BIOTHERM ENERGY (PTY) LTD

# TLISITSENG PROJECT - TLISITSENG 2 SUBSTATION AND POWER LINE

# Palaeontological Assessment Report

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# Executive Summary

PGS Heritage was appointed by SiVEST Environmental Division to undertake a Heritage Impact Assessment (HIA) Study that forms part of the Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) for the proposed development of Tlisitseng Solar 75MW solar photovoltaic (PV) energy facilities near Lichtenburg, Northern Cape Province. This report addresses the Tlisitseng Solar 2 132kV power line to connect the PV facilities to the proposed Tlisitseng substation.

Palaeontological resources are unique and non-renewable and as such any impact on such resources must be seen as significant.

The Palaeontological Scoping Report has shown that the proposed Tlisitseng Solar project may have palaeontological resources present on the property. This has been confirmed through archival research and evaluation of Satellite images and geological maps of the sites.

Evaluation of satellite images has indicated that the entire area proposed for development is very highly sensitive from a palaeontological perspective.

The fieldwork that covered the proposed power line corridor with an evaluation field of 20 meters for small finds (10 meters either side of the palaeontologists) and 100 meters for larger finds such as sinkholes and possible cave breccias (50 meters either side of the palaeontologists).

A total of a 11 photographic observations were logged (Table 5) of which all the stromatolites were not in situ and the possible cave breccias will only be confirmed after completion of the geotechnical investigations.

## 1.1 Find spots

No outcrops of dolomite with significant stromatolites structures nor any significant finds of cave breccias were recorded during the fieldwork investigation. All significant finds will only be confirmed after completion of the geotechnical surveys.

*Mitigation*

The EAP and ECO of the project must be informed of the slight possibility that significant stromatolites structures and cave breccias might be exposed during excavation of foundations deeper than 1.5m. Field observation indicated that most most the development site is underlain by deep soils and gravel deposits with a low significance for palaeontological heritage.

## 1.2 Sites

During the fieldwork on 17 February 2016 no confirmed palaeontological heritage sites were identified in the proposed Power line corridor.

*Mitigation:*

- Although no significant fossils were recorded in situ in both PV sites as well as the proposed alternative route corridors for the power lines, several well-defined micro-stromatolites and possible sites with cave breccia have been identified. Depending on the results of the geotechnical investigation and where potential excavations for foundations will exceed 1.5m, the ECO must investigate the possible presence of stromatolites and/or cave breccia and inform the HIA consultants immediately for appropriate action and appointment of a qualified palaeontologist to investigate the site before destruction of fossils occurs.
- Site visits as stipulated in the management tables will include an initial 2 day site visit and then fortnightly during construction.
- Such mitigation measures will require a permit from SAHRA before mitigation can be done as well as a final destruction permit on completion of the mitigation work.

## 1.3 Impact Summary

Table 1 provides a summary of the projected impact rating for this project on palaeontological heritage resources, with comparison of sites in Table 3. Key to preferences is given in Table 2.

**Table 1: Comparison of summarised impacts on environmental parameters**

| Environmental parameter | Issues | Rating prior to mitigation | Average | Rating post mitigation | Average |
|---|---|---|---|---|---|
| Heritage resources | Impact during construction | 62 | | 57 | |
| Palaeontological Heritage | High Negative | High Negative | High Negative Impact | High Positive | High Positive |

## 1.4 Comparative Assessment for Tlisitseng Solar

**Key**

**Table 2 Key to results of preference**

| | |
|---|---|
| **PREFERRED** | The alternative will result in a low impact / reduce the impact |
| **FAVOURABLE** | The impact will be relatively insignificant |
| **NOT PREFERRED** | The alternative will result in a high impact / increase the impact |

| | |
|---|---|
| **NO PREFERENCE** | The alternative will result in equal impacts |

**Table 3 Preference of sites**

| Alternative | Preference | Reasons |
|---|---|---|
| **SUBSTATION** | | |
| Substation Site Alternative 1 | NO PREFERENCE | No palaeontological heritage resources identified |
| Substation Site Alternative 2 | NO PREFERENCE | No palaeontological heritage resources identified |

## BIOTHERM (Pty) Ltd – Tlisitseng PV Solar Project

## PALAEONTOLOGICAL HERITAGE ASSESSMENT REPORT

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# 1 INTRODUCTION

PGS Heritage was appointed by SiVEST Environmental Division to undertake a Heritage Impact Assessment (HIA) Study that forms part of the Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) for the proposed development of Tlisitseng Solar 75MWsolar photovoltaic (PV) energy facilities near Lichtenburg, Northwest Province. This report was commissioned by PGS Heritage and was completed by Dr Gideon Groenewald, an accredited Palaeontologist.

## 1.1 Scope of the Study

The aim of the study is to identify possible palaeontological heritage sites, finds and sensitive areas that may occur in the study area for the EIA study. The Palaeontological Impact Assessment (PIA) aims to inform the Environmental Impact Assessment in the development of a comprehensive Environmental Management Plan to assist the developer in managing the discovered palaeontological 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 Specialist Qualifications

PGS Heritage (PGS) compiled this Heritage Impact Assessment Report.

The staff at PGS has a combined experience of nearly 70 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, Project manager for this project, 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).

Dr Gideon Groenewald has a PhD in Geology from the University of Port Elizabeth (Nelson Mandela Metropolitan University) (1996) and the National Diploma in Nature Conservation from Technicon RSA (the University of South Africa) (1989). He specialises in research on South African Permian and Triassic sedimentology and macrofossils with an interest in biostratigraphy, and palaeoecological aspects. He has extensive experience in the locating of fossil material in the Karoo Supergroup and has more than 20 years of experience in locating, collecting and curating fossils, including exploration field trips in search of new localities in the southern, western, eastern and north-eastern parts of the country. His publication record includes multiple articles in internationally recognized journals. Dr Groenewald is accredited by the Palaeontological Society of Southern Africa (society member for 25 years). Dr Groenewald was accompanied by Mr David Groenewald (BS Hons Palaeontology, Wits Univiersity) and experienced fieldworker.

## 1.3 Assumptions and Limitations

Not detracting in any way from the fieldwork undertaken, it is necessary to realise that the palaeontological heritage sites located during the fieldwork do not necessarily represent all the heritage sites present within the area. Should any heritage features or objects not included in the inventory be located or observed, a heritage specialist must immediately be contacted. Such observed or located heritage features and/or objects may not be disturbed or removed in any way, until such time that the heritage specialist has been able to make an assessment as to the significance of the site (or material) in question. This applies to exposing of stromatolites structures as well as cave breccias.

The survey was conducted over 1 day over the extent of the total footprint area by Dr Gideon Groenewald and David Groenewald on 17 February 2016. It must be stressed that the extent of the fieldwork was based on the available field time and was aimed at determining the palaeontological heritage character of the area.

The fieldwork that covered the Tlisitseng Solar site as well as the proposed power line corridors covered the whole area by vehicle and on foot, with specific observations recorded as a photographic database (**Table 2**). Detailed observation of outcrops were considered as highly important whereas loose gravel and boulders were recorded as representative examples of stromatolites structures which were out of situ observations. **No obvious cave breccias or sink holes were observed and the presence of these highly sensitive structures need to be confirmed during detailed geophysical investigations for possible sink hole structures on dolomitic terrains or karts topography.**

## 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:

i. National Environmental Management Act (NEMA), Act 107 of 1998
ii. National Heritage Resources Act (NHRA), Act 25 of 1999
iii. 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.

i. National Environmental Management Act (NEMA) Act 107 of 1998
    a. Basic Environmental Assessment (BEA) – Section (23)(2)(d)
    b. Environmental Scoping Report (ESR) – Section (29)(1)(d)
    c. Environmental Impact Assessment (EIA) – Section (32)(2)(d)
    d. Environmental Management Plan (EMP) – Section (34)(b)
ii. National Heritage Resources Act (NHRA) Act 25 of 1999
    a. Protection of Heritage Resources – Sections 34 to 36; and
    b. Heritage Resources Management – Section 38
iii. Mineral and Petroleum Resources Development Act (MPRDA) Act 28 of 2002
    a. 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, and those developments administered through NEMA, MPRDA legislation. In the latter cases, the feedback from the relevant heritage resources authority is required by the State and Provincial Departments managing these Acts before any authorizations are granted for development. The last few years have seen a significant change towards the inclusion of heritage assessments as a major component of Environmental Impacts Processes required by NEMA and MPRDA. This change requires us to evaluate the Sections of these Acts relevant to heritage (Fourie, 2008, Groenewald et al 2014).

The NEMA 23(2)(b) states that an integrated environmental management plan should, "…identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage".

A study of subsections (23)(2)(d), (29)(1)(d), (32)(2)(d) and (34)(b) and their requirements reveals the compulsory inclusion of the identification of cultural resources, the evaluation of the impacts of the proposed activity on these resources, the identification of alternatives and the management procedures for such cultural resources for each of the documents noted in the Environmental Regulations. A further important aspect to be taken account of in the Regulations under NEMA is the Specialist Report requirements laid down in Section 33 of the regulations (Fourie, 2008).

Refer to **Appendix A** as well as the recommendations and discussions in the Desktop Surveys and Scoping report for Palaeontological Impacts (Internal Report, 2015) for further discussions on heritage management and legislative frameworks

## 1.5 Terminology

**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

**Early 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.

**Late Stone Age**

The archaeology of the last 20 000 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 20-300 000 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.

## 1.6 Abbreviations

**Table 4 Acronyms**

| *Acronyms* | *Description* |
|---|---|
| AIA | Archaeological Impact Assessment |
| ASAPA | Association of South African Professional Archaeologists |
| CRM | Cultural Resource Management |
| CCS | Cryptocrystalline silicate |
| DEA | Department of Environmental Affairs |
| DoE | Department of Energy |
| DWS | Department of Water and Sanitation |
| EA | Environmental Authorisation |
| EIA practitioner | Environmental Impact Assessment Practitioner |
| EIA | Environmental Impact Assessment |
| ESA | Early Stone Age |
| GPS | Global Positioning System |
| HIA | Heritage Impact Assessment |
| HV | High Voltage |
| I&AP | Interested & Affected Party |
| LSA | Late 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 |
| PIA | Palaeontological Impact Assessment |
| PSSA | Palaeontological Society of South Africa |
| PV | Photovoltaic |
| ROD | Record of Decision |
| SPV | Special Purpose Vehicle |
| SADC | Southern African Development Community |
| SAHRA | South African Heritage Resources Agency |
| SAHRIS | South African Heritage Resources Information System |

# 2 TECHNICAL DESCRIPTION

Tlisitseng Solar PV will be located approximately 8km north-west of Lichtenburg, in the Ngaka Modiri Molema District of the North West Province. The application site is approximately 1000ha however the buildable area will be significantly smaller than this and will be determined by sensitive areas identified during the Scoping Phase of the EIA. Tlisitseng Solar will consist of two (2) 75MW solar PV facilities, namely Tlisitseng Solar 1 and Tlisitseng Solar 2. Additionally, 132kV power lines will connect the PV facilities to the proposed Tlisitseng substation (Figure 1).

## 2.1 PV Project Components

Panels will be either fixed axis mounting or single axis tracking solutions, and will be either crystalline silicon or thin film technology. In addition to the PV panels each project will consist of:

- An onsite switching station, with the transformers for voltage step up from medium voltage to high voltage;
- The panels will be connected in strings to inverters and inverter stations will be required throughout the site. Inverter stations will house 2 x 1MW inverters and 1 x 2MVA transformers;
- DC power from the panels will be converted into AC power in the inverters and the voltage will be stepped up to 22-33kV (medium voltage) in the transformers.
- The 22-33kV cables will be run underground in the facility to a common point before being fed to the onsite switching station where the voltage will be stepped up to 132kV.
- A power line with a voltage of 132kV to the proposed Tlsitseng substation;
- A laydown area for the temporary storage of materials during the construction activities;
- Access roads and internal roads;
- A car park and fencing; and
- Administration, control and warehouse buildings.

## 2.2 Solar Field

Solar PV panels are usually arranged in rows or ‘arrays’ consisting of a number of PV panels. The area required for the PV panel arrays will likely need to be entirely cleared or graded. Where tall vegetation is present, this vegetation will be removed from the PV array area.

Approximately 300 000 solar PV panels will be required per project for a total export capacity of 75MW. Support structures will be either fixed axis mounting or single axis tracking solutions and the modules will be either crystalline silicon or thin film technology. The solar PV panels are variable in size, and are affected by advances in technology between project inception and project realisation. The actual size of the PV panels to be used will be determined in the final design stages of the project. The PV panels are mounted onto metal frames which are usually aluminium. Rammed or screw pile foundations are commonly used to support the panel arrays (Figure 2).

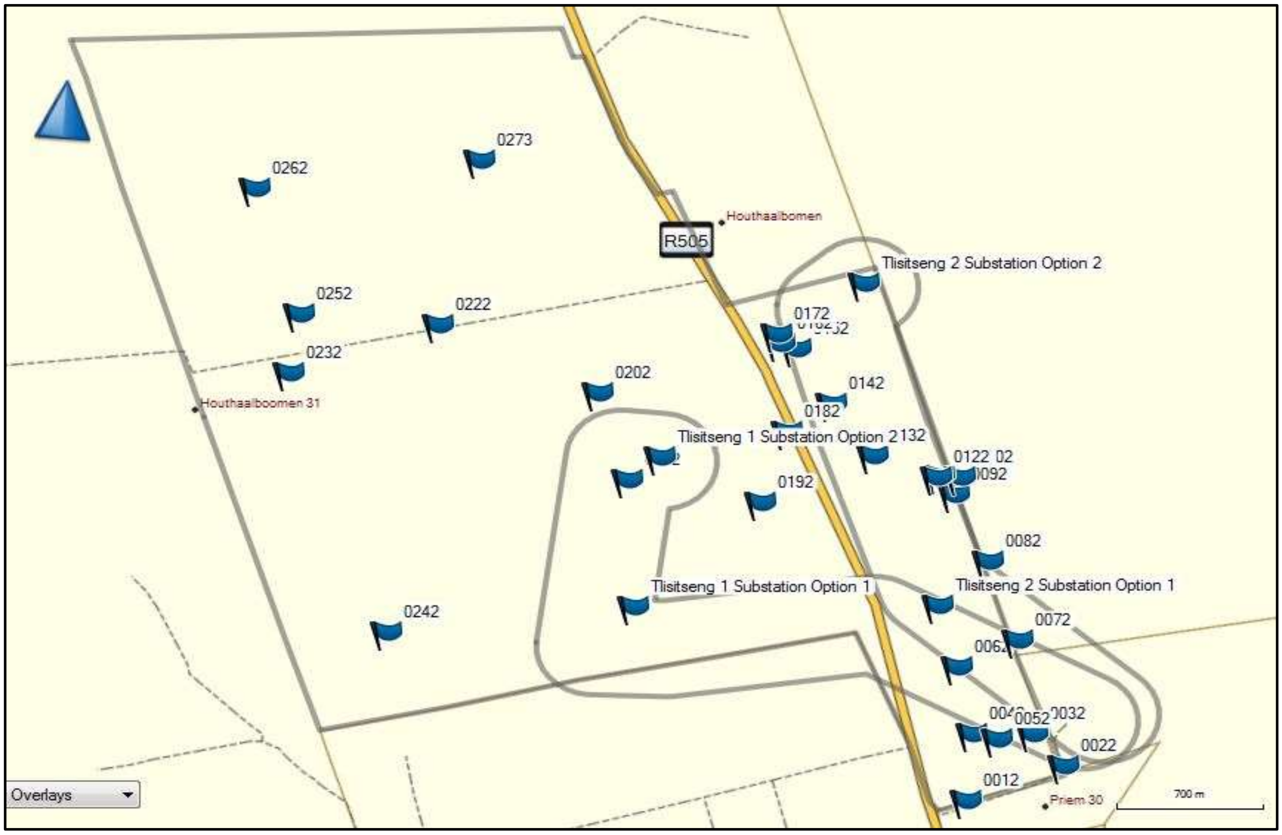


**Figure 1 - Study area with indication of observation points as described in Table 5**

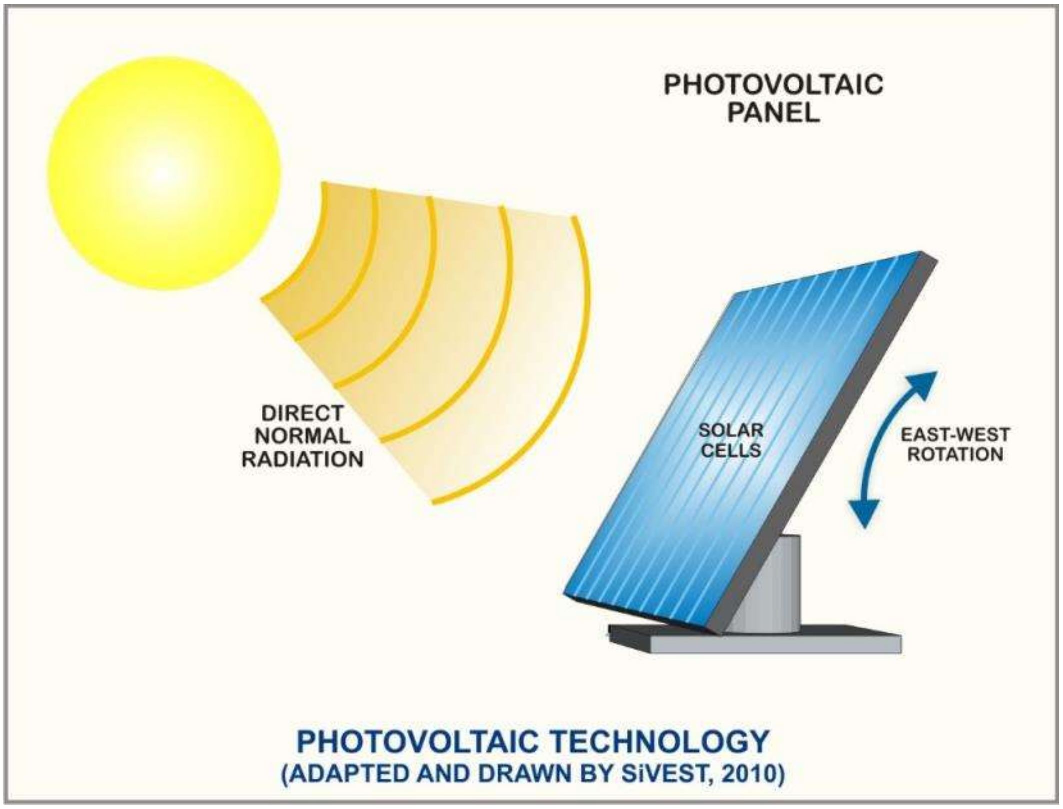


**Figure 2 - Example of a Photovoltaic Panel with tracking capability.**

## 2.3 Associated Infrastructure

### *2.3.1 Electrical Infrastructure*

The solar PV panel arrays are connected to each other in strings, which are in turn connected to inverters. For a 75MW size facility, typically 2MW inverter stations which are containerised stations housing 2x1MW inverters and 1x2MVA transformers will be used; therefore approximately 43 inverter stations will be required throughout the site for the proposed solar PV energy facility (Figure 3). DC power from the panels will be converted into AC power in the inverters and the voltage will be stepped up to 22-33kV (medium voltage) in the transformers. The 22-33kV cables will be run underground in the facility to a common point before being fed to the onsite substation and switching station where the voltage will typically be stepped up to 132kV. A Power line with a voltage of up to 132kV will run from the onsite substation to the existing Tlisitseng substation. The distance will be about 4km.

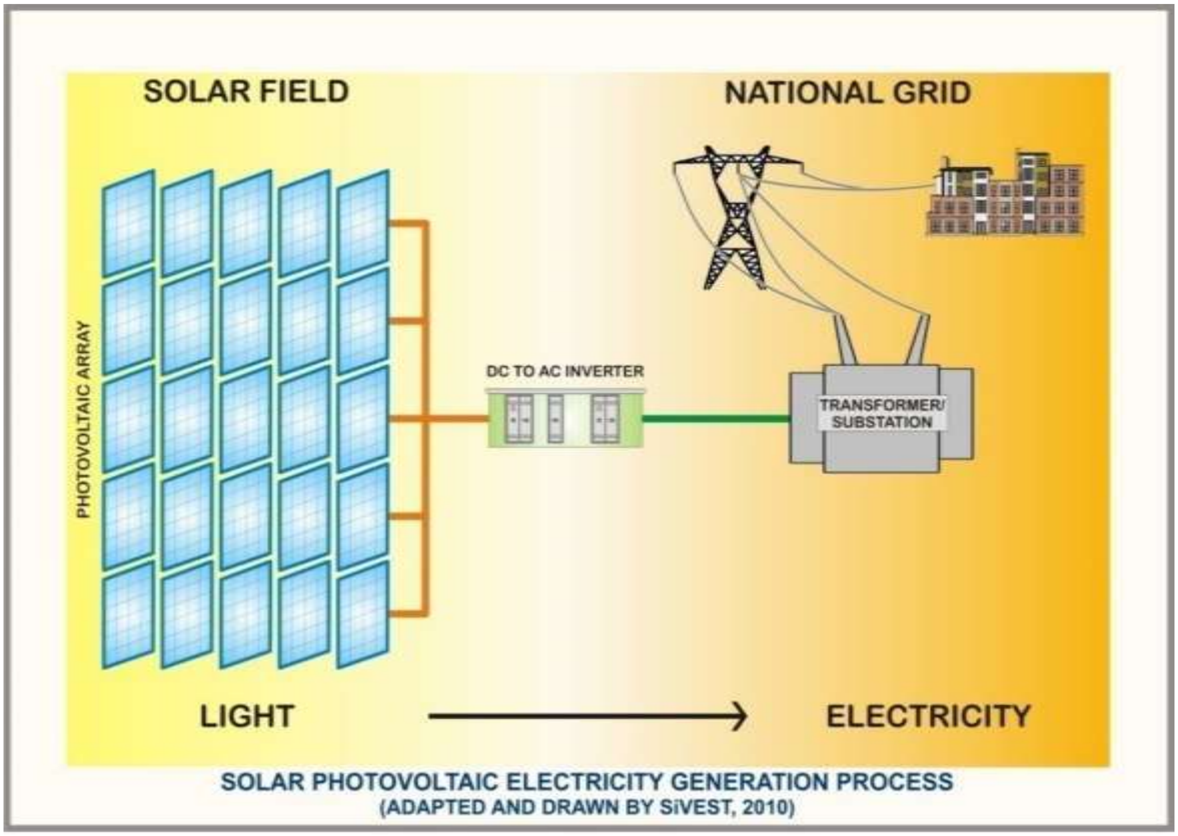


**Figure 3 - PV process**

### *2.3.2 Buildings*

The solar field will require onsite buildings, which will be used in the daily operation of the plant and includes an administration building (office). The buildings will likely be single storey buildings, which will be required to accommodate the following:

- Control room
- Workshop
- High Voltage (HV) switchgear
- Mess Room
- Toilets
- Warehouse for storage
- Car park and fencing around the project

### *2.3.3 Construction Lay-down Area*

A general construction lay-down area will be required for the construction phase of the proposed solar PV energy facility. The size of this area is yet to be determined, but 3 to 5 hectares is likely.

*2.3.4 Other Associated In*

*2.3.5 Infrastructure*

Other associated infrastructure includes the following:

- Access roads and internal roads;
- A car park; and
- Fencing around the project.

## 2.4 Alternatives

Due to the limited space available as well as the constraints of the sensitive areas, two alternative PV panel layouts were identified. The final proposed layout is to be assessed following the fieldwork investigations.

Two alternative corridors for the power line routes are proposed and a final layout for corridor 2 (Figure 4).

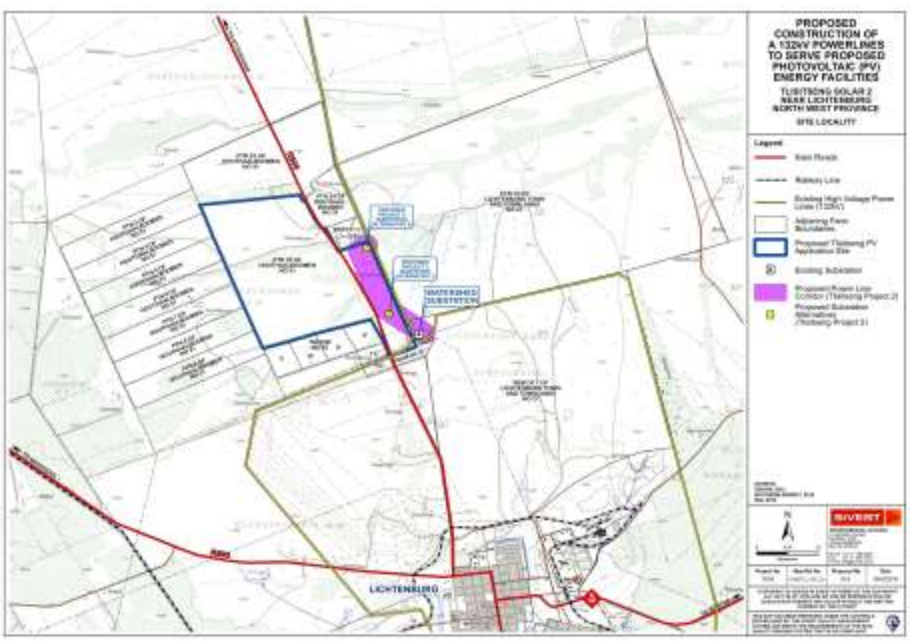


**Figure 4 - Alternative power line route corridors**

# 3 ASSESSMENT METHODOLOGY

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

## 3.1 Methodology for Assessing Palaeontological Heritage Site significance

PGS Heritage (PGS) compiled this Palaeontological Heritage Assessment Document as part of the Heritage Impact Assessment (HIA) report for the proposed Tlisitseng Solar 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: On Wednesday 17 February 2016, a Phase 1 PIA Survey survey was conducted by vehicle and on foot through the proposed project area by two qualified palaeontologists, Dr Gideon Groenewald and David Groenewald. The survey aimed at locating and documenting any palaeontological sensitive information falling within and adjacent to the proposed development footprint.

Step III – The final step involved the recording and documentation of relevant palaeontological 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 Plan of study for the Heritage Impact Assessment process, while **Appendix C** provides the guidelines for the impact assessment evaluation that was used during the EIA phase of the project.

# 4 BACKGROUND RESEARCH

The examination of heritage databases, historical data and cartographic resources (1:250 000 scale geological map 2626 WEST-RAND) represents a critical additional tool for locating and identifying palaeontological heritage resources and in determining the historical and cultural context of the study area. Relevant topographic maps and satellite imagery were studied (Scoping Report and Desktop PIA report, Groenewald, 2015).

## 4.1 Previous Studies

Researching the SAHRIS online database (http://www.sahra.org.za/sahris), it was determined that the proposed area falls in very highly sensitive palaeontological heritage regions due to the very high possibility of finding significant stromatolites structures as well as Quaternary aged cave breccias with possible homonin fossil remains.

### *4.1.1 Findings from the studies*

**Palaeontology**

The following map (Figure 5) is an extract from the palaeontological desktop study completed by Groenewald (2015) for the proposed solar project on the farm Houthaalbomen 31 comprising a large part of the study area. The map indicates the main geological units as indicated on the map:

The study area is underlain by Vaalian aged Monte Christo Formation of the Malmani Subgroup, Chuniespoort Group of the Transvaal Supergroup (Figure 5)

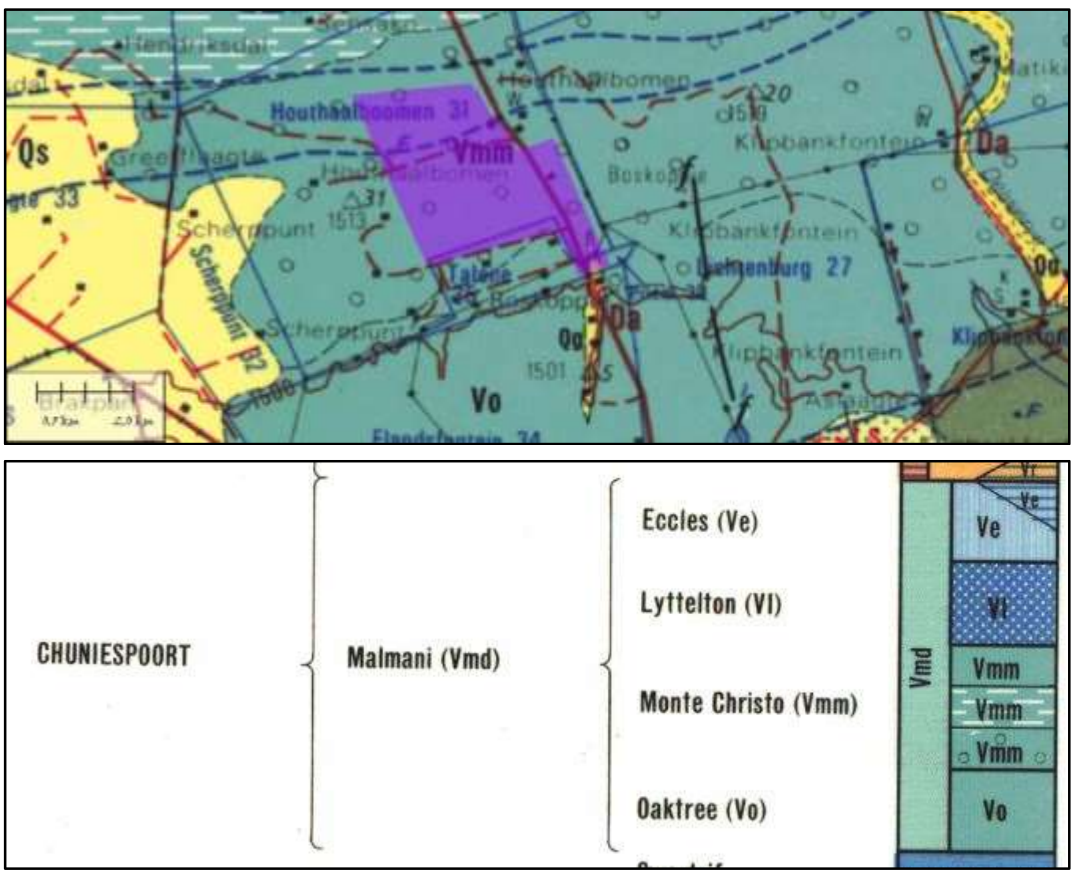


**Figure 5 - Geological Map of study area**

# 5 PALAEONTOLOGY OF THE AREA

## 5.1 Transvaal Supergroup

### *5.1.1 Chuniespoort Group, Malmani Subgroup*

The dolomites of the Malmani subgroup contain a range of shallow marine and lacustrine stromatolites (some very large), oolites, and pisolites in carbonates, filamentous and coccoid organic walled microfossils such as cyanobacteria in siliciclastics and carbonates, as well as cherts.

Dolomite areas are allocated a Very High Palaeontological Sensitivity due to presence of cast topography and possible cave breccias with potential Homonin fossils. Diverse Late Pliocene to Pleistocene (Makapanian, Cornelian, Florisian) mammalian biotas, including several extinct Hominins (spp. of *Australopithecus, Paranthropus, Homo*), micromammals, reptiles (lizards), frogs, birds, land snails, coprolites, stone and bone artefacts, plant remains (e.g. petrified wood, palynomorphs). A number of very important fossiliferous cave sites are for example present in Cradle of Humankind near Klerksdorp (Gauteng & North West)

*Monte Christo Formation*

The Vaalian aged Monte Christo Formation is a chert-rich dolomite with stromatolite structures and oolitic chert layers. Recording of these structures contributes significantly to our understanding of the palaeo-environments in this part of South Africa.

Groenewald (2015), indicated that the, "*The very high fossiliferous potential of the Monte Christo Formation, warrants an allocation of a Very High palaeontological sensitivity to the areas underlain by the rocks of the this formation. All the areas underlain by Dolomite have a very high potential of containing cave breccias with highly sensitive fossil remains including remains of Homonin fossils*." (Figure 6)


**Figure 6 - Very High Sensitivity for Palaeontological heritage for entire site with all alternatives and power line corridors**

### *5.1.2 Possible finds*

Evaluation of historical data, geological map and satellite images has indicated that the entire study area might have fossils associated with the dolomitic terrain (Figure 6).

To be able to compile a heritage management plan to be incorporated into the Environmental Management Plan the following further work will be required for the EIA.

- Palaeontological assessment of the area after completion of the geotechnical investigations to identify possible cave breccias and possible sites of sink hole formations.

# 6 IMPACT ASSESSMENT

## 6.1 Field work findings

### *6.1.1 Methodology*

Fieldwork was conducted on the two proposed PV developments of the Tlisitseng Project on 17 February 2016. The methodology focused of a tracked drive- and walkthrough of the foot print areas of proposed PV project as well as the two proposed power line corridors from the site to the Tlisitseng substation. An accredited professional palaeontologist, Dr Gideon Groenewald, assisted by David Groenewald, completed the fieldwork. All the fieldwork was done by vehicle and on foot and consisted of several kilometres of tracked field walking through the proposed development areas (Figure 7)

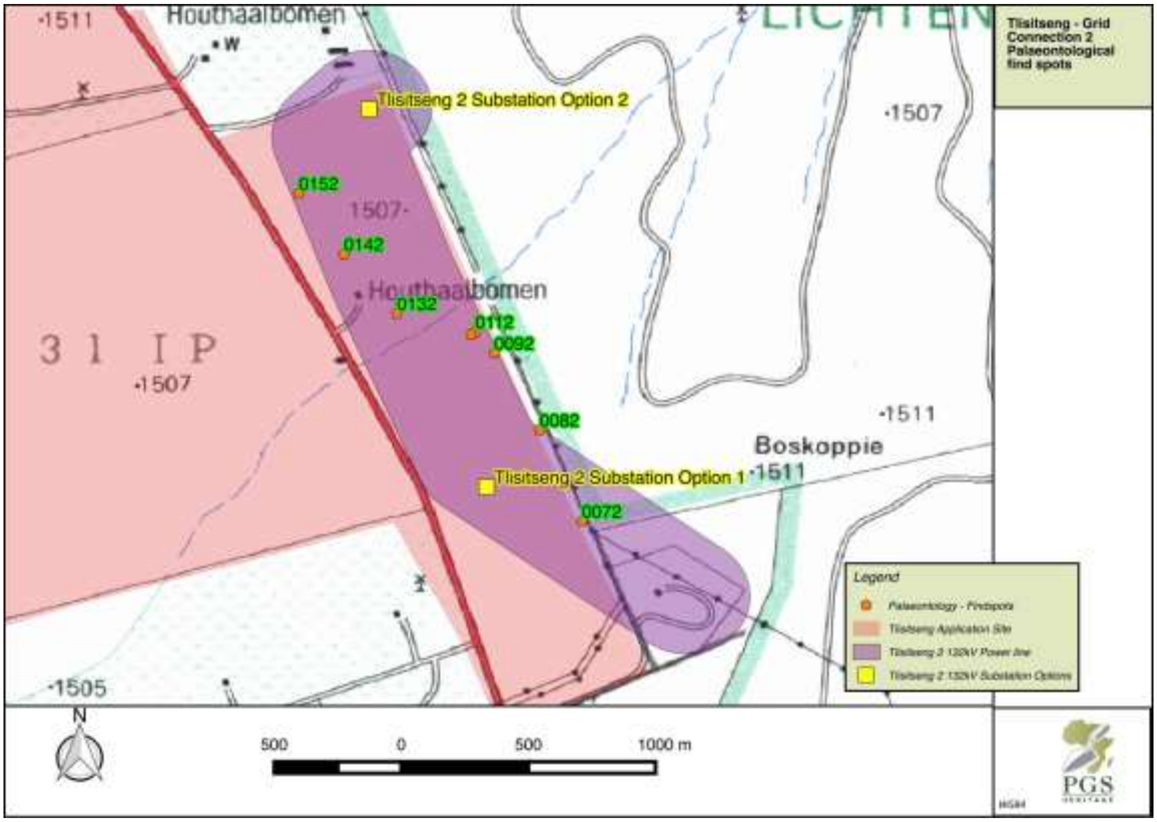


**Figure 7 - Observation sites of photographic recordings for palaeontological heritage. See Table 5**

All the palaeontological remains observed were associated with loose boulders on site and no significant outcrop was recorded (Table 5). Without access to the results of the geotechnical investigations it is not possible to assess the possible presence of sinkholes or potential cave deposits.

#### 6.1.2 Sites

During the fieldwork most of the areas have no outcrop and only a few loose blocks contained well-defined stromatolites, albeit not in situ.

**Table 5 Photographic observations during fieldwork session (See Figure 7)**

| Photo | GPS station no (Fig. 7) and coordinates | Description | Picture |
|---|---|---|---|
| 1 | (052)<br>-26° 05' 33.8"<br>26° 08' 22.8" | Very well defined stromatolites structures in dolomite and chert boulders on site. No outcrop and fossils are not in situ. |  |
| 2 | (062)<br>-26° 05' 21.9"<br>26° 08' 15.3" | Deep soils on dolomite. No outcrop. No fossils observed. Landscape indicate old river bed with river gravels and boulders of dolomite and chert. |  |
| 3 | (062)<br>-26° 05' 21.9"<br>26° 08' 15.3" | Micro-stromatolite structures in dolomite and chert layers. Boulders not in situ |  |

*Mitigation:*

| | | | |
|---|---|---|---|
| 4 | (072)<br>-26° 05' 16.8"<br>26° 08' 24.8" | Micro-stromatolites in possible outcrop, covered in shallow soil. Geotechnical reports will indicate possible exposure of these fossils during excavation for foundations |  |
| 5 | (082)<br>-26° 05' 03.9"<br>26° 08' 18.8" | Deep soils. Wind blown sand. No outcrop, no fossils observed |  |
| 6 | (092)<br>-26° 04' 53.0"<br>26° 08' 12.4" | Deep soil and alluvium with loose boulders of stromatolitic dolomite an chert. Stromatolites not in situ. No cave breccia observed |  |
| 7 | (0102)<br>-26° 04' 49.9"<br>26° 08' 13.1" | Stromatolitc dolomite and cave breccia used in grave covering. Stromatolites not in situ |  |

- Although no significant fossils were recorded in situ in both PV sites as well as the proposed alternative route corridors for the power lines, several well-defined micro-stromatolites and possible sites with cave breccia have been identified. Depending on the results of the geotechnical investigation and where potential excavations for foundations will exceed 1.5m,

| | | | |
|---|---|---|---|
| 8 | (0112)<br>-26° 04' 50.0"<br>26° 08' 09.7" | Deep ferricrete and soil used for brick making. No fossils observed. |  |
| 9 | (0122)<br>-26° 04' 50.4"<br>26° 08' 09.1" | Outcrop of pseudo cave breccia with not enough geotechnical information to prove sinkhole exisitence. No fossils observed during field inspection but site should be seen as highly sensitive for possible fossils |  |
| 10 | (0132)<br>-26° 04' 47.4"<br>26° 07' 58.6" | Brick field with blocks of stromatolitic dolomite not in situ. Dolomite rippled surfaces with stromatolitic growth on rippled surfaces. Stromatolites not in situ |  |
| 11 | (0142)<br>-26° 04' 39.0"<br>26° 07' 51.1" | Deep sandy soils. No outcrop, no fossils observed |  |

the ECO must investigate the possible presence of stromatolites and/or cave breccia and inform the HIA consultants immediately for appropriate action and appointment of a qualified palaeontologist to investigate the site before destruction of fossils occurs.

- Such mitigation measures will require a permit from SAHRA before mitigation can be done as well as a final destruction permit on completion of the mitigation work.

## 6.2 Assessment

The fieldwork findings have shown that the study area is characterised by a background scatter of Stromatolites in all the dolomite boulders on site and some areas have remains of cave breccia but no in situ outcrops were recorded.

It must be kept in mind that the fieldwork could in no way identify all palaeontological sites within the development footprint and as such the fieldwork has shown that the possibility of encountering possible cave breccias during geotechnical investigation is relatively high.

The following set of tables provide an assessment of the impact on palaeontological heritage resources within the development foot print

**Table 6 Rating of Impacts and Chance finds**

| **IMPACT TABLE** | |
|---|---|
| Environmental Parameter | *Palaeontological Resources* |
| Issue/Impact/Environmental Effect/Nature | *The possibility of encountering previously unidentified heritage resources and specifically Palaeontological sites. As well as the impact on the identified palaeontological sites* |
| *Extent* | *Will impact on the footprint area of the development* |
| *Probability* | *The fieldwork has shown that such a predicted impact will definitely occur* |
| *Reversibility* | *Due to the nature of palaeontological sites the impact is seen as irreversible, however mitigation could enable the collection of enough information to preserve the data from such a site* |
| *Irreplaceable loss of resources* | *The development could lead to significant losses in unidentified and unmitigated site* |
| *Duration* | *The impact on heritage resources such as palaeontological sites will be permanent* |
| *Cumulative effect* | *As the type of development impact on a large area, and other similar development in the area will also impact on palaeontological sites the cumulative* |

| | | |
|---|---|---|
| | *impact is seen as having a medium negative impact.* | |
| *Intensity/magnitude* | *The large scale impact on palaeontological sites might require mitigation work.* | |
| *Significance Rating* | *The overall significance rating for the impact on heritage resources is seen as very high pre-mitigation. This can be attributed to the very high possibility of encountering more palaeontological sites during geotechnical investigations. The implementation of the recommended heritage mitigation measures will address the envisaged impacts and reduce the overall rating to a low impact rating.* | |
| | | |
| | Pre-mitigation impact rating | Post mitigation impact rating |
| Extent | 4 | 4 |
| Probability | 3 | 2 |
| Reversibility | 4 | 3 |
| Irreplaceable loss | 3 | 3 |
| Duration | 4 | 4 |
| Cumulative effect | 3 | 3 |
| Intensity/magnitude | 3 | 3 |
| Significance rating | -63 (high negative) | 57 (high positive) |
| Mitigation measures | *Mitigation through palaeontological excavations and collection if Geotechnical Survey indicates necessity for mitigation*<br>*Monitoring during construction by palaeontologist if fossils are exposed during excavation of more than 1.5m of soil cover* | |

## 6.3 Cumulative Assessment

A large number of solar projects are proposed and some have been approved and is currently in construction around the study area (Table 8).

The need for the implementation of the recommended mitigation measures is of great importance and must be seen in the context of the large areas to be impacted by the construction activity. By implementing the mitigation measures the cumulative effect will be reduce from a High to a Medium negative impact rating.

**Table 7 Renewable energy developments proposed within a 20km radius from the proposed Tlisitseng PV application site**

| Proposed Development | DEA Reference Number | Current Status of EIA | Proponent | Proposed Capacity | Farm Details |
|---|---|---|---|---|---|
| Matrigenix Renewable Energy Project | 14/12/16/3/3/3/270 | Scoping and EIA processes underway | Matrigenix (Pty) Ltd | 70MW | A portion of portion 10 of the Farm Lichtenburg Town and Townlands 27 |
| Watershed Solar Energy Facility | 14/12/16/3/3/2/557 | Scoping and EIA processes underway. | FVR Energy South Africa (Pty) Ltd | 75MW | Portions 1, 9, 10 and 18 of the Farm Houthaalbomen 31 |
| Hibernia PV Solar Energy Facility | 14/12/16/3/3/2/1062 | Project has received environmental authorisation | South Africa Mainstream Renewable Power Developments (Pty) Ltd | **UNKNOWN** | Portions 9 and 31 of the Farm Hibernia 52 |

## 6.4 Impact Summary

Table 8 provides a summary of the projected impact rating for this project on heritage resources.

**Table 8 Projected Impact ratings for the palaeontological resources on site**

| Environmental parameter | Issues | Rating prior to mitigation | Average | Rating post mitigation | Average |
|---|---|---|---|---|---|
| Palaeontological resources | Impact during construction | 63 | High Negative Impact | 57 | High Positive |
| | | | | | |

## 6.5 Comparative Assessment for Tlisitseng Solar

**Key**

**Table 9 Key to the comparative assessment of sites**

| | |
|---|---|
| **PREFERRED** | The alternative will result in a low impact / reduce the impact |

| | |
|---|---|
| **FAVOURABLE** | The impact will be relatively insignificant |
| **NOT PREFERRED** | The alternative will result in a high impact / increase the impact |
| **NO PREFERENCE** | The alternative will result in equal impacts |

**Table 10 Summary of alternatives**

| Alternative | Preference | Reasons |
|---|---|---|
| **SUBSTATION** | | |
| Substation Site Alternative 1 | NO PREFERENCE | No significant palaeontological heritage resources identified before geotechnical report is available |
| Substation Site Alternative 2 | NO PREFERENCE | No significant palaeontological heritage resources identified before geotechnical report is available |

# 7 MANAGEMENT GUIDELINE

## 7.1 Heritage Management Plan for EMP implementation

**Table 11 Mitigation measures proposed**

| No. | Mitigation Measures | Phase | Timeframe | Responsible Party For Implementation | Monitoring Party (Frequency) | Target | Performance Indicators (Monitoring Tool) | Cost |
|---|---|---|---|---|---|---|---|---|
| **A** | Include section on possible [palaeontological heritage finds in induction prior to construction activities take place – Refer to Section 5 of this report referring to geotechnical reports | Planning /Pre-Construction | Prior to construction | Applicant<br>ECO<br>Heritage Specialist | ECO (Monthly) | Ensure compliance with relevant legislation and recommendations from SAHRA under Section 36 and 38 of NHRA | No legal directives<br>Legal compliance audit scores<br>(Legal register)<br>(ECO Monthly Checklist/Report) | **R5 000** |
| **B** | Implement chance find procedures in case where possible palaeontological heritage finds area made | Construction | During construction | Applicant<br>ECO<br>Heritage Specialist | ECO (weekly) | Ensure compliance with relevant legislation and recommendations from SAHRA under Section 35and 38 of NHRA | ECO Monthly Checklist/Report | **Possibly R10 000** |
| **C** | Monitoring of construction activities by palaeontologist if indicated after completion of geotechnical report | Construction | During construction | Applicant<br>ECO<br>Palaeontologist | Palaeontologist (Initial 2-day site visit.<br>Then Fortnightly during construction) | Ensure compliance with relevant legislation and recommendations from SAHRA under Section 35 and 38 of NHRA | Palaeontologist Monthly Checklist/Report | **Monthly R40-50 000** |

# 8 HERITAGE MANAGEMENT GUIDELINES

## 8.1 All phases of the project

### *8.1.1 Palaeontology*

The project will encompass a range of activities during the construction phase, including ground clearance, establishment of construction camps area. It is essential that the information gathered during the Geotechnical investigations for developments be made available to the Heritage Practitioner and Palaeontologist to assess the possibility of exposing bedrock with fossils where excavations will exceed 1.5m or where gravity surveys indicate possible karst topography in dolomitic terrains.

It is possible that cultural material, including palaeontological finds, will be exposed during operations and may be recoverable, but this is the high-cost front of the operation, and so any delays should be minimised. Development surrounding infrastructure and construction of facilities results in significant disturbance, but construction trenches do offer a window into the past and it thus may be possible to rescue some of the data and materials. It is also possible that substantial alterations will be implemented during this phase of the project and these must be catered for. Temporary infrastructure is often changed or added to during the subsequent history of the project. In general these are low impact developments as they are superficial, resulting in little alteration of the land surface, but still need to be catered for.

During the prospecting phase, it is important to recognise any significant material being unearthed, and to make the correct judgment on which actions should be taken. In the event that possible heritage resources are identified a qualified archaeologist/palaeontologist must be contacted to evaluate the finds and make recommendations on the mitigation required.

In addition, feedback reports can be submitted by the archaeologist to the client and SAHRA to ensure effective monitoring. This archaeological and palaeontological monitoring and feedback strategy should be incorporated into the Environmental Management Plan (EMP) of the project. Should an archaeological/palaeontological site or cultural material be discovered during construction (or operation), such as burials or grave sites, the project needs to be able to call on a qualified expert to make a decision on what is required and if it is necessary to carry out emergency recovery. SAHRA would need to be informed and may give advice on procedure. The developers therefore should have some sort of contingency plan so that operations could move elsewhere temporarily while the material and data are recovered. The project thus needs to have an archaeologist/palaeontologist available to do such work. This provision can be made in an archaeological and palaeontological monitoring programme.

In the case where archaeological or palaeontological material is identified during construction the following measures must be taken:

- Upon the accidental discovery of archaeological or palaeontological material, a buffer of at least 20 meters should be implemented.
- If archaeological and palaeontological material is accidentally discovered during construction, activities must cease in the area and a qualified archaeologist or palaeontologist be contacted to evaluate the find. To remove the material a permit must be applied for from SAHRA under Section 35 of the NHRA.

# 9 CONCLUSIONS AND RECOMMENDATIONS

Palaeontological Heritage resources are unique and non-renewable and as such any impact on such resources must be seen as significant.

The Heritage Scoping Report (Desktop PIA study) has shown that the proposed Tlisitseng Solar project may have palaeontological heritage resources present on the property. This has been confirmed through archival research and evaluation of aerial photography of the sites. Confirmation of actual presence of significant finds will only be possible after the completion of the geotechnical surveys for this project.

Evaluation of geological maps and satellite imagery has indicated the entire development area that may be sensitive from a palaeontological perspective (Error! Reference source not found.).

The fieldwork that covered the Tlisitseng Solar site as well as the proposed power line corridors covered the entire area with an evaluation field of 20 meters for small finds (10 meters either side of the palaeontologist) and 100 meters for larger finds such as possible sinkholes and cave breccias sites with tree growths (50 meters either side of the palaeontologist). Planted maize fields were excluded from the surveys due to the fact that fossils will not be visible.

## 9.1 Find spots

Local scree material and blocks of dolomite were inspected for fossils and all finds were recorded as photographic records (Table 2). No outcrop of bedrock with fossils was recorded and sites with cave breccia were recorded in areas where chert breccia was obviously present in the loose material. Final identification of possible sites where significant cave breccia will occur will only be identified after completion of the geotechnical surveys.

*Mitigation:*

- It is essential that the results of the Geotechnical Surveys be provided to the HIA team and palaeontologist to assess the possible presence of sinkholes and cave breccia sites on all the proposed development areas;

- Field assessment indicated the presence of both stromatolites structures and cave breccia but all the observed examples were out of situ;
- Any excavation of deeper than 1.5m is planned, the palaeontologist must assess the results of the geotechnical information and given the opportunity to comment on the likelihood of significant finds of fossils in all the planned development areas;
- If any excavation or collection of fossils are recommended, such mitigation measures will require a permit from SAHRA before mitigation can be done as well as a final destruction permit on completion of the mitigation work.

Due to the large number of boulders with stromatolites present on site it is recommended that an palaeontologist be appointed to monitor geotechnical investigations as part of a watching brief. The aim being the identification and mitigation of any newly discovered palaeontological sites.

## 9.2 Sites

During the fieldwork period several arbitrary finds of dolomite and chert with significantly well-defined stromatolites as well as a few potential sites with either associated sinkholes or cave breccias were recorded (Table 2). Confirmation of the significance of these sites will only be possible after completion of the geotechnical surveys.

Power line sites - *Mitigation:*

- Although no significant fossils were recorded in situ in both PV sites as well as the proposed alternative route corridors for the power lines, several well-defined micro-stromatolites and possible sites with cave breccia have been identified. Depending on the results of the geotechnical investigation and where potential excavations for foundations will exceed 1.5m, the ECO must investigate the possible presence of stromatolites and/or cave breccia and inform the HIA consultants immediately for appropriate action and appointment of a qualified palaeontologist to investigate the site before destruction of fossils occurs.
- Site visits as stipulated in the management tables will include an initial 2 day site visit and then fortnightly during construction.
- Such mitigation measures will require a permit from SAHRA before mitigation can be done as well as a final destruction permit on completion of the mitigation work.

## 9.3 Impact Summary

Table 14 provides a summary of the projected impact rating for this project on heritage resources.

**Table 12: Comparison of summarised impacts on environmental parameters**

| Environmental parameter | Issues | Rating prior to mitigation | Average | Rating post mitigation | Average |
|---|---|---|---|---|---|
| Palaeontology | Impact during construction | 63 | Negative | 57 | Positive |

## 9.4 Comparative Assessment for Tlisitseng Solar Development

**Key**

**Table 13 Key to comparative assessments**

| | |
|---|---|
| **PREFERRED** | The alternative will result in a low impact / reduce the impact |
| **FAVOURABLE** | The impact will be relatively insignificant |
| **NOT PREFERRED** | The alternative will result in a high impact / increase the impact |
| **NO PREFERENCE** | The alternative will result in equal impacts |

**Table 14 Comparative assessments**

| Alternative | Preference | Reasons |
|---|---|---|
| **SUBSTATION** | | |
| Substation Site Alternative 1 | NO PREFERENCE | No significant palaeontological heritage resources identified before geotechnical report is available |
| Substation Site Alternative 2 | NO PREFERENCE | No significant palaeontological heritage resources identified before geotechnical report is available |

# 10 REFERENCES


GROENEWALD, GH., GROENEWALD SM. AND GROENEWALD DP. 2014. Palaeontological Heritage of the Free State, Gauteng, Limpopo, Mpumalanga and North West Provinces. Internal Palaeotechnical Reports, SAHRA.

GROENEWALD GH. 2015. Palaeontological Desktop Assessment for the proposed Tlisitseng Solar PV. Internal Report, PGS Heritage (Pty) Ltd.

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 C

# Heritage Assessment Methodology

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

The Heritage Impact Assessment (HIA) report compiled by PGS Heritage (PGS) for the proposed Helena 1 Solar 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 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 15: 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) | Grade 4A | High / Medium Significance | Mitigation before destruction |
| Generally Protected B (GP.B) | Grade 4B | Medium Significance | Recording before destruction |
| Generally Protected C (GP.A) | Grade 4C | Low Significance | Destruction |

Appendix C

# Impact Assessment Methodology to be utilised during EIA phase

The EIA Methodology assists in evaluating the overall effect of a proposed activity on the environment. The determination of the effect of an environmental impact on an environmental parameter is determined through a systematic analysis of the various components of the impact. This is undertaken using information that is available to the environmental practitioner through the process of the environmental impact assessment. The impact evaluation of predicted impacts was undertaken through an assessment of the significance of the impacts.

## 10.1 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 3.

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.

## 10.2 Impact Rating System

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

- planning
- construction
- operation
- 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.

### *10.2.1 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 mitigation of the impact. Impacts have been consolidated into one rating. In assessing the significance of each issue the following criteria (including an allocated point system) is used:

**Table 16 Classification of sensitivity ratings**

| | | |
|---|---|---|
| **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. | | |
| | | |
| **GEOGRAPHICAL EXTENT** | | |
| 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** | | |
| 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** | | |
| 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** | | |
| 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** | | |
| 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). |
| | | |
| **CUMULATIVE EFFECT** | | |
| This describes the cumulative effect of the impacts on the environmental parameter. A cumulative effect/impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question. | | |
| 1 | Negligible Cumulative Impact | The impact would result in negligible to no cumulative effects |
| 2 | Low Cumulative Impact | The impact would result in insignificant cumulative effects |
| 3 | Medium Cumulative impact | The impact would result in minor cumulative effects |
| 4 | High Cumulative Impact | The impact would result in significant cumulative effects |
| | | |
| **INTENSITY / MAGNITUDE** | | |
| Describes the severity of an impact | | |
| 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**

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:

**(Extent + probability + reversibility + irreplaceability + duration + cumulative effect) 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 |
|---|---|---|
| | | |
| 6 to 28 | Negative Low impact | The anticipated impact will have negligible negative effects and will require little to no mitigation. |
| 6 to 28 | Positive Low impact | The anticipated impact will have minor positive effects. |
| 29 to 50 | Negative Medium impact | The anticipated impact will have moderate negative effects and will require moderate mitigation measures. |
| 29 to 50 | Positive Medium impact | The anticipated impact will have moderate positive effects. |
| 51 to 73 | Negative High impact | The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact. |
| 51 to 73 | Positive High impact | The anticipated impact will have significant positive effects. |
| 74 to 96 | 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". |
| 74 to 96 | Positive Very high impact | The anticipated impact will have highly significant positive effects. |

**Table 17 Impact Assessment**

The table below is to be represented in the Impact Assessment section of the report.

| IMPACT TABLE FORMAT | | |
|---|---|---|
| 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 | *A brief description of the nature of the impact that is likely to affect the environmental aspect as a result of the proposed activity e.g. alteration of aquatic biota The environmental impact that is likely to positively or negatively affect the environment as a result of the proposed activity e.g. oil spill in surface water* | |
| *Extent* | *A brief description of the area over which the impact will be expressed* | |
| *Probability* | *A brief description indicating the chances of the impact occurring* | |
| *Reversibility* | *A brief description of the ability of the environmental components recovery after a disturbance as a result of the proposed activity* | |
| *Irreplaceable loss of resources* | *A brief description of the degree in which irreplaceable resources are likely to be lost* | |
| *Duration* | *A brief description of the amount of time the proposed activity is likely to take to its completion* | |
| *Cumulative effect* | *A brief description of whether the impact will be exacerbated as a result of the proposed activity* | |
| *Intensity/magnitude* | *A brief description of whether the impact has the ability to alter the functionality or quality of a system permanently or temporarily* | |
| *Significance Rating* | *A brief description of the importance of an impact which in turn dictates the level of mitigation required* | |
| | | |
| | Pre-mitigation impact rating | Post mitigation impact rating |
| Extent | 4 | 1 |
| Probability | 4 | 1 |
| Reversibility | 4 | 1 |
| Irreplaceable loss | 4 | 1 |
| Duration | 4 | 1 |
| Cumulative effect | 4 | 1 |
| Intensity/magnitude | 4 | 1 |
| Significance rating | -96 (high negative) | -6 (low negative) |
| Mitigation measures | *Outline/explain the mitigation measures to be undertaken to ameliorate the impacts that are likely to arise from the proposed activity. Describe how the mitigation measures have reduced/enhanced the impact with relevance to the impact criteria used in analyzing the significance. These measures will be detailed in the EMP.* | |

## 10.3 Impact Summary

The impacts will then be summarized and a comparison made between pre and post mitigation phases as shown in Table 4 below. The rating of environmental issues associated with different parameters prior to and post mitigation of a proposed activity will be averaged. A comparison will then be made to determine the effectiveness of the proposed mitigation measures. The comparison will identify critical issues related to the environmental parameters.

The table below is to be represented in the Executive Summary of the report.

**Table 18 Executive Summary**

| **Environmental parameter** | **Issues** | **Rating prior to mitigation** | **Average** | **Rating post mitigation** | **Average** |
|---|---|---|---|---|---|
| Surface water | Erosion | 43 | | 16 | |
| | Oil spills | 22 | | 22 | |
| | Alteration of aquatic biota | 16 | | 3 | |
| | | | **- 0.0** | | **-0.0** |
| | | | Low Negative Impact | | Low Negative Impact |

Finally, the 2010 regulations also specify that alternatives must be compared in terms of impact assessment. Hence all alternatives will need to be comparatively assessed.

Appendix D

# Palaeontological Heritage Map


**Figure 8 Palaeontological Sensitivity of Tlisitseng PV Solar Study Area**