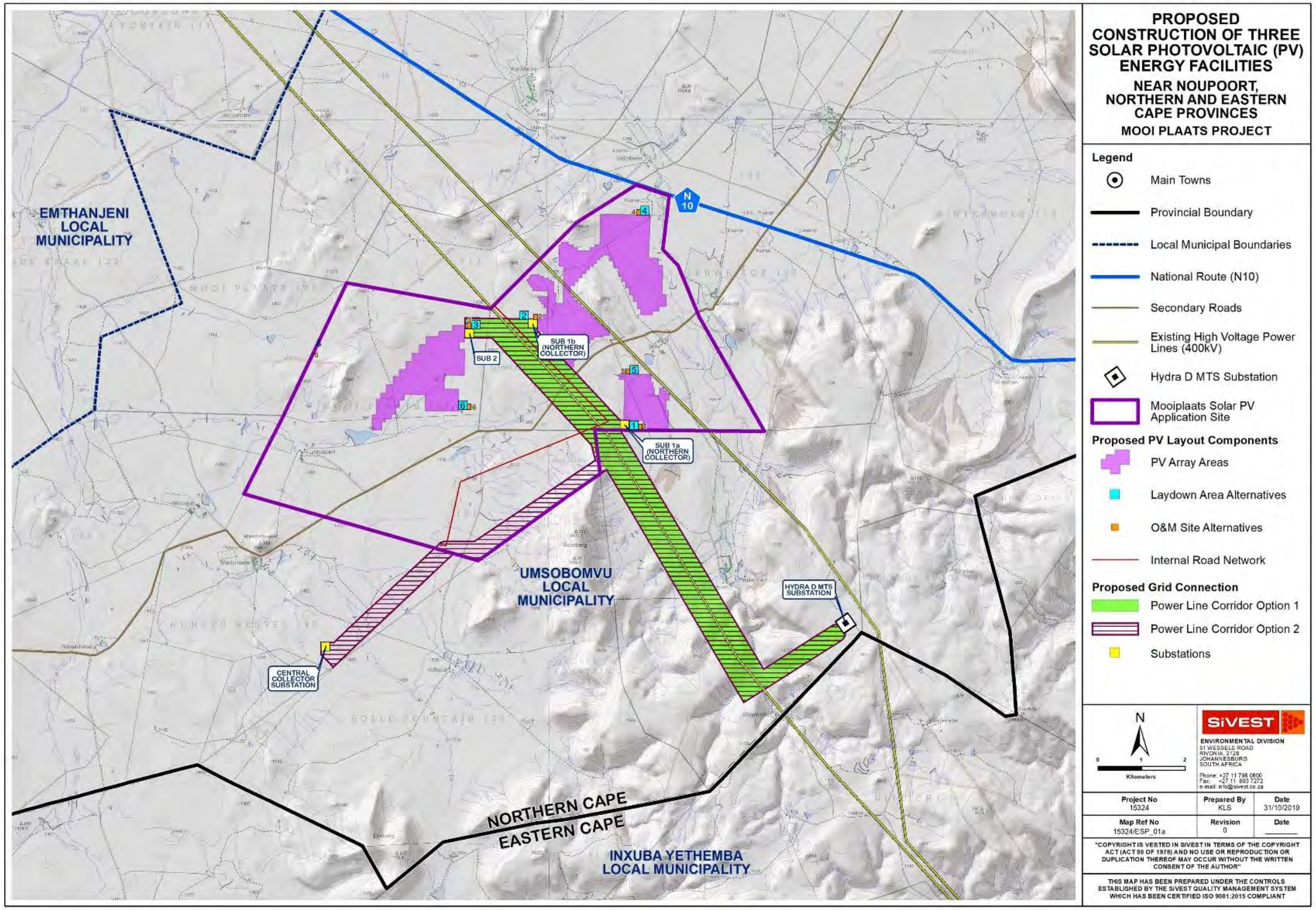


Figure 1: Site Locality of the proposed Mooi Plaats PV Energy facility near Noupoort, Northern Cape Province. Map provided by SiVEST

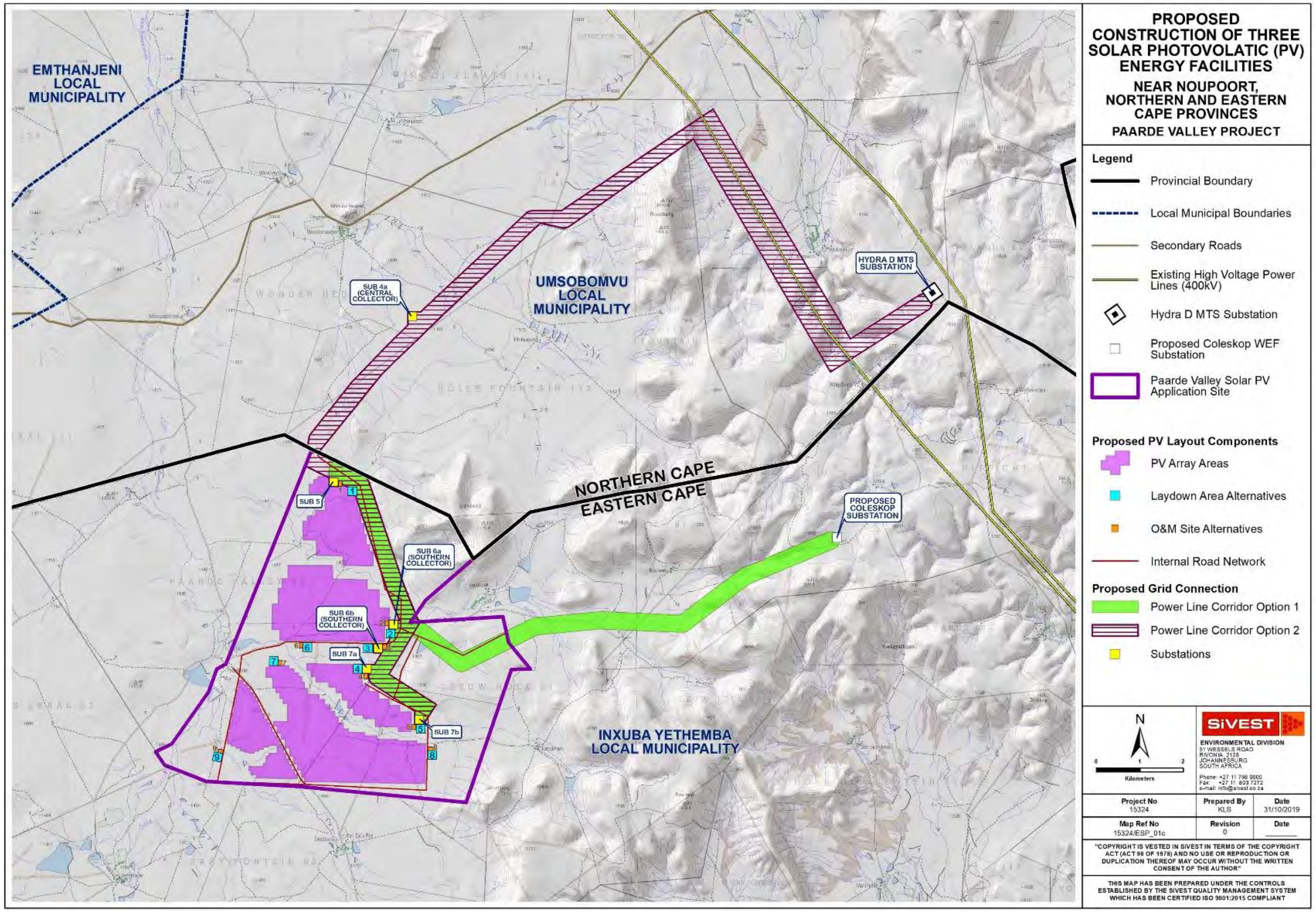


Figure 2: Site Locality of the proposed Paarde Valley PV Energy facility near Middelburg, Eastern Cape Province. Map provided by SiVEST

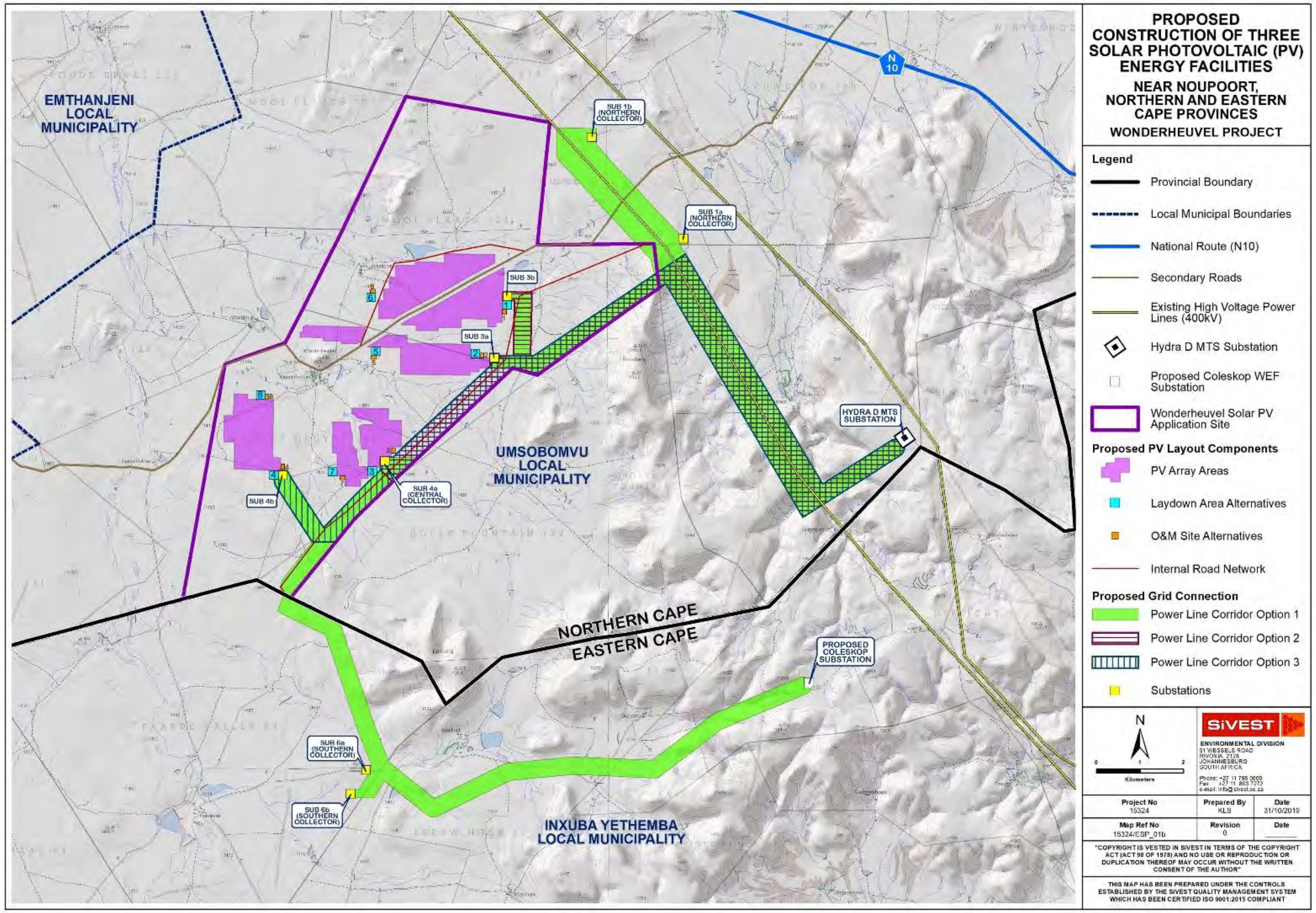


Figure 3: Site Locality of the proposed Wonderheuvel PV Energy facility near Noupoort, Northern Cape Province. Map provided by SiVEST

3 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

The author (Elize Butler) has an MSc in Palaeontology from the University of the Free State, Bloemfontein, South Africa. She has been working in Palaeontology for more than twenty-four years. She has extensive experience in locating, collecting and curating fossils, including exploration field trips in search of new localities in the Karoo Basin. She has been a member of the Palaeontological Society of South Africa for 12 years. She has been conducting PIAs since 2014.

4 LEGISLATION

4.1 National Heritage Resources Act (25 of 1999)

Cultural Heritage in South Africa, includes all heritage resources, is protected by the National Heritage Resources Act (Act 25 of 1999) (NHRA). Heritage resources as defined in Section 3 of the Act include **"all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens**".

Palaeontological heritage is unique and non-renewable and is protected by the NHRA. Palaeontological resources may not be unearthed, broken moved, or destroyed by any development without prior assessment and without a permit from the relevant heritage resources authority as per section 35 of the NHRA.

This DIA forms part of the Heritage Impact Assessment (HIA) and adhere to the conditions of the Act. According to **Section 38 (1)**, an HIA is required to assess any potential impacts to palaeontological heritage within the development footprint where:

- the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length;
- the construction of a bridge or similar structure exceeding 50 m in length;
- any development or other activity which will change the character of a site—
- (exceeding 5 000 m^2 in extent; or
- involving three or more existing erven or subdivisions thereof; or
- involving three or more erven or divisions thereof which have been consolidated within the past five years; or
- the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority
- the re-zoning of a site exceeding 10 000 m^2 in extent;
- or any other category of development provided for in regulations by SAHRA or a Provincial heritage resources authority.

5 GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

The geology of the three Solar Photovoltaic (PV) Energy Facilities, and associated grid connection infrastructure is present on the 1:250 000 3124 Middelburg Geological Map (Counsel for Geoscience, Pretoria) (Figure 4-6). The proposed development is underlain by the continental sediments of the Latest Permian sediments of the Balfour Formation (Upper Beaufort Group, Adelaide Subgroup) and earliest Triassic sediments of the Katberg Formation (Upper Beaufort Group, Tarkastad Subgroup, Karoo Supergroup) as well as Jurassic Karoo Dolerite. These sediments are generally mantled by a thick layer of Quaternary to Recent colluvium and alluvium (Figure 4-6). The uppermost Balfour and Katberg Formations are of extraordinary interest in that they provide some of the best existing information on ecologically complex terrestrial ecosystems during the catastrophic end-Permian mass extinction (Mc Carthy *et al*., 2005).

5.1 Geology

The development area is underlain by a series of Karoo sandstones, mudstones and shales, deposited under fluvial environments of the Adelaide Subgroup that forms part of the Beaufort Group. The Beaufort group overlays the Ecca Group and consists essentially of sandstones and shales, deposited in the Karoo Basin from the Middle Permian to the early part of the Middle Triassic periods and was deposited on land through alluvial processes. The Beaufort Group covers a total land surface area of approximately 200 000 km^2 in South Africa and is the first fully continental sequence in the Karoo Supergroup. The Beaufort Group is divided into the Adelaide subgroup and the overlying Tarkastad subgroup (Johnson *et al*, 2006).

The Adelaide subgroup rocks were deposited under a humid climate that allowed for the establishment of wet floodplains with high water tables and are interpreted to be fluvio-lacustrine sediments. The Balfour Formation forms the upper part of the Adelaide Subgroup and part of what was called lower to middle Beaufort. The Adelaide Subgroup contains alternating greyish-red, bluish-grey, or greenish-grey mudrocks in the southern and central parts of the Karoo Basin with very fine to medium grained, grey lithofeldspathic sandstones. Thicker sandstones of the Adelaide are usually multi-storey and usually have cut-and fill features. The sandstones are characterized internally by horizontal lamination together with parting lineation and less frequent trough cross-bedding as well as current ripple lamination. The bases of the sandstone units are massive beds, while ripple lamination is usually confined to thin sandstones towards the top of the thicker units.

The mudrocks of the Adelaide Subgroup usually has massive and blocky weathering apart from in the Normandien and Daggaboersnek Member. Sometimes desiccation cracks and impressions of raindrops are present. In the mudstones of the Beaufort Group calcareous nodules and concretions occur throughout.

The arenaceous Katberg Sandstone Formation of the Tarkastad Subgroup comprise of fine to medium-grained pinkish-grey sandstone with subordinate greenish-grey mudstone. The Katberg tabular sheet sandstones are vertically superimposed and divided by erosion surfaces lined with intraformational mud-pebble conglomerates. A maximum thickness of 1000 m has been measured (Hiller and Stavrakis, 1984). At the end of the Permian the rivers changed from a meandering river system in the Balfour Formation to a large sand braided fan system in the Katberg Sandstone Formation (Johnson *et al*, 2006, Smith *et al*, 2006)

During Jurassic times the subcontinent was inundated with basaltic lava to form the capping basalts of the Jurassic aged Drakensberg Group. During the Jurassic the volcanic Drakensberg were formed and cracks in the earth's crust were filled with molten lava that cooled to form dolerite dykes. Magma injected horizontally between sediments, cooled down and formed horizontal stills of dolerite.

The Beaufort Group is subdivided into a series of biostratigraphic units on the basis of its faunal content, namely the *Daptocephalus* Assemblage Zone (Balfour Formation) and the *Lystrosaurus* Assemblage (Katberg Formation) (Figure 7) (Groenewald et al, 1995; Groenewald, 1996)).

The Tertiary to Quaternary Cenozoic superficial deposits consist of aeolian sand, alluvium (clay, silt and sand deposited by flowing floodwater in a river valley/ delta producing fertile soil), colluvium (material collecting at the foot if a steep slope), spring tufa/tuff (a porous rock composed of calcium carbonate and formed by precipitation from water, for example, around mineral springs) and lake deposits, peats, pedocretes or duricrusts (calcrete, ferricrete), soils and gravels (Partridge *et a*l, 2006).

5.2 Palaeontology

The Beaufort Group is the third of the main subdivisions of the Karoo Supergroup (Johnson et al, 2006). The flood plains of the Beaufort Group (Karoo Supergroup) are internationally renowned for the early diversification of land vertebrates and provide the worlds' most complete transition from early "reptiles" to mammals. The diverse *Daptocephalus* Assemblage Zone biotas are of extraordinary interest in that they provide some of the best available information on ecologically complex terrestrial ecosystems immediately preceding the catastrophic end-Permian mass extinction (Abdala *et al*, 2006; Mc Carthy *et al*., 2005, Gastaldo *et al.* 2005, Retallack *et al.,* 2006).

Sediments of the Beaufort Group are relatively rich in fossils, especially vertebrate fossils. The *Daptocephalus* Assemblage Zone is characterized by the occurrence of the two therapsids namely *Dicynodon* and *Theriognathus.* The *Daptocephalus* Assemblage Zone expands into the lower Palingkloof Member of the Upper Balfour Formation. This Zone is characterized by the occurrence of the two therapsids namely *Dicynodon* and *Theriognathus*. The *Daptocephalus* Zone shows the greatest vertebrate diversity and includes numerous well preserved genera and species of dicynodonts, biarmosuchians, gorgonopsian, therocephalian and cynodont therapsid Synapsida as well as captorhinid Reptilia and less well represented eosuchian Reptilia, Amphibia and Pisces (Kitching, 1977; National Palaeontology Museum databases). Trace fossils of vertebrates and invertebrates as well as *Glossopteris* flora plants have also been described (Bamford, 2004).

The lower Palingkloof Member is of special importance as it precedes the Permo-Triassic Extinction Event which destroyed the vertebrate fauna and extinguished the diverse glossopterid plants (Bamford, 2004).

The lower *Lystrosaurus* Assemblage Zone forms part of the Katberg Formation. Fauna and flora from this assemblage zone is rare as few genera survived the Permo-Triassic Extinction Event (Botha et al, 2007) The *Lystrosaurus* Assemblage Zone is characterized by the dicynodont, *Lystrosaurus*, and captorhinid reptile, *Procolophon*. The biarmosuchian and gorgonopsian Therapsida did not survive into the *Lystrosaurus* Assemblage Zone although the therocephalian and cynodont Therapsida are present in moderate quantities. Captorhinid Reptilia are reduced, but this interval is characterised by a unique diversity of oversize amphibians. Fossil fish, millipedes and diverse trace fossils have also been recorded.

Quaternary fossil assemblages are generally rare and low in diversity and is spread out over a wide geographic area. These fossil assemblages may sometimes occur in extensive alluvial and colluvial deposits cut by dongas. In the past palaeontologists did not concentrate their research on Cenozoic superficial deposits although they sometimes comprise of important fossil biotas. Fossils assemblages may comprise of bones, horn corns, fragments of ostrich eggs and mammalian teeth; as well as reptile skeletons. Microfossils, non- marine mollusc shells and freshwater stromatolites are also known from Quaternary deposits. Plant material such as foliage, pollens peats and wood are recovered as well as trace fossils like vertebrate tracks, burrows, termitaria (termite heaps/ mounds) and rhizoliths (root casts).

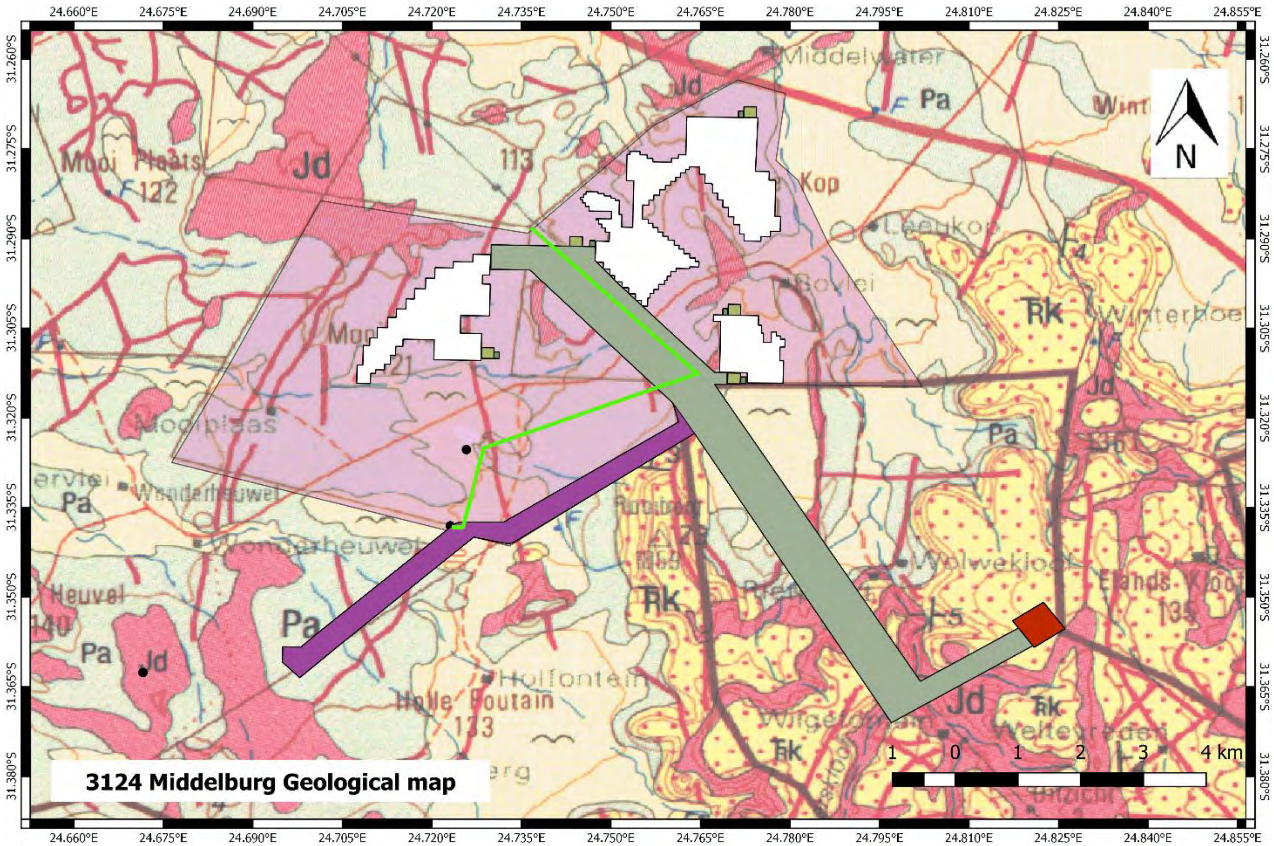


Figure 4: Surface geology of the proposed Umsobomvu Solar PV Energy Facilities: Mooi Plaats. The proposed development is underlain by the Adelaide and Tarkastad Subgroup, Beaufort Group, Karoo Supergroup) as well as Jurassic Karoo Dolerite. Map drawn QGIS Desktop 2.18.1. Map drawn QGIS Desktop 2.28.18

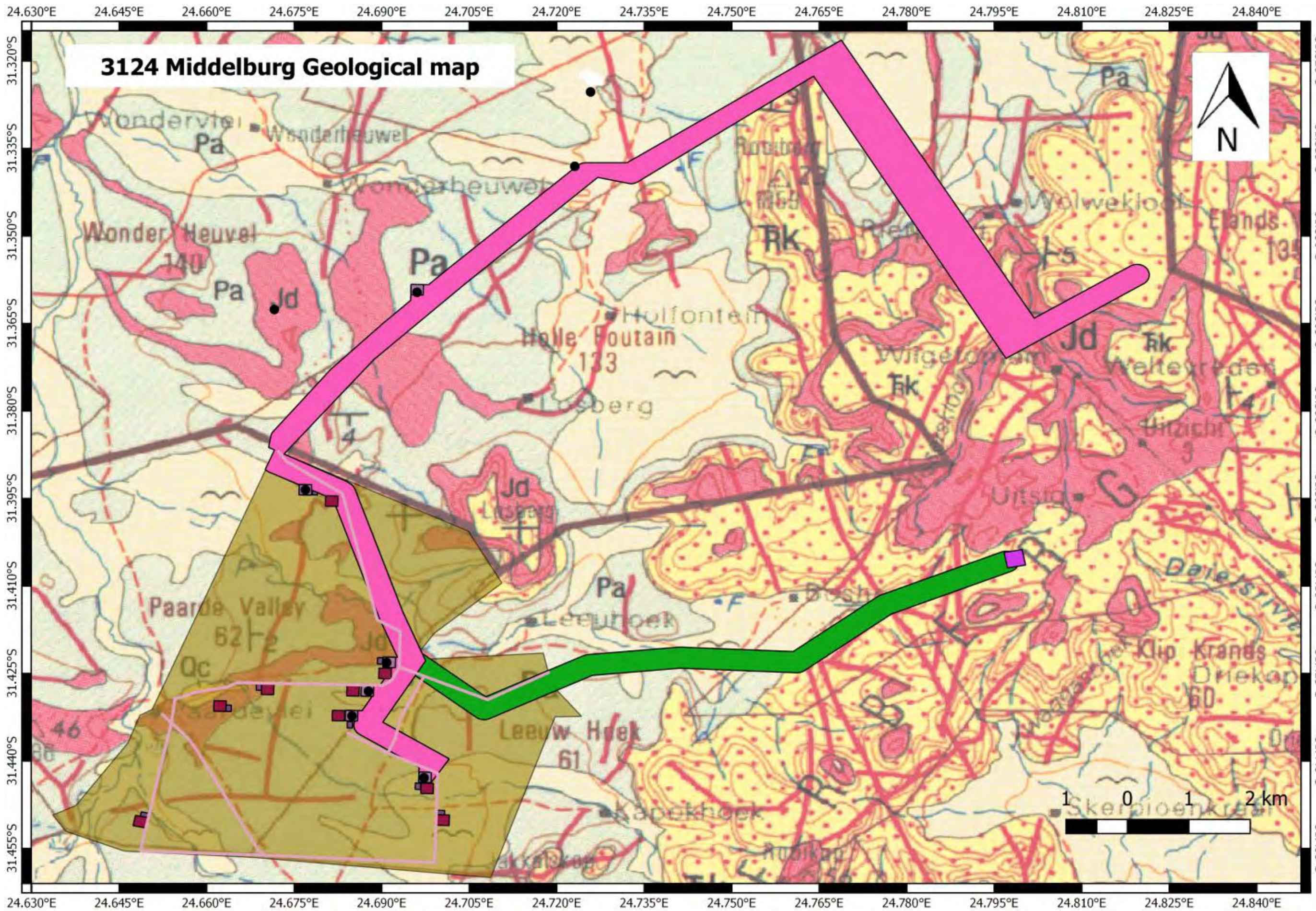


Figure 5: Surface geology of the proposed Umsobomvu Solar PV Energy Facilities: Paarde Valley. The proposed development is underlain by the Adelaide and Tarkastad Subgroup, Beaufort Group, Karoo Supergroup) as well as Jurassic Karoo Dolerite. Map drawn QGIS Desktop 2.28.18

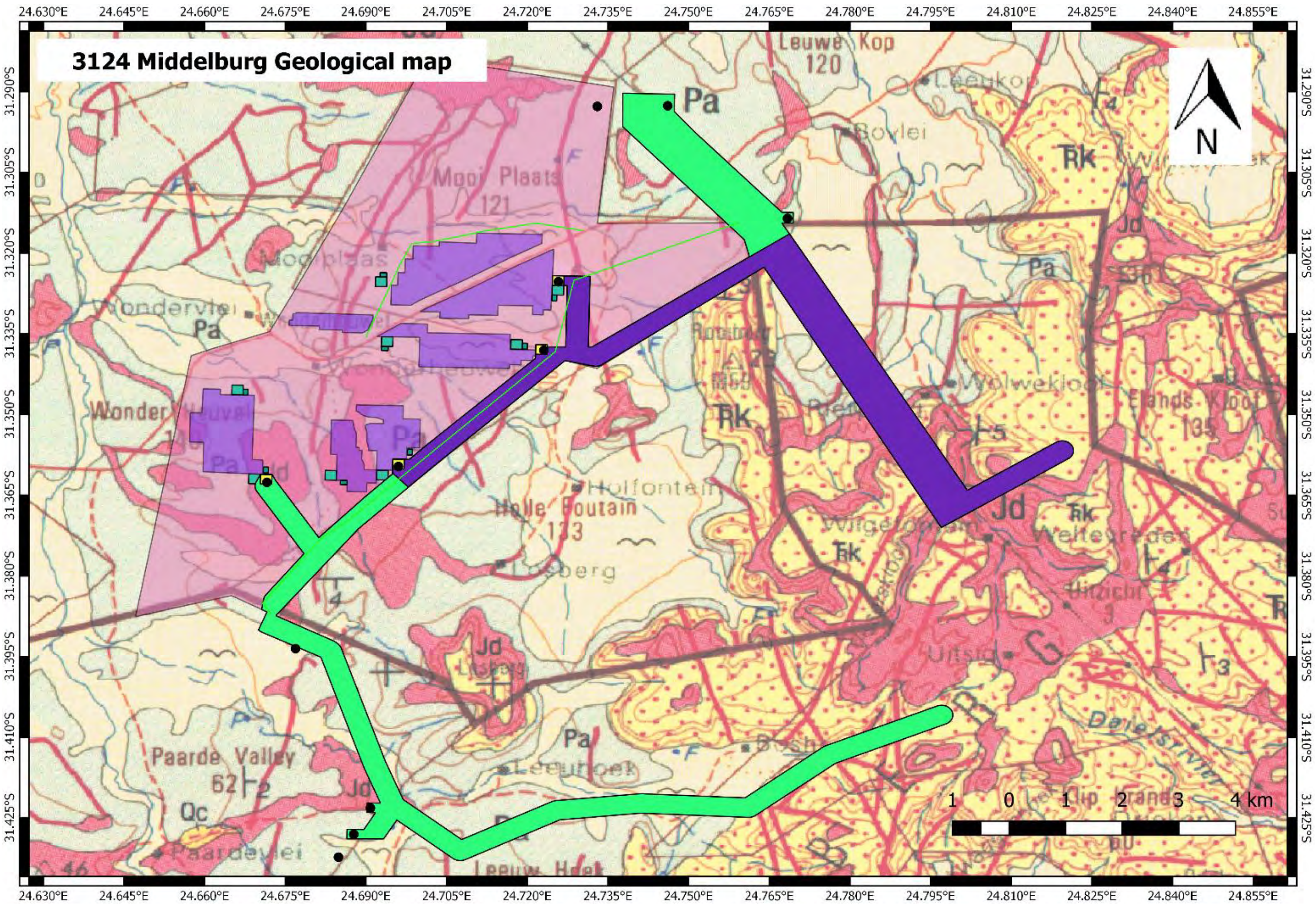
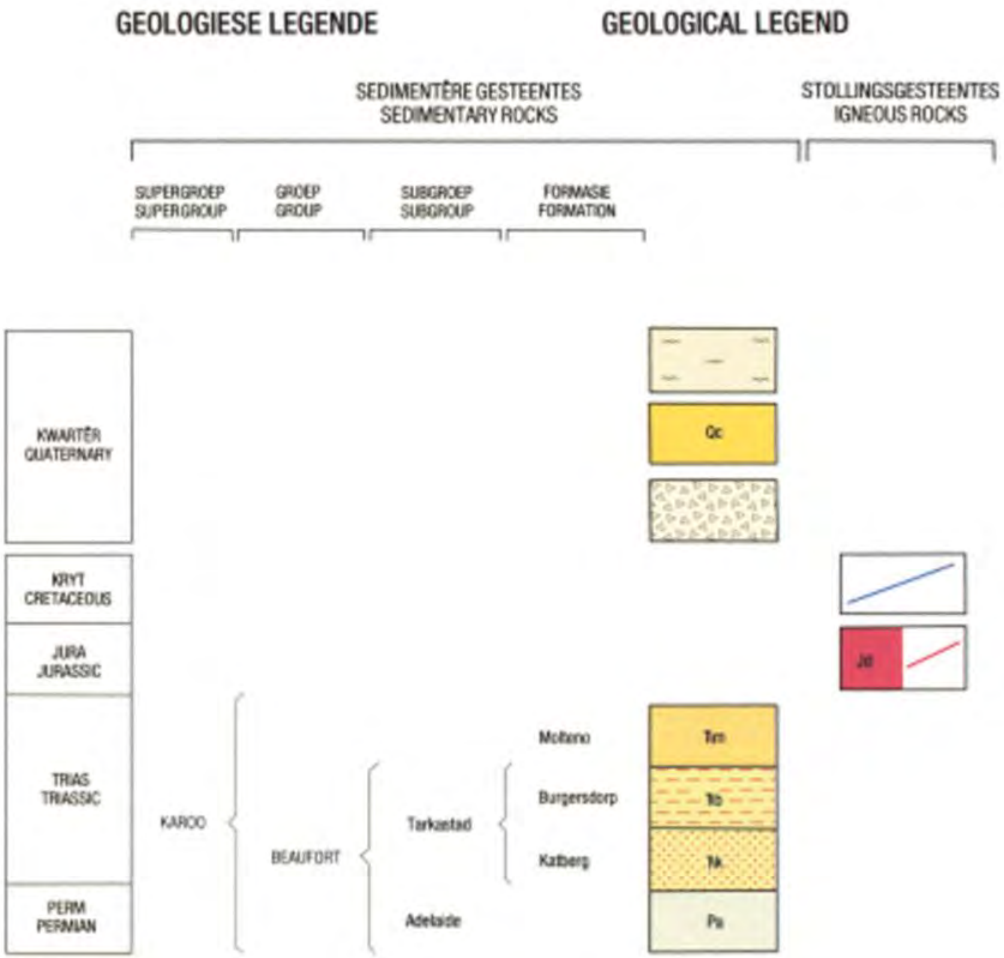


Figure 6: Surface geology of the proposed Umsobomvu Solar PV Energy Facilities: Wonderheuvel. The proposed development is underlain by the Adelaide and Tarkastad Subgroup, Beaufort Group, Karoo Supergroup) as well as Jurassic Karoo Dolerite. Map drawn QGIS Desktop 2.28.18

Map Clarification



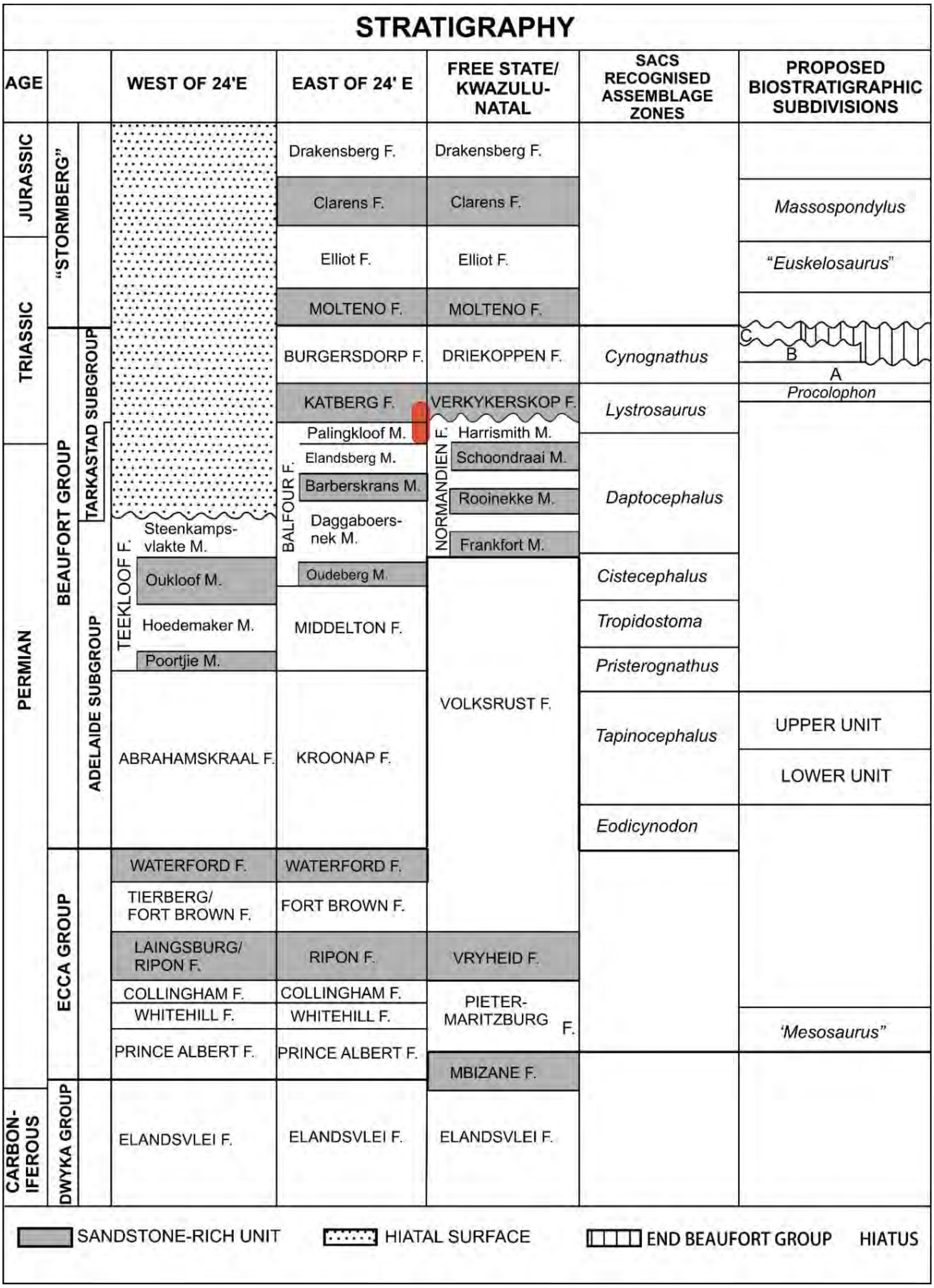


Figure 7: *Lithostratigraphic (rock-based) and biostratigraphic (fossil-based) subdivisions Beaufort Group of the Karoo Supergroup with rock units and fossil assemblage zones relevant to the present study marked in red (Modified from Rubidge, 1995). Abbreviations: F. = Formation, M. = Member*

6 GEOGRAPHICAL LOCATION OF THE SITE

The proposed three (3) Solar Photovoltaic (PV) Energy Facilities, with associated grid connection infrastructure comprises of the following farms and portions of farms:

- ***Mooi Plaats Solar PV Facility***, on an application site of approximately 5 303ha, comprising the following farm portions:
  - Portion 1 of Leuwe Kop No 120
  - Remainder of Mooi Plaats No 121

- ***Wonderheuvel Solar PV Facility***, on an application site of approximately 5 652ha, comprising the following farm portions:
  - Remainder of Mooi Plaats No 121
  - Portion 3 of Wonder Heuvel No 140
  - Portion 5 of Holle Fountain No 133

- ***Paarde Valley Solar PV Facility***, on an application site of approximately 3 695ha, comprising the following farm portion:
  - Portion 2 of Paarde Valley No 62: and
  - Portion 7 of the Farm Leeuw Hoek No. 61.

7 APPROACH AND METHODOLOGY

The objective of a Palaeontological Impact Assessment is to determine the impact of the development on potential palaeontological material at the site.

According to the "SAHRA APM Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports" the aims of the palaeontological impact assessment are:

1. to identify the palaeontological importance of the exposed and rocks below the surface in the development footprint
2. to evaluate the palaeontological importance of the formations
3. to determine the impact of the development on fossil heritage; and
4. to recommend how the developer ought to protect or mitigate damage to fossil heritage.

The potentially fossiliferous rocks present within the study area are established from 1:250 000 geological maps and utilized when a palaeontological desktop study is compiled. The topography of the development area is identified using 1:50 000 topography maps as well as Google Earth Images of the development area. Fossil heritage within the rock formation is obtained from palaeontological impact studies in the same region, the PalaeoMap from SAHRIS; and databases of various institutions. The palaeontological importance of each rock unit is calculated and the probable impact of the proposed development footprint on local fossil heritage is established on the following criteria

1. the palaeontological importance of the rocks,
2. the type and scale of the development, and
3. Quantity of bedrock excavated.

A field-based assessment by a palaeontologist is required when rocks of moderate to high palaeontological sensitivity are present within the study area. Based on both the desktop data and field assessment, the impact significance of the planned development is determined and recommendations for further studies or mitigation is made. In general, destructive impacts on palaeontological heritage only happen during construction. The excavations will change the current topography and may destruct or permanently seal-in fossils at or below the ground surface. Fossil Heritage will then no longer be accessible for scientific research.

Mitigation involves the collection and recording of fossils preceding construction or during construction when fossiliferous bedrock is uncovered. Importantly, preceding the excavation of any fossil heritage a permit from SAHRA must be obtained and the material will have to be housed in a permitted institution (Museum or university). When mitigation is applied correctly, a positive impact is possible because our knowledge of local palaeontological heritage may be increased.

7.1 SAHRA minimum standards for Palaeontology reports

As per the “SAHRA APM Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports” it states that “Although the details of the Phase 1 Minimum Standards discussed below may not apply directly where these are specifically archaeological, these standards can be used as a general guide to what is needed in Phase 1 palaeontological reports”. The compliance of this PIA to these standards is described in below.

7.2 Assumptions and Limitation

The accuracy of Palaeontological Impact Assessments is reduced by several factors which may include the following: the databases of institutions are not always up to date and relevant locality and geological information was not accurately documented in the past. Various remote areas of South Africa have not been assessed by palaeontologists and data is based on aerial photographs alone. Geological maps concentre on the geology of an area and the sheet explanations were never intended to focus on palaeontological heritage.

Similar Assemblage Zones, but in different areas are used to provide information on the presence of fossil heritage in an unmapped area. Desktop studies of similar geological formations and

Assemblage Zones generally assume that exposed fossil heritage is present within the development area. The accuracy of the Palaeontological Impact Assessment is thus improved considerably by conducting a field-assessment.

8 ADDITIONAL INFORMATION CONSULTED

In compiling this report the following sources were consulted:

- The Palaeosensitivity Map from the SAHRIS website.
- Geological map 1:100 000, Geology of the Republic of South Africa (Visser 1984)
- Geological Map 1: 250 000 3124 Middelburg.
- A Google Earth map with polygons of the proposed development was obtained from *SiVEST*.

9 SITE VISIT

As part of the PIA, a field-survey of the development footprint was conducted on 24 to 28 January 2019 to assess the potential risk to palaeontological material (fossil and trace fossils) in the proposed footprint of the development. A physical field-survey was conducted on foot and by motor vehicle within the proposed development footprint. The results of the field-survey, the author's experience, aerial photos (using Google Earth, 2018), topographical and geological maps and other reports from the same area were used to assess the proposed development footprint. No consultations were undertaken for this Impact Assessment as it will be undertaken as part of the EIA process

Figure 8: Flat topography and low vegetation of the proposed Mooi Plaats development 31°17' 24"S 47°09' 25"E

Figure 9: Flat topography and low vegetation of the proposed Mooi Plaats development 31° 16' 35"S 24° 45' 52"E

Figure 10: Existing power line on the development Mooi Plaats footprint 31° 16' 352"S 24° 45' 03"E

Figure 11: Dolerite outcrop on the development Mooi Plaats footprint 31° 17’ 38”S 24° 45’ 54”E

Figure 12: Unfossiliferous outcrop in the Balfour Formation on the Mooi Plaats development 31° 19' 19"S 24° 43' 22"E

Figure 13: Dry Riverbed in the Balfour Formation (Paarde Valley development)
31° 21'19 S 24 47 59" E

Figure 14: Existing powerline on Paarde Valley development *31°21'56"S 24°47'57" E*

Figure 15: Unfossiliferous mountain side without any outcrops on the Paarde Valley development *31°22'02" S24°48'46" E*

Figure 16: Unfossiliferous dolerite outcrops on the Paarde Valley development
31°21'48" S 24°49'04" E

Figure 17: Quaternary deposits covering the underlying sediments on the Paarde Valley development

31°24'22.14"S 24°47'57.06"E

Figure 18: Side of a mountain indicating the lack of outcrop on the Paarde Valley development 31°24'11" S 24°48'18" E

Figure 19: Igneous Jurassic dolerite outcrop on the Paarde Valley development
31°23’54”S 24°47’24”E

Figure 20: General lack of outcrops
31°22’48” S 24°8’02” E

Figure 21: Quaternary to Recent colluvium and alluvium on Wonderheuvel development 31°26'34.78"S 24°41'19.37"E

Figure 22: Tabular bedded sandstones of the Katberg Formation s high up on the mountain 31°22’01” S 24°47’59” E in the Paarde Valley Corridor

Figure 23: Small exposure of grey, blocky weathered, mudrocks with blocky weathering. 31°20'23" S 24 40'46" E

Figure 24: Fragmented fossil found loose on the surface near the home stead just south of the Mooi Plaats (Adelaide Subgroup, Balfour Formation)
31°20'23" S 24 40'47" E

Figure 25: Flat topography of the development 31°25'14" S 24°42'41" E in a southernly direction

Figure 26: Unfossiliferous sandstone outcrops of the Katberg Formation on the Paarde Valley Corridor development

31°25'18.41"S 24°43'33.41"E

Figure 27*: In situ Lystrosaurus* skull in the Tarkastad Subgroup, *Lystrosaurus* AZ . 31°19’43.07”S 24°44’45.05” E (Paarde Valley Corridor 1&2)

Figure 28*: Flat topography on the Wonderheuvel development*

31°25'27"S 24°40'49"E

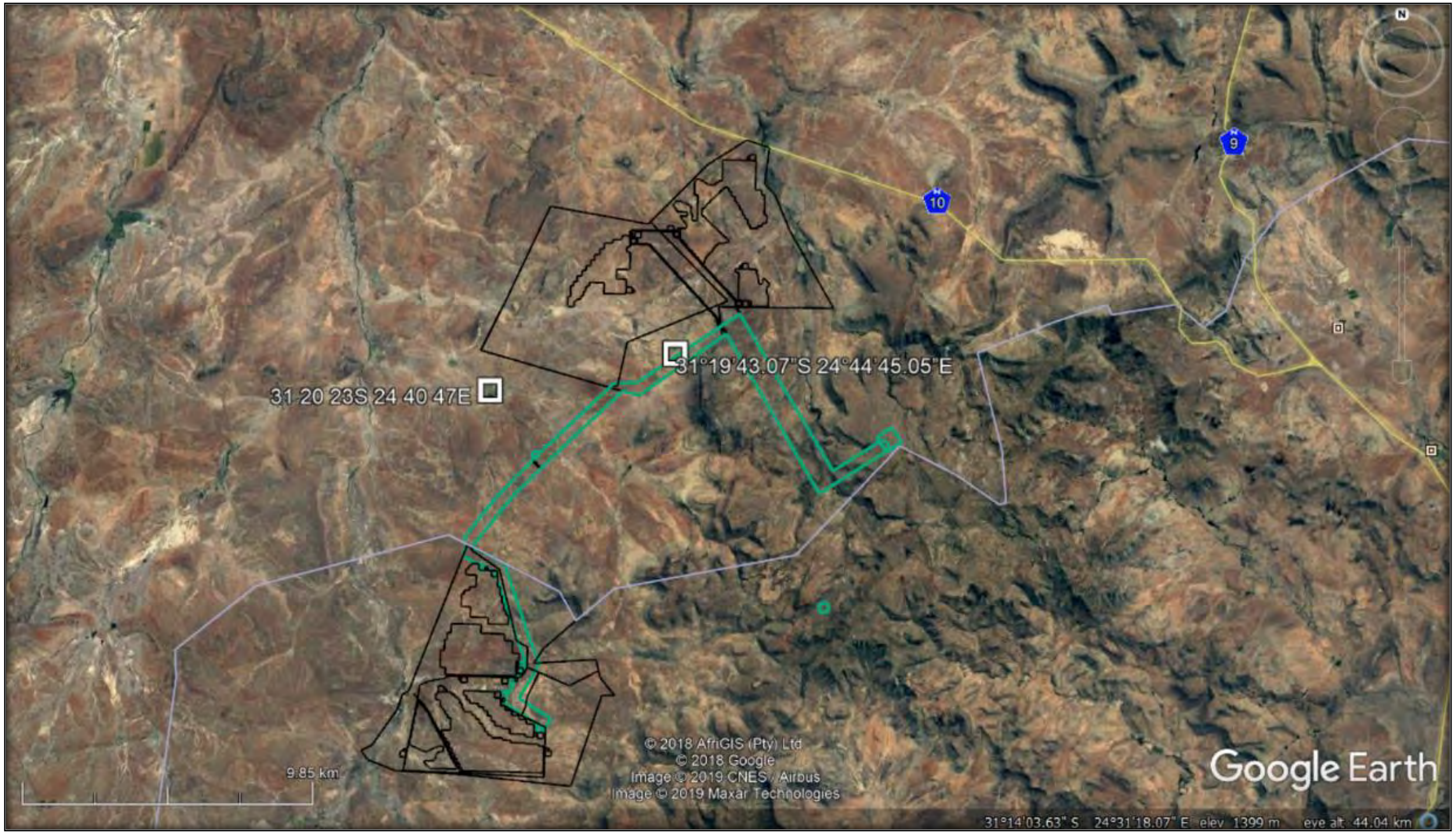


Figure 29*: Location of the fossils found on the* Umsobomvu Solar PV Energy Facilities

10 FINDINGS, RECOMMENDATIONS AND CONCLUSIONS

The proposed development includes three PV facilities as well as grid connections and infrastructure. These proposed developments are underlain by the continental sediments of the Latest Permian sediments of the Balfour Formation (Upper Beaufort Group, Adelaide Subgroup) and earliest Triassic sediments of the Katberg Formation (Upper Beaufort Group, Tarkastad Subgroup, Karoo Supergroup) as well as Jurassic Karoo Dolerite. These sediments are generally mantled by a thick layer of Quaternary to Recent colluvium and alluvium. The uppermost Balfour and Katberg Formations are of extraordinary interest in that they provide some of the best existing information on ecologically complex terrestrial ecosystems during the catastrophic end-Permian mass extinction. According to the PalaeoMap of South African Heritage Resources Information System the Palaeontological Sensitivity of the Tarkastad and Adelaide Subgroups has a Very High Palaeontological Sensitivity, while that of the Quaternary superficial deposits of the Central interior is high and the Karoo dolerite (igneous rocks) is insignificant and rated as zero.

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A site-specific field survey of the development footprint was conducted on foot and by motor vehicle from the 24^{tht} – 28^{th} January 2019. Elsewhere in the Karoo Basin numerous fossils have been uncovered in these geological sediments but only two sites on koppies with fossiliferous outcrops were identified. Although these localities do not currently fall in the proposed development sites, these fossiliferous sites have been identified as Highly Sensitive and No-go areas and it is recommended that a 50 m buffer will be placed around these areas. In the event that construction is necessity in these sensitive areas it is recommended that the fossils will be collected by a professional palaeontologist. Preceding excavation of any fossil material, the specialist would need to apply for a collection permit from SAHRA. Fossil material must be curated in an accredited collection (museum or university collection), while all fieldwork and reports should meet the minimum standards for palaeontological impact studies suggested by SAHRA.

With the above mentioned in consideration, the proposed development, as well as all alternatives have a similar geology and therefore there is no preferences on the grounds of palaeontological fossil heritage for any specific layout among the different options under consideration. As impacts on fossil heritage usually only occur during the excavation phase and no further impacts on fossil heritage are expected during the operation and decommissioning phases of the SEF.

The impact of development on fossil heritage are usually negative but it could also have a positive impact due to the discovery of newly uncovered fossil material that would have been unavailable for scientific research. The SEF could also provide a long-term benefit to the country by supplying renewable energy to the electricity grid.

In the event that fossil remains are discovered during any phase of construction, either on the surface or exposed by fresh excavations the **Chance Find Protocol** must be implemented by the ECO in charge of these developments. These discoveries ought to be protected (if possible *in situ*) and the ECO must report to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za) so that correct mitigation (*e.g.* recording and collection) can be carry out by a paleontologist.

It is consequently recommended that no further palaeontological heritage studies, ground truthing and/or specialist mitigation are required pending the discovery of newly discovered fossils. From a Palaeontological Heritage view there are no fatal floors in the proposed SEF development project. However, it is recommended that the mitigation measures are included in the EMPr and fully implemented.

11 CHANCE FIND PROCEDURE

A following procedure will only be followed in the event that fossils are uncovered during excavation.

11.1 Legislation

Cultural Heritage in South Africa (includes all heritage resources) is protected by the **National Heritage Resources Act (Act 25 of 1999) (NHRA).** According to Section 3 of the Act, all Heritage resources include **"all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens**".

Palaeontological heritage is unique and non-renewable and is protected by the NHRA and are the property of the State. It is thus the responsibility of the State to manage and conserve fossils on behalf of the citizens of South Africa. Palaeontological resources may not be excavated, broken, moved, or destroyed by any development without prior assessment and without a permit from the relevant heritage resources authority as per section 35 of the NHRA.

11.2 Background

A fossil is the naturally preserved remains (or traces) of plants or animals embedded in rock. These plants and animals lived in the geologic past millions of years ago. Fossils are extremely rare and irreplaceable. By studying fossils, it is possible to determine the environmental conditions that existed in a specific geographical area millions of years ago.

11.3 Introduction

This informational document is intended for workmen and foremen on construction sites. It describes the actions to be taken when mining or construction activities accidentally uncovers fossil material.

It is the responsibility of the Environmental Control Officer (ECO) of the project to train the workmen and foremen in the procedure to follow when a fossil is accidentally uncovered. In the absence of the ECO, a member of the staff must be appointed to be responsible for the proper implementation of the chance find protocol as not to compromise the conservation of fossil material.

11.4 Chance Find Procedure

- If a chance find is made the person responsible for the find must immediately **stop working** and all work must cease in the immediate vicinity of the find.
- The person who made the find must immediately **report** the find to his/her direct supervisor which in turn must report the find to his/her manager and the ECO or site manager. The

ECO must report the find to the relevant Heritage Agency (South African Heritage Research Agency, SAHRA). (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). The information to the Heritage Agency must include photographs of the find, from various angles, as well as the GPS co-ordinates.

- A preliminary report must be submitted to the Heritage Agency within **24 hours** of the find and must include the following: 1) date of the find; 2) a description of the discovery and a 3) description of the fossil and its context (depth and position of the fossil), GPS co-ordinates.
- Photographs (the more the better) of the discovery must be of high quality, in focus, accompanied by a scale. It is also important to have photographs of the vertical section (side) where the fossil was found.

Upon receipt of the preliminary report, the Heritage Agency will inform the ECO (site manager) whether a rescue excavation or rescue collection by a palaeontologist is necessary.

- The site must be secured to protect it from any further damage. **No attempt** should be made to remove material from their environment. The exposed finds must be stabilized and covered by a plastic sheet or sand bags. The Heritage agency will also be able to advise on the most suitable method of protection of the find.
- In the event that the fossil cannot be stabilized the fossil may be collected with extreme care by the ECO (site manager). Fossils finds must be stored in tissue paper and in an appropriate box while due care must be taken to remove all fossil material from the rescue site.
- Once Heritage Agency has issued the written authorization, the developer may continue with the development.

12 IMPACT ASSESSMENTS

Impact on Palaeontological Heritage will only occur during the construction phase of the proposed development with no impacts on the preconstruction, operational and decommissioning phases. Impacts will only occur when the vegetation is cleared and levelled, and excavations into the bedrock will occur

The Nature of the Impact is to Damage, destroy or permanently seal-in fossils at or below the ground surface that are un-available for scientific study, this will occur during vegetation clearance or during the construction phase. The extent will have an effect nationally (3). Since fossil heritage is known from these formations the probability of impacts on palaeontological heritage during the construction phase is probable (3). Impacts on fossil heritage are generally **irreversible** (4). By taking a precautionary approach, an insignificant loss of fossil resources is expected (**No Loss**). (1). The expected duration of the impact is assessed as potentially permanent to **long term**. In the absence of mitigation procedures (should fossil material be present within the affected area) the damage or destruction of any palaeontological materials will be permanent. (4).

The cumulative effect of the development of the SEF and WEF and associated infrastructure within the proposed location is considered to be **High**. This is as a result of the broader Middelburg and Noupoort areas being considered as fossiliferous (3). Probable significant impacts on palaeontological heritage during the construction phase are high, but the intensity of the impact on fossil heritage is rated as medium as fossil heritage is common in the greater Middelburg and Noupoort area (2).

Should the project progress without due care to the possibility of fossils being present at the proposed site the resultant damage, destruction or inadvertent relocation of any affected fossils will be **permanent and irreversible**. Thus, any fossils occurring within the area are potentially scientifically and culturally significant and any negative impact on them would be of **high** significance (without the implementation of mitigation measures)

IMPACT RATINGS

As the geology of all the alternatives is the same a single impact rating table is provided (Table) for all three (3) proposed Solar PV Energy Facilities. The impact assessment rating is based on the rating scale as contained in Appendix B.

Table 2: Combined impact table for the Mooi Plaats, Wonderheuvel and Paarde Valley PV and grid options is presented here

MOOI PLAATS, WONDERHEUVEL and PAARDE VALLEY SOLAR PV FACILITIES																					
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																					
Fossil Heritage		1	2	4	4	4	4	60	Negative -	High Impact	A palaeontologist must conduct a field visit after vegetation clearance. Fossil Excavation will need a SAHRA permit. If an excavation is impossible, the fossil and locality could be protected and the development	1	1	4	4	4	2	28	Negative -	Medium Impact	

											moved and Chance Find Protocol									
Operational Phase																				
No Impact								0			Not applicable							0		
Decommissioning Phase																				
No Impact								0			Not applicable							0		
Cumulative																				
Fossil Heritage		2	2	4	4	4	2	32	Negative -	Medium Impact	Not applicable	1	1	4	4	4	1	14	Negative -	Low Impact

MOOI PLAATS, WONDERHEUVEL and PAARDE VALLEY SOLAR PV FACILITIES																				
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																				
Fossil Heritage	Excavations and site clearance of the development will involve substantial excavations into the superficial sediment cover as well as locally into the underlying bedrock.	1	2	4	4	4	4	60	- Negative	High Impact	A palaeontologist must conduct a field visit after vegetation clearance. Fossil Excavation will need a SAHRA permit. If an excavation is impossible, the fossil and locality could be protected and the development moved	1	1	4	4	4	2	28	Negative -	Medium Impact

Operational Phase																				
No Impact								0										0		
Decommissioning Phase																				
No Impact								0										0		
Cumulative																				
Fossil Heritage	Excavations and site clearance of the development will involve substantial excavations into the superficial sediment cover as well as locally into the underlying bedrock.	2	2	4	4	4	2	32	Negative -	Medium Impact	A palaeontologist must conduct a field visit after vegetation clearance. Fossil Excavation will need a SAHRA permit. If an excavation is impossible, the fossil and locality could be protected and the development moved	1	1	4	4	4	1	14	Negative -	Low Impact

12.1 Cumulative Impacts

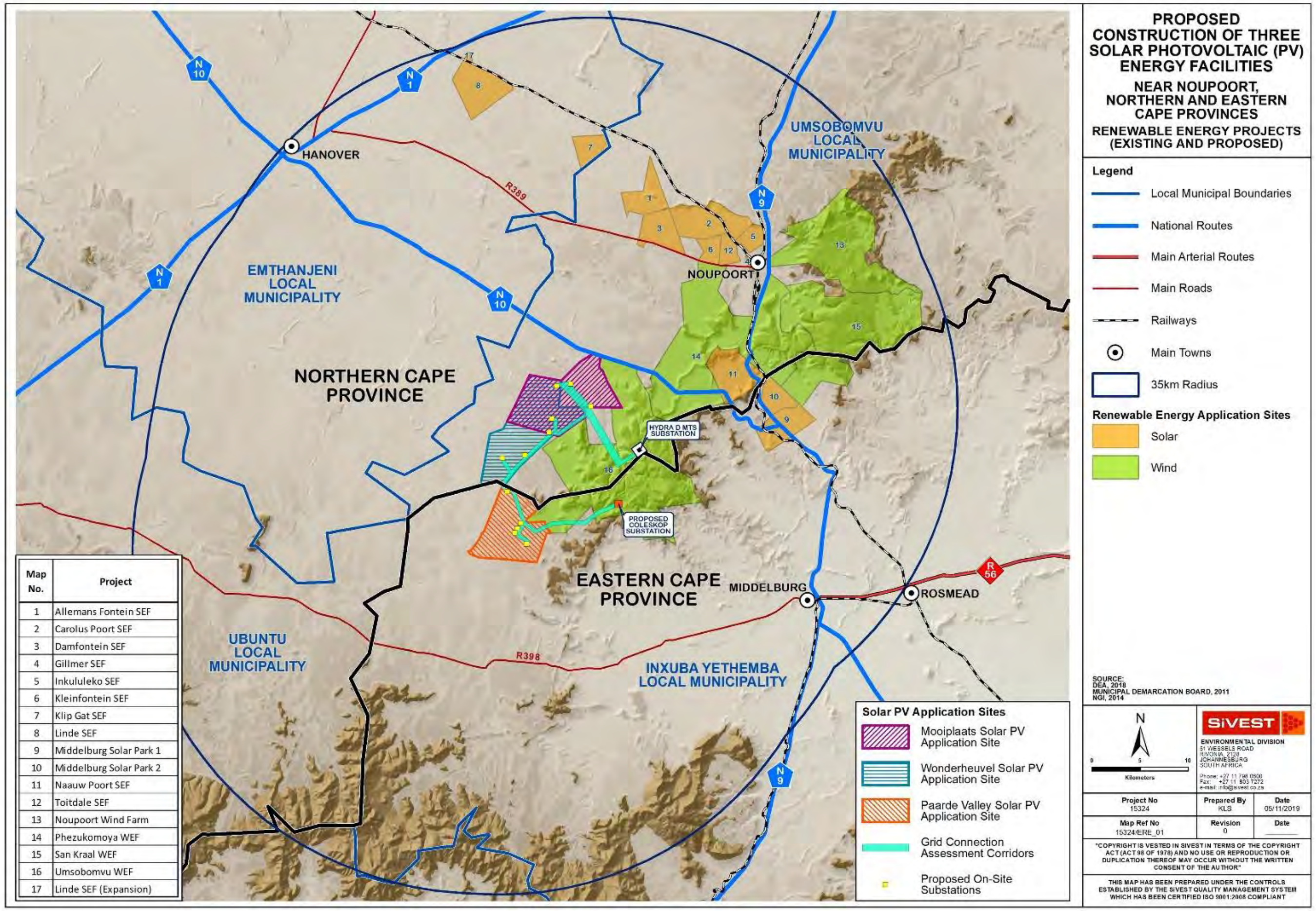

Figure 30: Other Renewable Energy developments in relation to the Umsobomvu SEF application area (SiVEST 2018)

A total of 17 Renewable Energy Facilities (13 Solar Energy Facilities and 3 Wind Energy Facilities) are present in a 35 km radius of the proposed Umsobomvu Solar PV Energy Facilities.13 of these facilities have been approved while 2 facilities are operational and 2 are in and EIA Process (Table 2)

It was difficult to obtain all the relevant Palaeontological Impact Assessments from the internet except the following

ALMOND, J. E., 2017. Palaeontological Impact Assessment of the proposed Phezukomoya wind farm near Nouwpoort, Northern and Eastern Cape.

BUTLER, E. 2016. Palaeontological Impact Assessment of the proposed construction of the 150 MW Noupoort concentrated solar power facility and associated infrastructure on portion 1 and 4 of the farm Carolus Poort 167 and the remainder of Farm 207, near Noupoort, Northern Cape.

GESS, R. 2012**.** Proposed construction of a Photovoltaic Power station and associated infrastructure at Collett substation near Middelburg in the Eastern Cape. Palaeontological Impact Assessment Report.

ORTON, J., ALMOND, J., CLARKE, N., FISHER, R., HALL, S., KRAMER, P., MALAN, A., MAGUIRE, J. AND JANSEN, L. 2016. IMPACTS ON HERITAGE. IN SCHOLES, R., LOCHNER, P., SCHREINER, G., SNYMAN- VAN DER WALT, L. AND DE JAGER, M. (EDS.). 2016. Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks. CSIR/IU/021MH/EXP/2016/003/A, ISBN 978-0-7988-5631-7, Pretoria: CSIR. Available at http://seasgd.csir.co.za/scientific-assessmentchapters/

Table 2: Other Renewable Energy developments in relation to the Umsobomvu application area (SiVEST 2019)

Project	DEA Reference No	Technology	Capacity	Status of Application / Development
Allemans Fontein SEF	14/12/16/3/3/1/730	Solar	20MW	Approved
Carolus Poort SEF	14/12/16/3/3/1/729	Solar	20MW	Approved
Damfontein SEF	14/12/16/3/3/1/728	Solar	20MW	Approved
Gillmer SEF	14/12/16/3/3/1/735	Solar	20MW	Approved
Inkululeko SEF	14/12/16/3/3/1/553	Solar	20MW	Approved
Kleinfontein SEF	12/12/20/2654	Solar	20MW	Approved
Klip Gat SEF	14/12/16/3/3/2/354	Solar	75M	Approved
Linde SEF	12/12/20/2258	Solar	40MW	In Operation
Linde SEF (Expansion)	14/12/16/3/3/1/1122	Solar	75MW	Approved
Middelburg Solar Park 1	12/12/20/2465/2	Solar	75MW	Approved
Middelburg Solar Park 2	12/12/20/2465/1	Solar	75MW	Approved
Naauw Poort SEF	14/12/16/3/3/2/355	Solar	75MW	Approved
Toitdale SEF	12/12/20/2653	Solar	20MW	Approved
Noupoort Wind Farm	12/12/20/2319	Wind	188MW	In Operation
Phezukomoya WEF	14/12/16/3/3/1/1028	Wind	315MW	EIA in Process
San Kraal WEF	14/12/16/3/3/1/1069	Wind	390MW	EIA in Process
Umsobomvu WEF	14/12/16/3/3/2/730	Wind	140MW	Approved

Project	Findings	Recommendations
Allemans Fontein SEF	Mudstones and sandstones and dolerite	No fossils observed, No special recommendations Proceed with Project
Carolus Poort SEF	Katberg and Balfour Formations present, dolerite	No fossils observed, No special recommendations Proceed with Project
Damfontein SEF	Mudstones and sandstones and dolerite	Pre-construction site visit
Gillmer SEF	Mudstones and sandstones and dolerite	No fossils observed, No special recommendations Proceed with Project
Inkululeko SEF	-	-
Kleinfontein SEF	-	-
Klip Gat SEF	Adelaide Subgroup and dolerite	Pre-construction site visit
Linde SEF	-	-
Linde SEF (Expansion)	-	-
Middelburg Solar Park 1	Katberg and Balfour Formations, dolerite and Quaternary	Pre-construction site visit
Middelburg Solar Park 2	Katberg and Balfour Formations, dolerite and Quaternary	Pre-construction site visit
Naauw Poort SEF	Katberg Formation	Pre-construction site visit
Toitdale SEF	-	-
Noupoort Wind Farm	Katberg Formation, dolerite and Quaternary	No site visits pending discovery of fossils
Phezukomoya WEF	Katberg and Balfour Formations present; fragmentary bones vertebrate burrows,	Buffer, mitigation
San Kraal WEF	Katberg and Balfour Formations present;	Buffer, mitigation
Umsobomvu WEF		

12.2 Comparative Assessments of alternatives (Palaeontology)

PROPOSED UMSOBOMVU SOLAR PV ENERGY FACILITIES

COMPARATIVE ASSESSMENT OF ALTERNATIVES

PV AND GRID CONNECTION INFRASTRUCTURE

Key

PREFERRED	The alternative will result in a low impact / reduce the impact
FAVOURABLE	The impact will be relatively insignificant
LEAST PREFERRED	The alternative will result in a high impact / increase the impact
NO PREFERENCE	The alternative will result in equal impacts

PV INFRASTRUCTURE ALTERNATIVES (LAYDOWN AREAS AND O&M BUILDINGS)	**Preference**	**Reasons (incl. potential issues)**
MOOI PLAATS SOLAR PV FACILITY:		
Laydown Area and O&M Building Site Option 1	No Preference	Similar geology
Laydown Area and O&M Building Site Option 2	No Preference	Similar geology
Laydown Area and O&M Building Site Option 3	No Preference	Similar geology
Laydown Area and O&M Building Site Option 4	No Preference	Similar geology
Laydown Area and O&M Building Site Option 5	No Preference	Similar geology
Laydown Area and O&M Building Site Option 6	No Preference	Similar geology
WONDERHEUVEL SOLAR PV FACILITY:		
Laydown Area and O&M Building Site Option 1	No Preference	Similar geology
Laydown Area and O&M Building Site Option 2	No Preference	Similar geology
Laydown Area and O&M Building Site Option 3	No Preference	Similar geology

PV INFRASTRUCTURE ALTERNATIVES (LAYDOWN AREAS AND O&M BUILDINGS)	Preference	Reasons (incl. potential issues)
Laydown Area and O&M Building Site Option 4	No Preference	Similar geology
Laydown Area and O&M Building Site Option 5	No Preference	Similar geology
Laydown Area and O&M Building Site Option 6	No Preference	Similar geology
Laydown Area and O&M Building Site Option 7	No Preference	Similar geology
Laydown Area and O&M Building Site Option 8	No Preference	Similar geology
PAARDE VALLEY SOLAR PV FACILITY:		
Laydown Area and O&M Building Site Option 1	No Preference	Similar geology
Laydown Area and O&M Building Site Option 2	No Preference	Similar geology
Laydown Area and O&M Building Site Option 3	No Preference	Similar geology
Laydown Area and O&M Building Site Option 4	No Preference	Similar geology
Laydown Area and O&M Building Site Option 5	No Preference	Similar geology
Laydown Area and O&M Building Site Option 6	No Preference	Similar geology
Laydown Area and O&M Building Site Option 7	No Preference	Similar geology
Laydown Area and O&M Building Site Option 8	No Preference	Similar geology
Laydown Area and O&M Building Site Option 9	No Preference	Similar geology

GRID CONNECTION INFRASTRUCTURE ALTERNATIVES (POWER LINE CORRIDORS AND ASSOCIATED SUBSTATIONS)	Preference	Reasons (incl. potential issues)
MOOI PLAATS SOLAR PV FACILITY:		
Grid Connection Option 1a	No Preference	Similar geology
Grid Connection Option 1b	No Preference	Similar geology
Grid Connection Option 2a	No Preference	Similar geology
Grid Connection Option 2a	No Preference	Similar geology
WONDERHEUVEL SOLAR PV FACILITY:		
Grid Connection Option 1a	No Preference	Similar geology
Grid Connection Option 1b	No Preference	Similar geology
Grid Connection Option 1c	No Preference	Similar geology
Grid Connection Option 1d	No Preference	Similar geology
Grid Connection Option 2a	No Preference	Similar geology
Grid Connection Option 2b	No Preference	Similar geology
Grid Connection Option 3	No Preference	Similar geology
PAARDE VALLEY SOLAR PV FACILITY:		
Grid Connection Option 1a	No Preference	Similar geology
Grid Connection Option 1b	No Preference	Similar geology
Grid Connection Option 1c	No Preference	Similar geology
Grid Connection Option 1d	No Preference	Similar geology
Grid Connection Option 2a	No Preference	Similar geology
Grid Connection Option 2b	No Preference	Similar geology
Grid Connection Option 2c	No Preference	Similar geology
Grid Connection Option 2d	No Preference	Similar geology

12.3 Conclusion

The proposed development, as well as all alternatives have a similar geology and therefore there is no preferences on the grounds of palaeontological fossil heritage for any specific layout among the different options under consideration. As impacts on fossil heritage usually only occur during the excavation phase and no further impacts on fossil heritage are expected during the operation and decommissioning phases of the SEF.

The impact of development on fossil heritage are usually negative but it could also have a positive impact due to the discovery of newly uncovered fossil material that would have been unavailable for scientific research. The SEF could also provide a long-term benefit to the country by supplying renewable energy to the electricity grid.

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Appendix A – Elize Butler CV

CURRICULUM VITAE

ELIZE BUTLER

PROFESSION: Palaeontologist

YEARS' EXPERIENCE: 26 years in Palaeontology

EDUCATION:

B.Sc Botany and Zoology, 1988
University of the Orange Free State

B.Sc (Hons) Zoology, 1991
University of the Orange Free State

Management Course, 1991
University of the Orange Free State

M. Sc. *Cum laude* (Zoology), 2009
University of the Free State

Dissertation title: The postcranial skeleton of the Early Triassic non-mammalian Cynodont *Galesaurus planiceps*: implications for biology and lifestyle

Registered as a PhD fellow at the Zoology Department of the UFS
2013 to current

Dissertation title: A new gorgonopsian from the uppermost D*aptocephalus Assemblage Zone*, in the Karoo Basin of South Africa

MEMBERSHIP

Palaeontological Society of South Africa (PSSA) 2006-currently

EMPLOYMENT HISTORY

Part-time Laboratory assistant	Department of Zoology & Entomology University of the Free State Zoology 1989-1992
Part-time laboratory assistant	Department of Virology University of the Free State Zoology 1992

Research Assistant	National Museum, Bloemfontein 1993 – 1997
Principal Research Assistant and Collection Manager	National Museum, Bloemfontein 1998–currently

TECHNICAL REPORTS

Butler, E. 2014. Palaeontological Impact Assessment of the proposed development of private dwellings on portion 5 of farm 304 Matjesfontein Keurboomstrand, Knysna District, Western Cape Province. Bloemfontein.

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Butler, E. 2015. Palaeontological Impact Assessment of the proposed Orkney solar energy farm and associated infrastructure on the remaining extent of Portions 7 and 21 of the farm Wolvehuis 114, near Orkney, North West Province. Bloemfontein.

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Butler, E. 2016. Palaeontological Impact Assessment of the proposed construction of the 150 MW Noupoort concentrated solar power facility and associated infrastructure on portion 1 and 4 of the farm Carolus Poort 167 and the remainder of Farm 207, near Noupoort, Northern Cape. Prepared for Savannah Environmental. Bloemfontein.

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Butler, E. 2016. Palaeontological Impact Assessment of the proposed Senqu Pedestrian Bridges in Ward 5 of Senqu Local Municipality, Eastern Cape Province. Bloemfontein.

Butler, E. 2016. Recommendation from further Palaeontological Studies: Proposed Construction of the Modderfontein Filling Station on Erf 28 Portion 30, Founders Hill, City Of Johannesburg, Gauteng Province. Bloemfontein.

Butler, E. 2016. Recommendation from further Palaeontological Studies: Proposed Construction of the Modikwa Filling Station on a Portion of Portion 2 of Mooihoek 255 Kt, Greater Tubatse Local Municipality, Limpopo Province. Bloemfontein.

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Butler, E. 2016. Recommended Exemption from further Palaeontological studies: Proposed Construction of the Gunstfontein Switching Station, 132kv Overhead Power Line (Single Or Double Circuit) and ancillary infrastructure for the Gunstfontein Wind Farm Near Sutherland, Northern Cape Province. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment of the proposed Galla Hills Quarry on the remainder of the farm Roode Krantz 203, in the Lukhanji Municipality, division of Queenstown, Eastern Cape Province. Bloemfontein.

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Butler, E. 2016. Palaeontological Impact Assessment of the proposed upgrading of the main road MR450 (R335) from the Motherwell to Addo within the Nelson Mandela Bay Municipality and Sunday's river valley Local Municipality, Eastern Cape Province. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment construction of the proposed Metals Industrial Cluster and associated infrastructure near Kuruman, Northern Cape province.. Bloemfontein.

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Butler, E. 2017. Palaeontological impact assessment for the proposed development of a new cemetery, near Kathu, Gamagara local municipality and John Taolo Gaetsewe district municipality, Northern Cape. Bloemfontein.

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Butler, E. 2017. Palaeontological Impact Assessment of the proposed construction of a 132KV powerline from the Tweespruit distribution substation (in the Mantsopa local municipality) to the Driedorp rural substation (within the Naledi local municipality), Free State province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed development of the new coal-fired power plant and associated infrastructure near Makhado, Limpopo Province. Bloemfontein.

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Butler, E. 2017. Palaeontological Impact Assessment of the proposed Belvoir aggregate quarry II on portion 7 of the farm Maidenhead 169, Enoch Mgijima Municipality, division of Queenstown, Eastern Cape. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed construction of the Melkspruit-Rouxville 132KV Power line. Bloemfontein.

Butler, E. 2017 Palaeontological Desktop Assessment of the proposed development of a railway siding on a portion of portion 41 of the farm Rustfontein 109 is, Govan Mbeki local municipality, Gert Sibande district municipality, Mpumalanga Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed consolidation of the proposed Ilima Colliery in the Albert Luthuli local municipality, Gert Sibande District Municipality, Mpumalanga Province. Bloemfontein.

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Butler, E. 2017. Palaeontological Desktop Assessment of the proposed construction of a filling station and associated facilities on the Erf 6279, district municipality of John Taolo Gaetsewe District, Ga-Segonyana Local Municipality Northern Cape. Bloemfontein.

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Butler, E. 2017. Palaeontological Desktop Assessment of the proposed Overvaal Trust PV Facility, Buffelspoort, North West Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed development of the H2 Energy Power Station and associated infrastructure on Portions 21; 22 And 23 of the farm Hartebeestspruit in the Thembisile Hani Local Municipality, Nkangala District near Kwamhlanga, Mpumalanga Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed upgrade of the Sandriver Canal and Klippan Pump station in Welkom, Free State Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed upgrade of the 132kv and 11kv power line into a dual circuit above ground power line feeding into the Urania substation in Welkom, Free State Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed Swaziland-Mozambique border patrol road and Mozambique barrier structure. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed diamonds alluvial & diamonds general prospecting right application near Christiana on the remaining extent of portion 1 of the farm Kaffraria 314, registration division HO, North West Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment for the proposed development of Wastewater Treatment Works on Hartebeesfontein, near Panbult, Mpumalanga. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment for the proposed development of Wastewater Treatment Works on Rustplaas near Piet Retief, Mpumalanga. Bloemfontein.

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Butler, E. 2018. Palaeontological Desktop Assessment for the proposed Mashishing township establishment in Mashishing (Lydenburg), Mpumalanga Province. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment for the Proposed Mlonzi Estate Development near Lusikisiki, Ngquza Hill Local Municipality, Eastern Cape. Bloemfontein.

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Butler, E. 2018. Palaeontological Desktop Assessment for the proposed electricity expansion project and Sekgame Switching Station at the Sishen Mine, Northern Cape Province. Bloemfontein.

Butler, E. 2018. Palaeontological field assessment of the proposed construction of the Zonnebloem Switching Station (132/22kV) and two loop-in loop-out power lines (132kV) in the Mpumalanga Province. Bloemfontein.

Butler, E. 2018. Palaeontological Field Assessment for the proposed re-alignment and de-commisioning of the Firham-Platrand 88kv Powerline, near Standerton, Lekwa Local Municipality, Mpumalanga province. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment of the proposed Villa Rosa development In the Buffalo City Metropolitan Municipality, East London. Bloemfontein.

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Butler, E. 2018. Palaeontological desktop assessment of the proposed housing development on portion 237 of farm Hartebeestpoort 328. Bloemfontein.

Butler, E. 2018. Palaeontological desktop assessment of the proposed New Age Chicken layer facility located on holding 75 Endicott near Springs in Gauteng. Bloemfontein.

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E. Butler. 2019. Recommended Exemption from further Palaeontological studies for the proposed agricultural development on farms 1763, 2372 and 2363, Kakamas South settlement, Kai! Garib Municipality, Mgcawu District Municipality, Northern Cape Province.

E. Butler. 2019. Recommended Exemption from further Palaeontological Studies for Proposed formalisation of Gamakor and Noodkamp low cost Housing Development, Keimoes, Gordonia Rd, Kai !Garib Local Municipality, ZF Mgcawu District Municipality, Northern Cape Province.

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E. Butler. 2019. Palaeontological Desktop Assessment of the proposed mining permit application for the removal of diamonds alluvial and diamonds kimberlite near Windsorton on a certain portion of Farm Zoelen's Laagte 158, Registration Division: Barkly Wes, Northern Cape Province

E. Butler. 2019. Palaeontological Desktop Assessment of the proposed Vedanta Housing Development, Pella Mission 39, Khâi-Ma Local Municipality, Namakwa District Municipality, Northern Cape.

CONFERENCE CONTRIBUTIONS

NATIONAL

PRESENTATION

Butler, E., Botha-Brink, J., and F. Abdala. A new gorgonopsian from the uppermost *Dicynodon Assemblage Zone*, Karoo Basin of South Africa.18 the Biennial conference of the PSSA 2014.Wits, Johannesburg, South Africa.

INTERNATIONAL

Attended the Society of Vertebrate Palaeontology 73th Conference in Los Angeles, America. October 2012.

CONFERENCES: POSTER PRESENTATION

NATIONAL

Butler, E., and J. Botha-Brink. Cranial skeleton of *Galesaurus planiceps*, implications for biology and lifestyle. University of the Free State Seminar Day, Bloemfontein. South Africa. November 2007.

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Butler, E., and J. Botha-Brink. The biology of the South African non-mammaliaform cynodont *Galesaurus planiceps*.15th Conference of the PSSA, Howick, South Africa. August 2008.

INTERNATIONAL VISITS

Natural History Museum, London	July 2008
Paleontological Institute, Russian Academy of Science, Moscow	November 2014

Appendix B

14 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.

14.1 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.

14.2 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).

14.2.1 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 3: 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: **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 4: 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	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**	2	3	2	1	3	2	22	-	Low

	processes such as fragmentation.										**activity. These measures will be detailed in the EMPr.**									