SOUTH AFRICA MAINSTREAM RENEWABLE POWER DEVELOPMENTS (PTY) LTD

Dwarsrug Wind Energy Facility

Heritage Impact Report

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Executive Summary

PGS Heritage was appointed by SiVEST Environmental Division to undertake a Heritage Impact Report that forms part of the Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) for the Alternative Wind Energy Project for South Africa Mainstream Renewable Power Developments (Pty) Ltd (hereafter referred to as Mainstream), near Loeriesfontein in the Northern Cape Province.
Heritage resources are unique and non-renewable and as such any impact on such resources must be seen as significant.

The Heritage Scoping Report completed in May 2014 has shown that the proposed Dwarsrug site to be developed as a Wind Energy Facility (WEF) may have heritage resources present on the property. This has been confirmed through archival research and evaluation of aerial photography of the sites.

The subsequent field work completed for the HIA component in September 2014, has confirmed the presence of 17 archaeological find spots, 4 historical sites and 7 archaeological sites. The archaeological sites are associated with the Middel (MSA) and Later Stone Age (LSA) and are representative of archaeological sites with a medium significance. The historical sites and cemeteries were rated as having a medium to high local heritage significance.

The design process and methodology followed by the developer for this project enabled the heritage assessment to provide input into the proposed layouts before the impact assessment. This resulted in cognisance being taken of the positions of the heritage sites and thus the reduction of impacts at an early design phase. Analysis of the impact matrix tables will reflect this. It must be noted that the only heritage aspect not utilised during the design stages are the palaeontology (Table 7), this purely due to the extent of the palaeontological sensitive formations covering nearly 90% of the proposed study area. However the opportunity to implement a palaeontological management plan pre-and during construction provides the means of mitigating any envisaged impacts.

The mitigation measures proposed is a follows:

1.1 Pre-Construction

1. *A walk down of the final approved layout will be required before construction commence;*
2. *Any heritage features of significance identified during this walk down will require formal mitigation or where possible a slight change in design could accommodate such resources.*
3. *A management plan for the heritage resources needs then to be compiled and approved for implementation during construction and operations.*

1.2 Palaeontology

1. *The EAP as well as the ECO for this project must be made aware of the fact that the Ecca Group sediments contains significant fossil remains, albeit mostly trace fossil assemblages. Several types of fossils have been recorded from this Group in the Karoo Basin of South Africa, with special mention of the very important Whitehill Formation. The Whitehill Formation outcrops are however very restricted in this study area.*
2. *In areas that are allocated a Very High and High Palaeontological sensitivity and specifically where deep excavation into bedrock is envisaged (following the geotechnical investigation), or where fossils are recorded during the geotechnical investigations, a qualified palaeontologist must be appointed to assess and record fossils at specific footprints of infrastructure developments (Phase 1 PIA).*
3. *If significant fossil finds (e.g. vertebrate teeth, bones, burrows, petrified wood) are recorded during excavations for infrastructure such as road developments, the palaeontologist must apply for a collection permit to collect the fossils according the SAHRA specifications.*

1.3 Archaeological Sites

1. *Demarcate sites as no-go areas*
2. *Demarcate and fence during construction if construction activities area to happened within 100 meters from a site.*
3. *Monitor find spot areas if construction is going to take place through them.*
4. *A management plan for the heritage resources needs then to be compiled and approved for implementation during construction and operations.*

1.4 Historical sites

1. *Demarcate sites as no-go areas*
2. *Demarcate and fence during construction if construction activities area to happened within 100 meters from a site.*
3. *A management plan for the heritage resources needs then to be compiled and approved for implementation during construction and operations.*

1.5 Comparative Assessment of Alternatives

The comparative assessment of the alternatives have shown that an overall low impact on heritage is foreseen, as all of the heritage sites identified fall outside the proposed alternative foot prints.

1.5.1 Wind Turbine Layouts

Allowing for a 60m diameter construction foot print for on all turbine positions has shown that al the find spots and sites fall outside and in most case more than 100 meters way from any construction activities.

1.5.2 Access roads

None of the proposed access roads will have any impact on known heritage resources.

1.5.3 Gridline corridors

The two grid line alternatives intersect 4 of the same find spots (rated as having low heritage significance). Gridline Alternative 2 intersects an additional heritage finds pot (rated as having low heritage significance). This additional impact is negligible.

1.5.4 Associated Infrastructure

No heritage resources will be impacted by any of the infrastructure alternatives.

Key

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

Alternative	**Preference**	**Reasons**
WIND FARM TURBINE LAYOUT		
Expanded Layout – Alternative 1	No preference	The alternative will result in equal impacts
Constrained Layout – Alternative 2	No preference	The alternative will result in equal impacts
ACCESS ROAD		
Access Road Alternative 1	No preference	The alternative will result in equal impacts
Access Road Alternative 2	No preference	The alternative will result in equal impacts
GRID LINE		
Grid Line Alternative 1 (orange kml)	No preference	The alternative will result in equal impacts
Grid Line Alternative 2 (green kml)	No preference	The alternative will result in equal impacts
ASSOCIATED INFRASTRUCTURE		

Alternative	Preference	Reasons
Associated Infrastructure Alternative 1 (purple kml)	No preference	The alternative will result in equal impacts
Associated Infrastructure Alternative 2 (orange kml)	No preference	The alternative will result in equal impacts

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HERITAGE IMPACT REPORT

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1 INTRODUCTION

PGS Heritage was appointed by SiVEST Environmental Division to undertake a Heritage Scoping Report that forms part of the Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) for the Alternative Wind Energy Project for South Africa Mainstream Renewable Power Developments (Pty) Ltd (hereafter referred to as Mainstream), near Loeriesfontein in the Northern Cape Province.

1.1 Scope of the Study

The aim of the study is to identify possible heritage sites, finds and sensitive areas that may occur in the study area for the EIA study. The Heritage Impact Assessment (HA) aims to inform the Environmental Impact Assessment in the development of a comprehensive Environmental Management Plan 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

The heritage resources located during the fieldwork do not necessarily represent all the possible heritage resources present within the area. Various factors account for this, including the subterranean nature of some heritage sites.

The impact assessment conducted for heritage sites assumes the possibility of finding heritage resources during the project life and has been conducted as such.

1.3 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
iv. Development Facilitation Act (DFA), Act 67 of 1995

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)

iv. Development Facilitation Act (DFA) Act 67 of 1995
a. The GNR.1 of 7 January 2000: Regulations and rules in terms of the Development Facilitation Act, 1995. Section 31.

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 and the DFA 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).

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** 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
CRM	Cultural Resource Management
DEA	Department of Environmental Affairs
DWA	Department of Water Affairs
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
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
SADC	Southern African Development Community
SAHRA	South African Heritage Resources Agency

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.

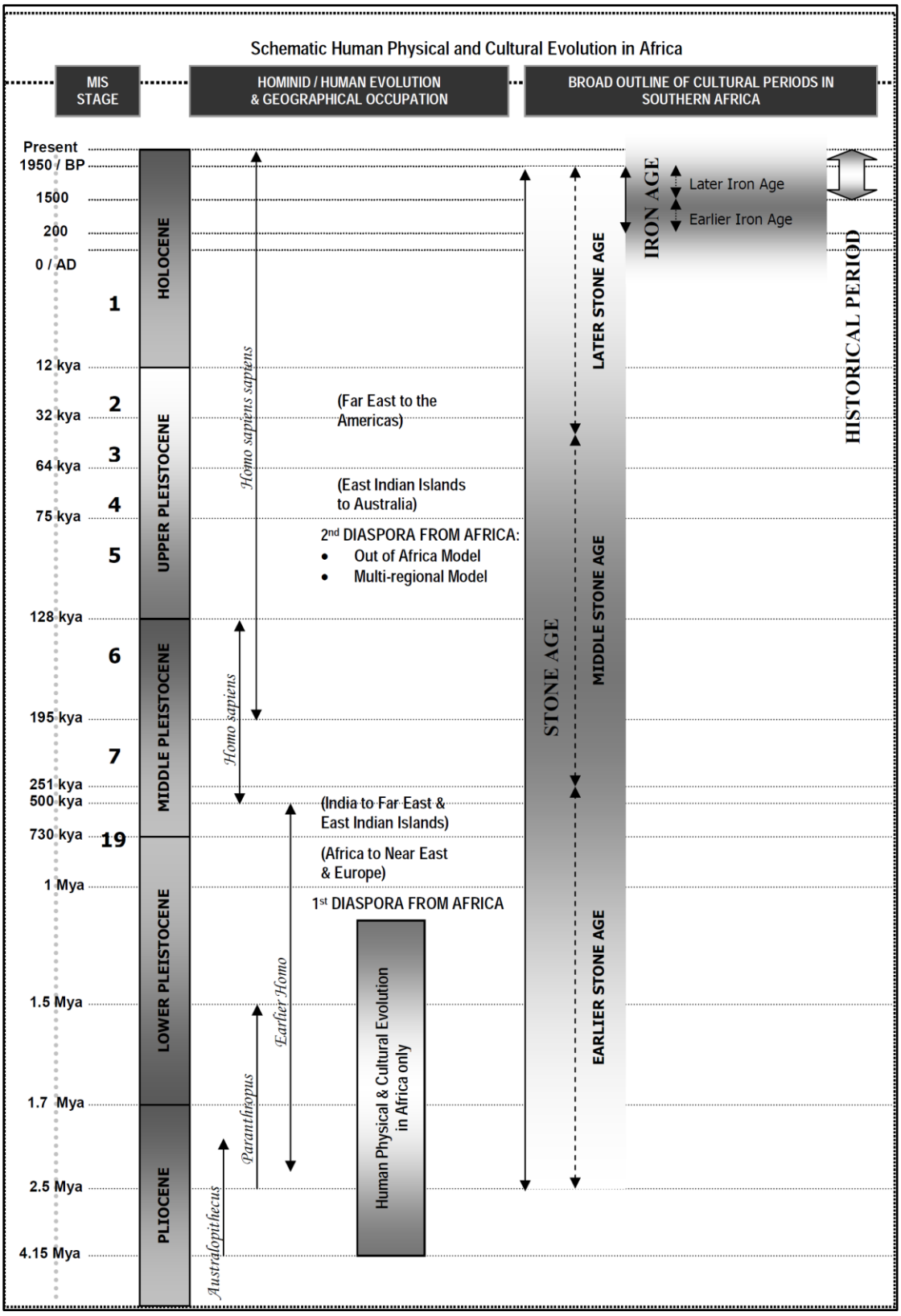


Figure 1: Human and Cultural Timeline in Africa (Morris, 2008)

2 TECHNICAL DETAILS OF THE PROJECT

2.1 Project Description

The area of the proposed wind farm site is approximately 10701.04 ha, however the actual footprint of the wind farm will cover a smaller area that will fit within this 10701.04 ha. It is estimated that the wind farm proposed project will encompass the installation of a number of wind turbine generators and associated components in order to generate electricity that is to be fed into the national distribution network at Helios substation via a 132kV power line.

The project is proposed on the following farm portions:

- Remainder of the Farm Brak Pan No. 212, Northern Cape
- Stinkputs North No. 229, Northern Cape
- Remainder of the Farm Narosies No. 228, Northern Cape
- Portion 1 of the Farm Ann De Karree Doorn Pan No 213, Northern Cape
- Remainder of the Farm Kleine Rooiberg 227, Northern Cape
- Portion 5 of the Farm Kleine Rooiberg 227, Northern Cape
- Portion 4 of the Farm Rooiberg 263, Northern Cape
- Portion 1 of the farm Sous No. 226, Northern Cape
- Remainder of the farm Sous No. 226, Northern Cape

At this stage, it is proposed that the development will consist of approximately 70 wind turbines and associated infrastructure with a total generation capacity of approximately 140MW. As mentioned above, the generated electricity will be fed into the national distribution network at Helios substation via a 132kV power line with a length of between approximately 10km and 15km, depending on the route alternative selected.

The key components of the project are detailed below.

2.1.1 Turbines

The size of the wind turbines will depend on the developable area and the total generation capacity that can be produced as a result. The wind turbines will therefore have a hub height of up to 150m and a rotor diameter of up to 140m (**Figure 2**). The blade rotation direction will depend on wind measurement information received later in the process. The foundation of each wind turbine will have a footprint of approximately 20m x 20m, and will be approximately 5m deep. A hard standing area of approximately 2 800m^2 per turbine will be required for crane usage. As already mentioned, approximately 35-95 wind turbines will be constructed with a total generation capacity of approximately 140MW. The electrical generation capacity for each turbine will range from 1.5 to 4MW depending on the final wind turbine selected for the proposed development.

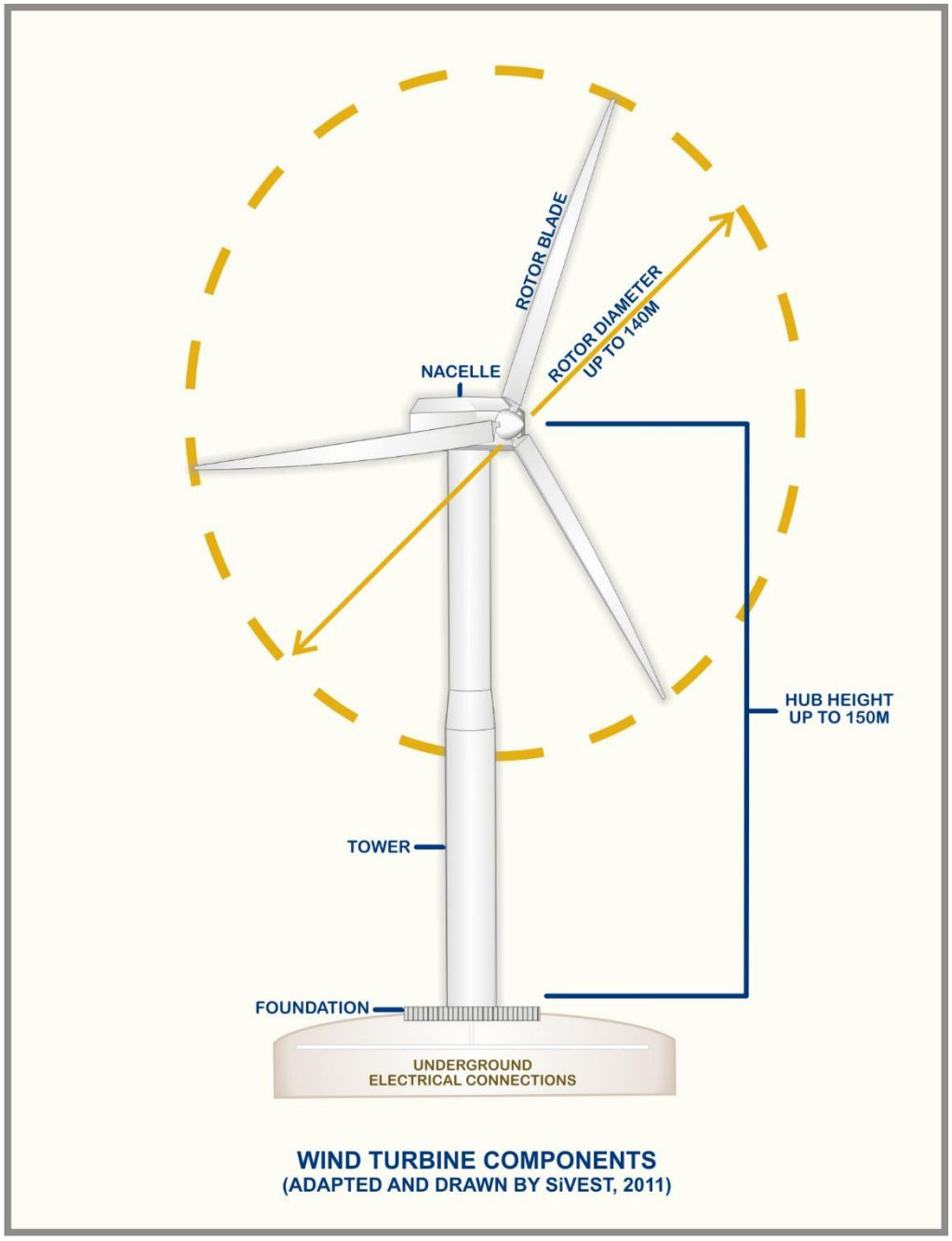


Figure 2: Typical Components of a wind turbine

2.1.2 Electrical Connections

The wind turbines will be connected to the substation using buried (up to a 1.5m depth) medium voltage cables (**Figure 3**) except where a technical assessment of the proposed design suggests that overhead lines are appropriate such as over rivers and gullies. Where overhead power lines are to be constructed, monopole tower structures will be used in combination with the steel lattice towers at bend points. The dimensions of the monopole structures will depend on grid safety requirements and the grid operator. The exact location of the towers, the selection of the tower type and the final design will comply with the requirements of Eskom. No servitudes will be associated with the wind farm infrastructure although servitudes for Eskom infrastructure

may be required on site. As mentioned, the proposed wind farm will connect with the national distribution network at Helios substation via a 132kV power line with a length of up to 15km.

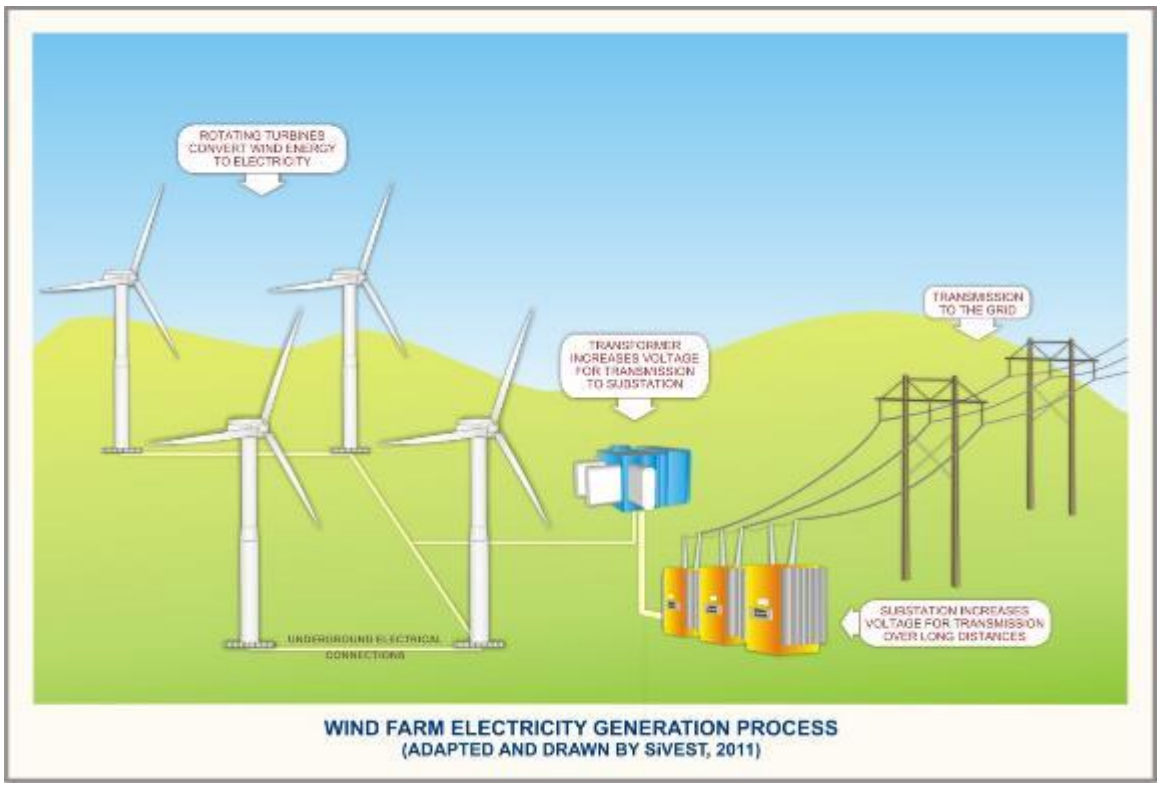


Figure 3: Conceptual wind farm electricity generation process showing electrical connections

2.1.3 Substation

A new substation (approx. 90 x 120m) and associated transformers will be developed which will supply the generated electricity to the Eskom grid. The transformers' operating voltage may range up to 275kV. The footprint of the substation yard will be approximately 10 800m². The connection from the substation to the Eskom grid line will be an overhead power line as mentioned above.

A new substation bay may be required at Helios substation along with associated transformers, breakers, and associated gear. It is expected that this work will be completed within the existing substation yard at Helios Substation.

2.1.4 Roads

The internal access roads are proposed to be between 8 and 10m wide and an existing access road from the Granaatboskolk road will be upgraded to provide access to the site. In some sections the road may need to be as wide as 12 meters at certain corners to accommodate the turning circle of the extended trucks transporting the turbine tower sections and turbine blades.

2.1.5 Temporary Construction Area

A maximum 10 000m^2 temporary lay down area will be constructed for the proposed development and will include an access road and a contractor's site offices of up to 5 000m².

2.1.6 Other Associated Infrastructure

Other infrastructure includes the following:

- Administration and warehouse buildings with a footprint of 5 000 m²;
- Borrow pits (if required);
- Fencing (if required); and
- Linking station (if required).

2.2 Alternatives

In terms of the EIA regulations, feasible and reasonable alternatives are required to be considered during the EIA process. As such, layout alternatives and the no-go alternative have been considered in this Draft Environmental Impact Report.

Two (2) layout alternatives have been investigated for the proposed project and these are presented in **Figure 4** and **Figure 5** below. The layout alternatives relate to the location of the turbines and associated infrastructure within the proposed development site. They include an expanded layout (alternative 1) and a constrained layout (alternative 2).

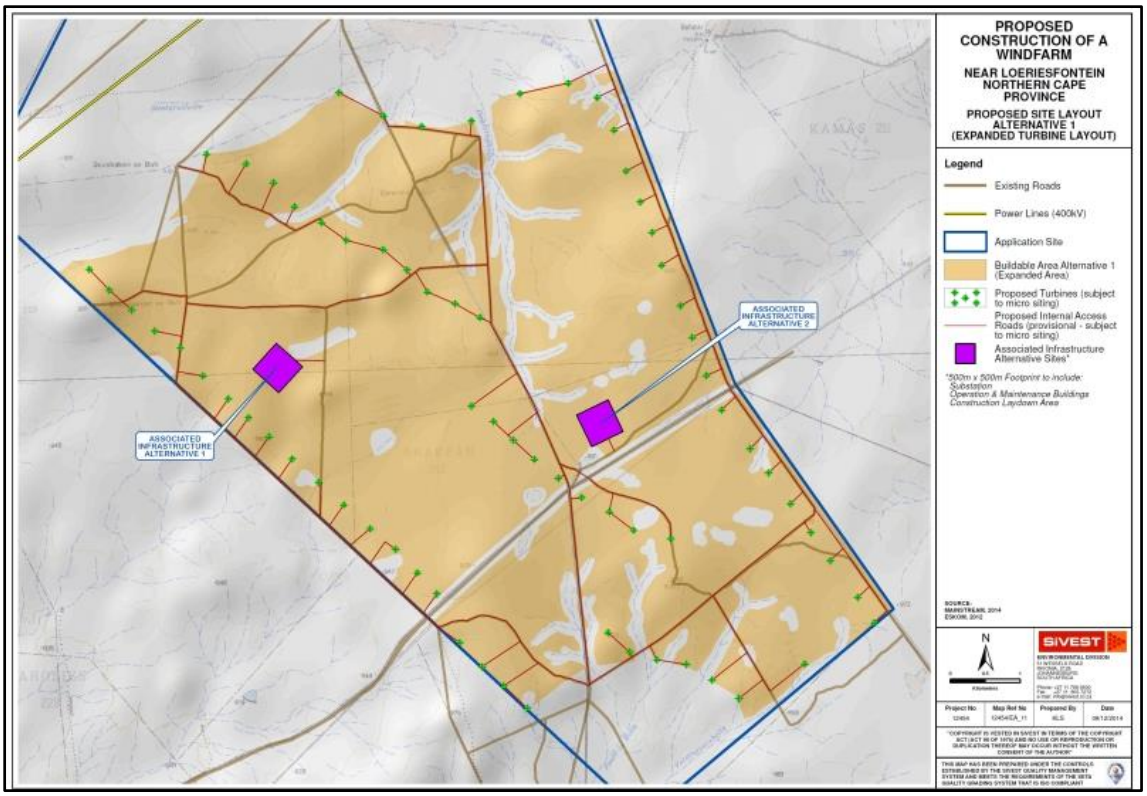


Figure 4: Site layout alternative 1 – expanded layout

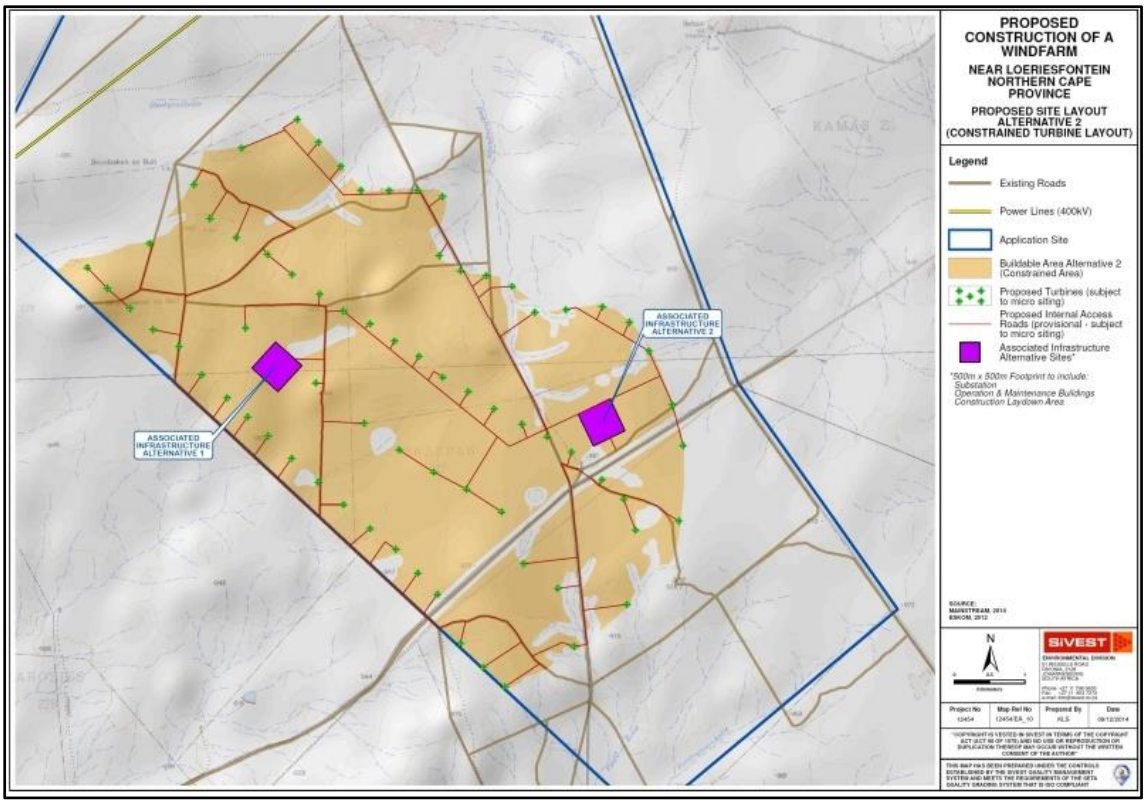


Figure 5: Site layout alternative 2 – constrained layout

Two (2) alternatives for the position of the substation have been investigated; these are substation alternative 1 and 2 (Figure 6).

In addition, two (2) grid line corridors that vary between approximately 500m and 1km wide have been proposed to provide grid access from the proposed substation alternatives to Helios substation (alternative 1 and 2) (Figure 6). Grid line corridor alternative 1 and 2 overlap as they run from Helios substation in a north-easterly direction relatively parallel to the existing 400kV power line toward the development site. Approximately 1km after entering the development site the power line corridors turn to run in a south-easterly direction. Thereafter, corridor alternative 1 runs for approximately 4km before terminating at substation site alternative 1 proposed on the wind farm site. At this point corridor alternative 2 continues for an additional 3km before turning to run in an easterly direction until it terminates at substation site alternative 2 (**Figure 6**).

Access to the site from the Granaatboskolk road would be provided by a 6-10m wide gravel road, which will be upgraded as required in order to provide access to the proposed Dwarsrug wind farm site. Two (2) access road alternatives are currently being investigated which are used to access local farmsteads. Access road alternative 1 is approximately 50km from Loeriesfontein. This road runs in an easterly direction and is used to access the Narosies, Stinkputs Noord and Stinkputs Suid farmsteads. This road is a graded dirt road which is slightly maintained by farmers in the surrounding area. Access road alternative 2 is approximately 40km from Loeriesfontein and runs in a north-easterly direction from the Granaatboskolk Road.

This road is a public road which is in very poor condition and transverses a number of drainage lines and water courses (Figure 6).

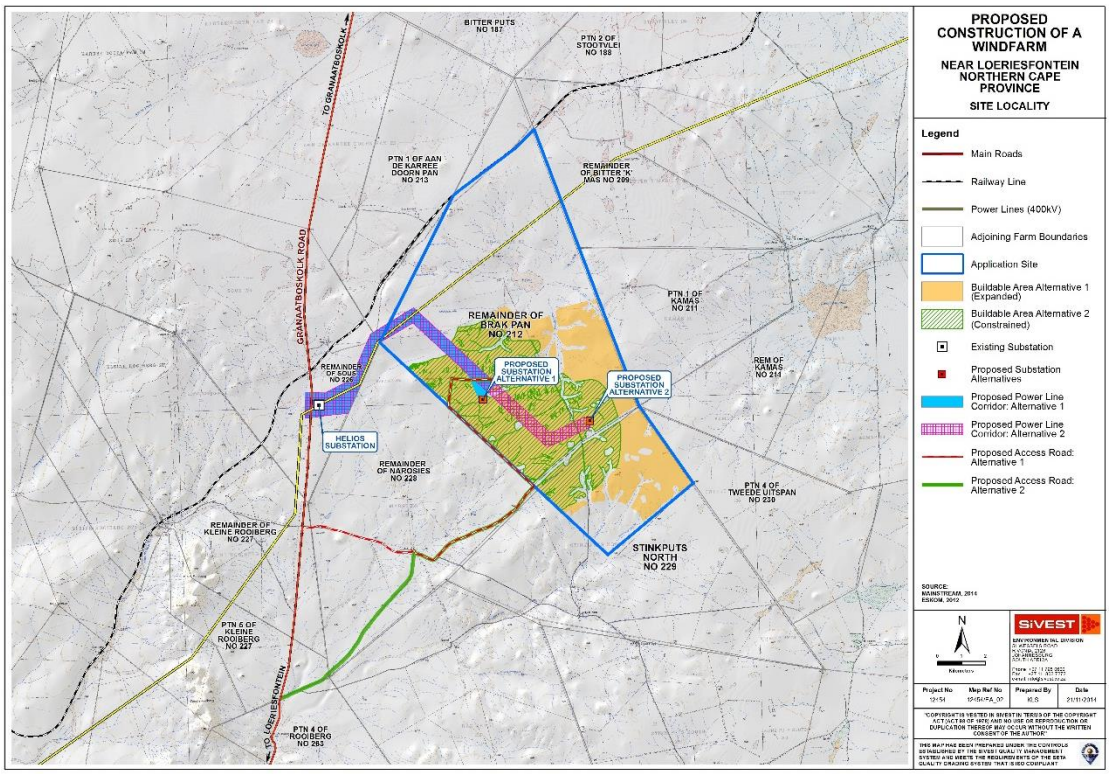


Figure 6: Site locality map showing grid access, access road and substation site alternatives

2.2.1 No-go Alternative

The 'no-go' alternative is the option of not establishing the proposed wind farm facility. South Africa is currently under immense pressure to generate electricity to accommodate for the additional demand which has been identified. With the current global focus on climate change, the government is exploring alternative energy sources in addition to coal fired power stations. Although wind power is not the only solution to solving the energy crisis in South Africa, not establishing the proposed wind farm facility would be detrimental to the mandate that the government has set to promote the implementation of renewable power. It is a suitable sustainable solution to the energy crisis and this project would contribute to this solution. This project will aid in achieving South Africa's goals in terms of sustainability, energy security, mitigating energy cost risks, local economic development and national job creation.

In light of the above, the no-go alternative has also been evaluated in Chapter 6below.

3 ASSESSMENT METHODOLOGY

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

3.1 Methodology for Assessing Heritage Site significance

This Heritage Impact Assessment (HIA) report was compiled by PGS Heritage (PGS) for the proposed Dwarsrug WEF. 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 – Completed in May 2014

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 through the proposed project area by a qualified archaeologist, which 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, 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 will be done during the EIA phase of the project.

4 BACKGROUND RESEARCH

The examination of heritage databases, historical data and cartographic resources represents a critical additional tool for locating and identifying heritage resources and in determining the historical and cultural context of the study area. Therefore an internet literature search was conducted and relevant archaeological and historical texts were also consulted. Relevant topographic maps and satellite imagery were studied.

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:

- MORRIS, DAVID. 2007. Archaeological Specialist input with respect to the upgrading railway infrastructure on the Sishen-Saldanha ore line in the vicinity of Loop 7a near Loeriesfontein. McGregor Museum.

- FOURIE, WOUTER. 2011. Heritage Impact Assessment for the proposed Solar Project on the farm Kaalspruit, Loeriesfontein. PGS Heritage and Grave Relocation Consultants.
- ALMOND, J.E. 2011. Palaeontological Desktop Study for the Proposed Mainstream Wind Farm Near Loeriesfontein, Namaqua District Municipality, Northern Cape Province.
- VAN SCHALKWYK, J. 2011. Heritage Impact Assessment for the proposed establishment of a wind farm and PV facility by Mainstream Renewable Power in the Loeriesfontein Region, Northern Cape Province.
- VAN DER WALT, JACO. 2012. Archaeological Impact Assessment for the proposed Hantam PV Solar Energy Facility on the farm Narosies 228, Loeriesfontein, Northern Cape Province.
- WEBLEY, L & HALKETT, D. 2012. Heritage Impact Assessment: Proposed Loeriesfontein Photo-Voltaic Solar Power Plant On Portion 5 of the Farm Klein Rooiberg 227, Northern Cape Province.
- MORRIS, DAVID. 2013. Specialist Input for the Environmental Basic Assessment And Environmental Management Program for the Khobab Wind Energy Facility: Power Line Route Options, Access Road And Substation Positions.
- ORTON, JAYSON. 2014. Heritage Impact Assessment for the proposed re-alignment of the authorized 132kV Power Line for the Loeriesfontein 2 WEF, Calvinia Magisterial District, Northern Cape.

4.1.1 Findings from the studies

Palaeontology

The following map (
Figure 7) is an extract from the palaeontological desktop study completed by Groenewald (2014) (**Appendix D**) for this project.

Groenewald (2014) notes "*study area is underlain by shales of the Permian aged Tierberg Formation, as well as two very small outcrops of Permian aged shales of the Whitehill Formation, Ecca Group of the Karoo Supergroup. Large areas are covered in dolerite scree whilst small areas are covered in Quaternary aged alluvium and pan sediments".*

The two formations of palaeontological significance are the Tierberg and Whitehill formations, with the following possible finds:

Table 2: Paleontology of geological formations

Formation	Finds
Tierberg	Fossils are mainly associated with event beds, with the commonest fossils being sparse to locally concentrated assemblages of trace fossils. Body fossils are very rarely recorded.

Whitehill	the main groups of Early Permian fossils found within the Whitehill Formation include: • aquatic mesosaurid reptiles (the earliest known sea-going reptiles) • rare cephalochordates (ancient relatives of the living lancets) • a variety of palaeoniscoid fish (primitive bony fish) • highly abundant small eocarid crustaceans (bottom-living shrimp-like forms) • insects (mainly preserved as isolated wings, but some intact specimens also found) • a low diversity of trace fossils (e.g. king crab trackways, possible shark coprolites / faeces) • palynomorphs (organic-walled spores and pollens) • petrified wood (mainly of primitive gymnosperms, silicified or calcified) • other sparse vascular plant remains (Glossopteris leaves, lycopods etc)".

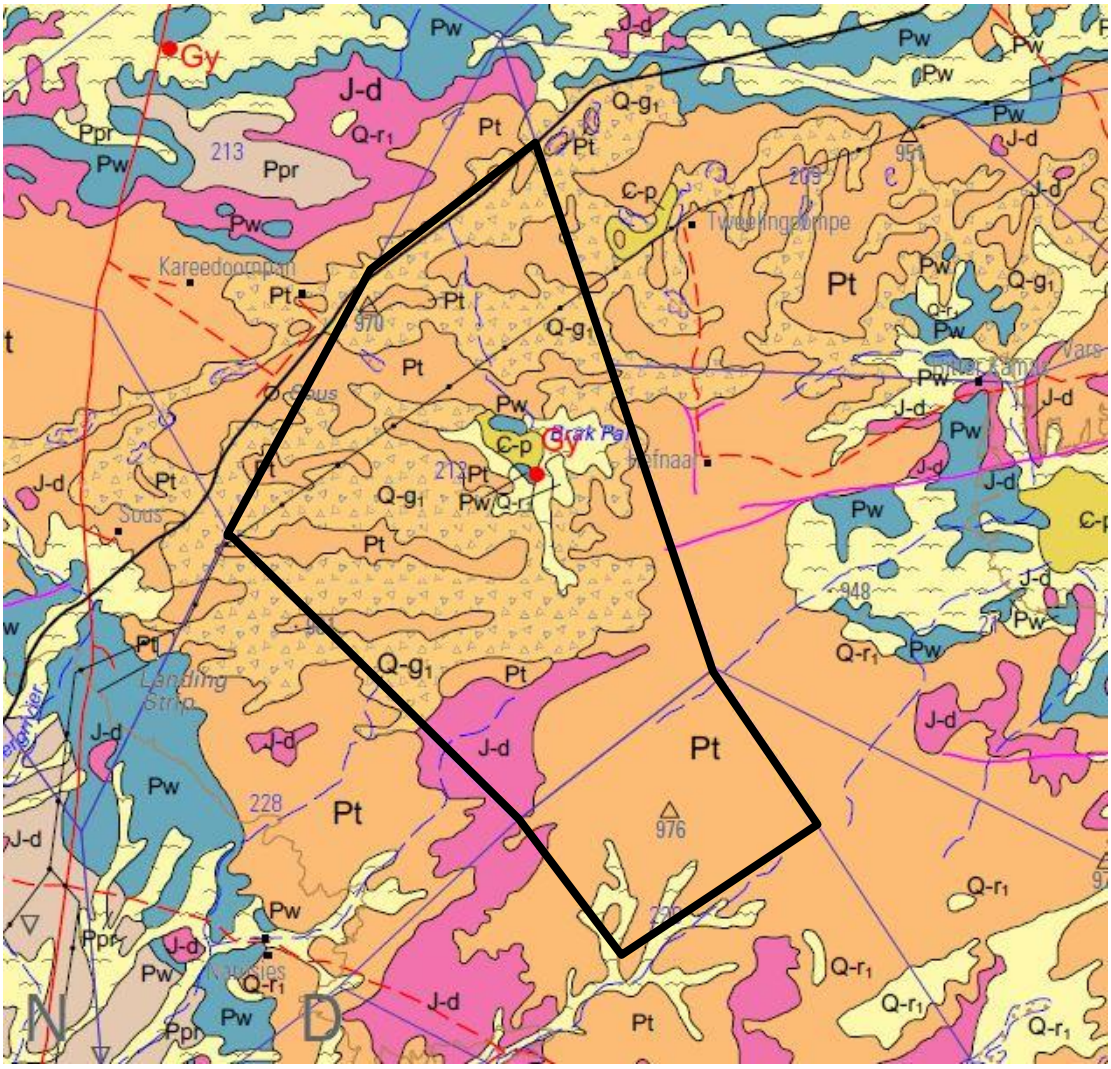


Figure 7 : Geology of the study area. Pt - Tierberg Formation, Pw - Whitehill Formation, Jd – Dolerite, Q-g1 - Dolerite scree, C-p - Pan sediments and Alluvium (yellow)

Archaeology

Although a study conducted by Morris (2007) have indicated minimal finds of archaeological sites in the vicinity of the upgrade of Loop 7A of the Sishen-Saldanha ore line to the north of the study area, discussions with local farmers have indicated the occurrence of some archaeological sites.

Morris (2010) notes that previous studies have indicated that substantial MSA scatters is fairly uncommon in the Bushmanland/Namaqualand areas. While herder sites where more limited to sheltered and dune areas close to water sources such as pans and rivers.

The HIA's (Fourie, 2011; Van Schalkwyk, 2011; Webley & Halkett, 2012 and Orton, 2014) and the AIA's (Morris, 2007; Van der Walt, 2012 and Morris, 2013), have added to the body of work conducted in the area since the observations of Beaumont et al. (1995), that "thousands of square kilometres of Bushmanland area covered by a low density lithic scatter".

Orton (2014) notes that previous studies in the vicinity of the current study area, have found and assessed archaeological material dating to the early (ESA), Middel (MSA) and Later (LSA) Stone Ages.

4.1.2 Historical structures and history

Four areas of possible historical settlements have been identified in the study area during the Scoping phase and were assessed during the field work component of the HIA.

4.1.3 Possible finds identified during the Scoping Phase

Evaluation of aerial photography has indicated the following area that may be sensitive from an archaeological perspective (**Figure 8**). The analysis of the studies conducted in the area assisted in the development of the following landform type to heritage find matrix in **Table 3**.

Table 3: Landform to heritage matrix

LAND FROM TYPE	HERITAGE TYPE
Crest and foot hill	LSA and MSA scatters (Orton, 2014 & Van Schakwyk, 2011)
Crest of small hills	Small LSA sites – scatters of stone artefacts, ostrich eggshell, pottery and beads
Pans	Dense LSA sites (Morris, 2013)
Dunes	Dense LSA sites
Dolerite outcrops	Engravings (Orton, 2014)
Dolerite outcrops	Occupation sites dating to LSA (Orton, 2014)
Farmsteads	Historical archaeological material

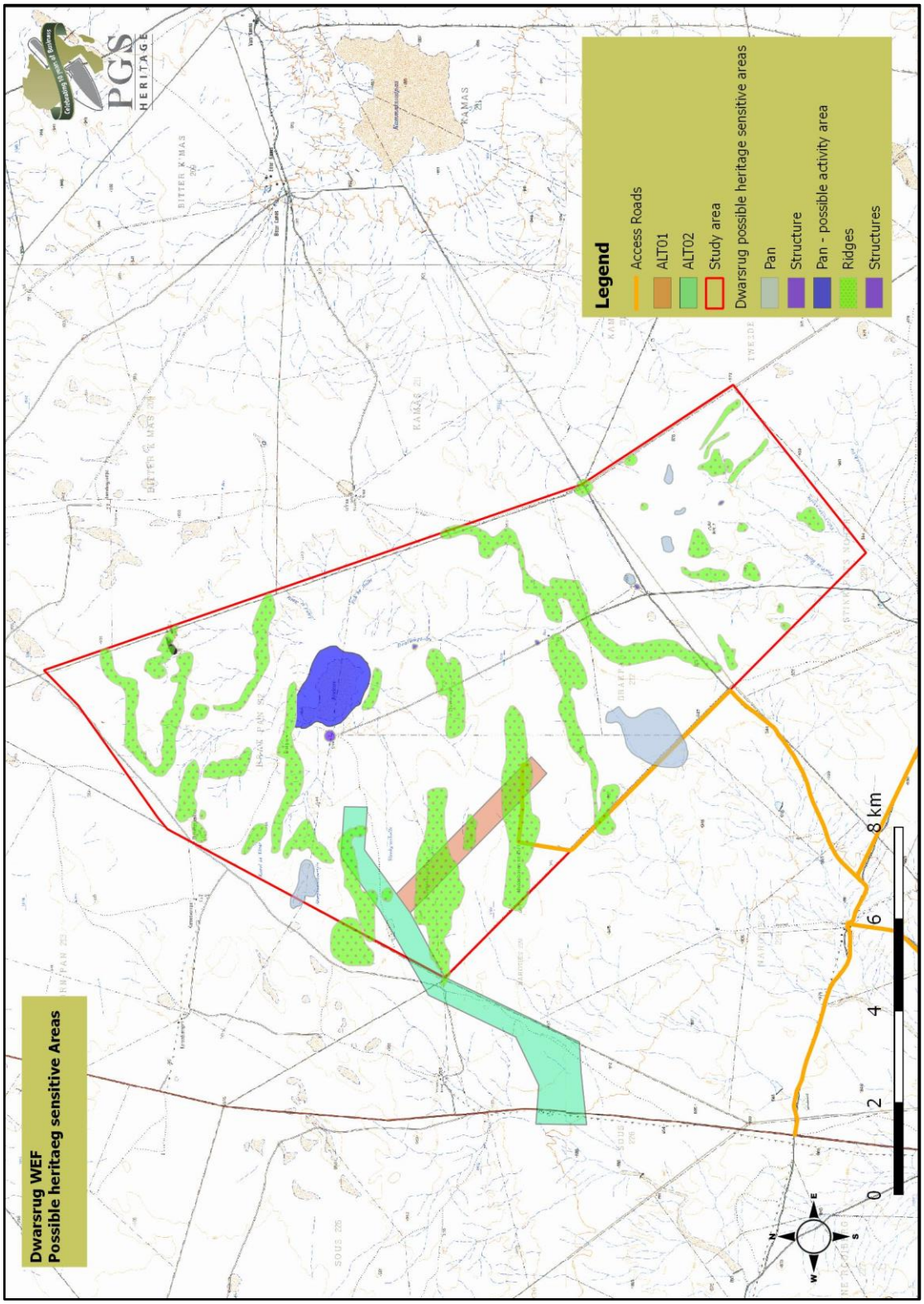


Figure 8 – Possible heritage sensitive areas

5 FIELD WORK FINDINGS

5.1 Methodology

A selective survey of the study area was conducted from 15 to 18 September 2014. Due to the nature of cultural remains, with the majority of artefacts occurring below surface, a vehicle and foot-survey that covered the study area was conducted by an archaeologist and field assistant of PGS. The fieldwork was logged with a GPS to provide a background of the areas covered (**Figure 9**).

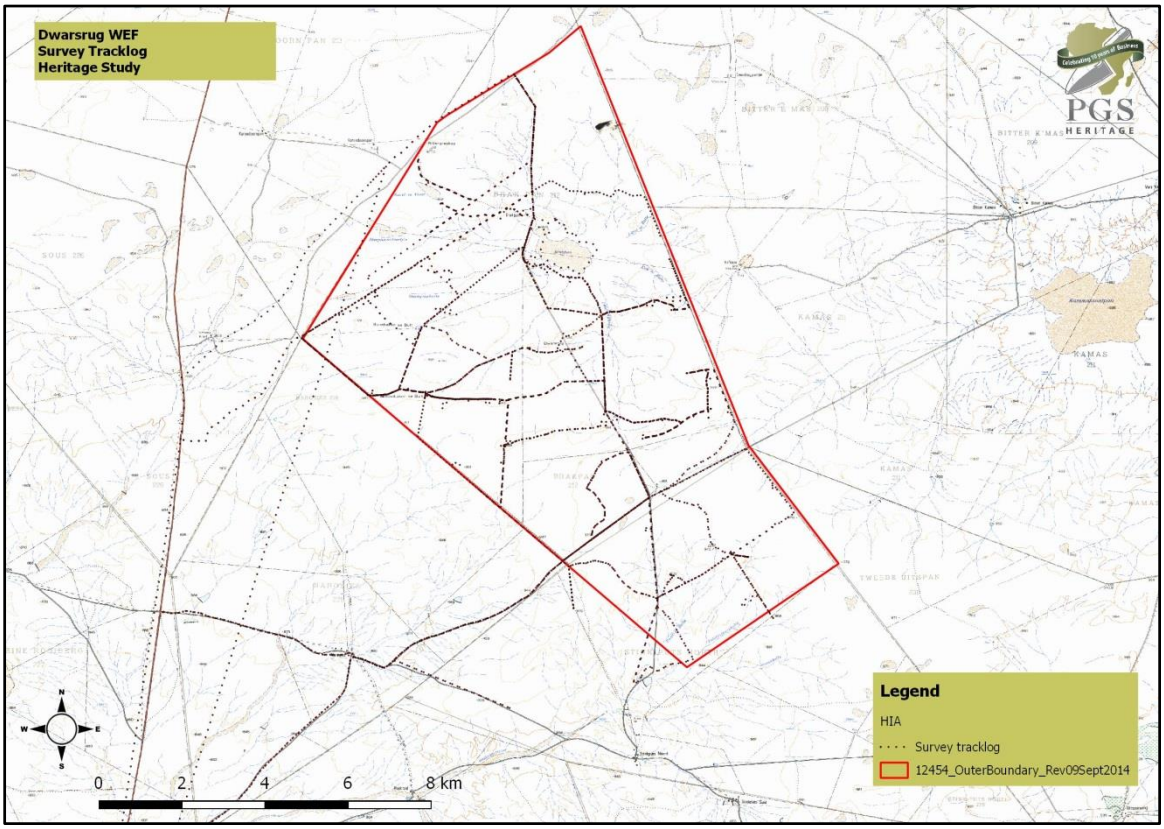


Figure 9: Tracklog generated during field work

The study area is characterised by low rises (**Figure 10**) over large parts of the study area, while the northern section of the study area is dominated by a large salt pan (**Figure 11**) and a range of ridges rising towards the north

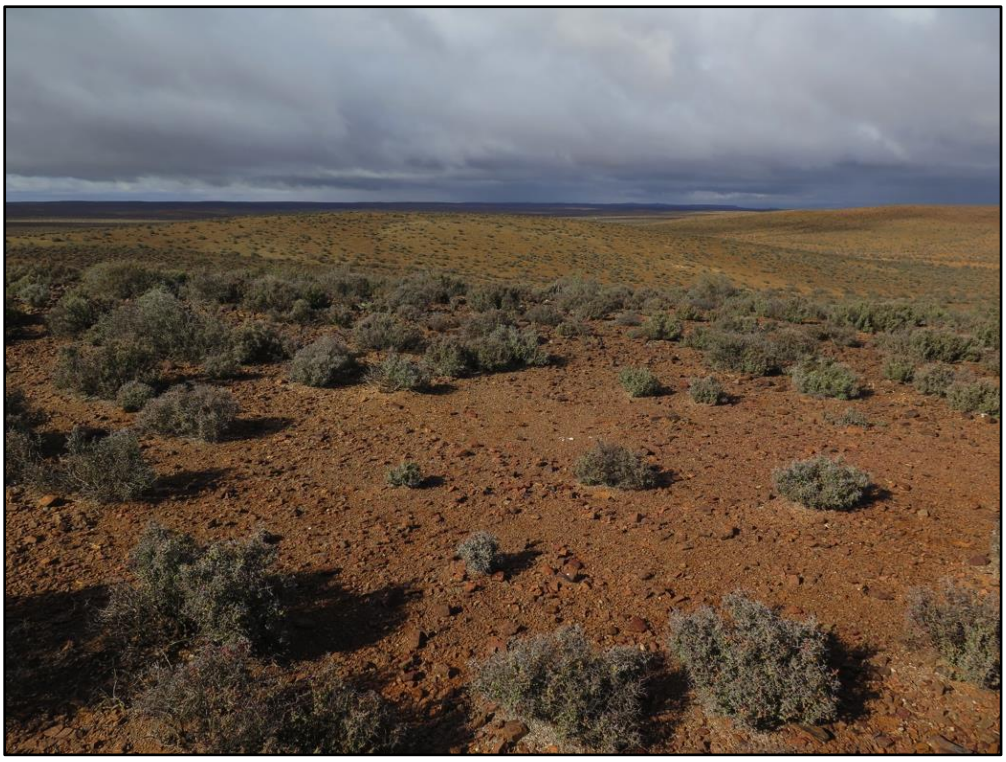


Figure 10: Row of low rises and ridges characterizing the property

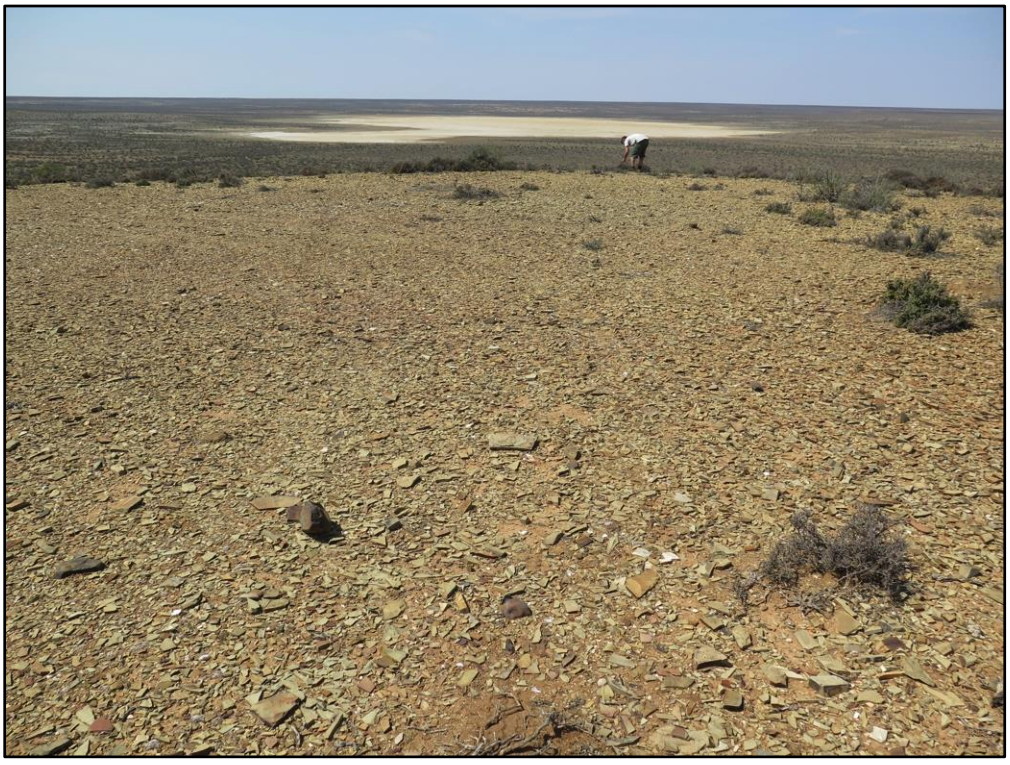


Figure 11: View from northern ridges towards the salt pan in the distance

The field work identified 31 heritage finds that were then classified either as find spots [1] or site[2]. This information was then provided to the developer to take into account during the development of the layout alternatives. The following sections list and describe the finds and sites.

5.2 Find spots

The find spots (**Table 4**) identified during the field work was found to correlate with ridges and drainage lines as predicted in the Scoping Phase of this study. This observation also correlates with the findings of the studies done by Webley (2012) and Orton (2014). The finds spots mostly consist of single or low density finds of Middel Stone Age (MSA) or Later Stone Age (LSA) lithics. These find spot were dominates by MSA cores and LSA blades, side scrapers and in some cases chunks of raw material with some flaking marks. The material was predominantly crypto-crystalline silica (CCS) with a very low concentration of hornfels material utilized.

A low incidence of patination and weathering was observed on lithics from these finds spots.

Table 4: Find spots

Site Number	Lat	Lon	Description	Sensitivity	Heritage Rating
DR07	-30.4559	19.6453	Single MSA core	Low	4C
DR08	-30.4790	19.6444	Single LSA scraper with O/E	Low	4C
DR09	-30.4922	19.6373	Single LSA scraper	Low	4C
DR10	-30.4928	19.6227	Single MSA point	Low	4C
DR14	-30.4679	19.6049	Single LSA blade (utilised)	Low	4C
DR15	-30.4674	19.6036	Single retouched & utilised LSA blade	Low	4C
DR16	-30.4599	19.6207	Single LSA core	Low	4C
DR17	-30.4595	19.6232	Single LSA flake next to a large chunk of unused raw material	Low	4C
DR19	-30.4890	19.5783	Single LSA scraper	Low	4C
DR20	-30.5356	19.6796	LSA flake and core & some O/E	Low	4C
DR25	-30.5185	19.6877	Single broken MSA flake. Heavily patinated.	Low	4C

[1] Can be classified as an area where only a single artefact or low density of artefacts occurs. The absence of associated material or artefacts that indicate a temporal shallow or ephemeral occupation

[2] The association of numerous artefacts or structures and /or cultural deposits that all combine to indicate a temporal depth and information to a site.

DR26	-30.5008	19.6489	2 LSA flakes	Low	4C
DR27	-30.5027	19.6397	Single LSA scraper	Low	4C
DR28	-30.5121	19.6731	Single LSA scraper	Low	4C
DR29	-30.4706	19.5922	2 artefacts - one (possibly MSA) core and a LSA flake	Low	4C
DR30	-30.4628	19.6244	Single LSA core	Low	4C
DR31	-30.5379	19.7045	Small number of LSA waste flakes and raw material	Low	4C

5.3 Sites

5.3.1 Archaeological

The archaeological sites

Table 5) identified were all associated with the LSA and situated predominantly situated on ridges or low rises. A large proportion so the sites consist of unweathered LSA material manufactured from CCS and associated with ostrich eggshell fragments. The largest of these sites, **DR04**, covers an area of 900m^2.

Site **DR18**, situated on the edge of a small hill, exhibited a large array of material including several bladelets, flakes and coresas well as a small cobble/pebble used as a hammerstone. All the material present on site was manufactured from CCS. The site also exhibited a scatter of broken ostrich eggshell over most its extent.

The single most exciting find of the field work was the cache of buried ostrich eggshell flasks found *in situ* (**DR24**). One is broken and 2 still intact. Mr. Hussleman, (of the farm Kaalfontein to the south of Dwarsrug) related a story on how one of his herders found a cache of ostrich eggs washing out in a donga. This type of ostrich egg cache is indicative of the finds made through out of the Northern Cape found at places like Thomas' Farm, Saratoga, Spuigslangfontein, Vaalbos (Henderson, 2002; Morris, 2002).

Due to its research value sites and **DR04**, **DR05**, **DR18**, **DR22** and **DR24** are given a Medium archaeological significance.

Table 5: Archaeological Sites

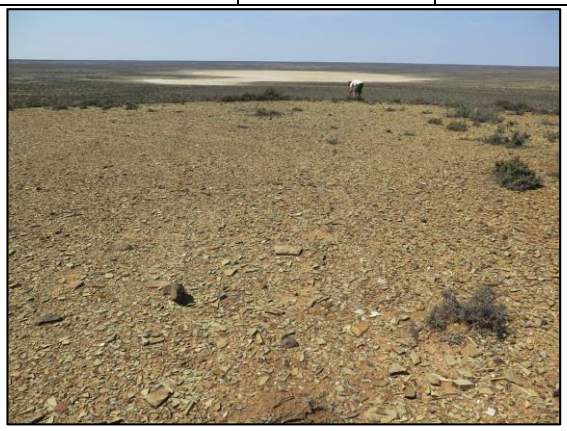
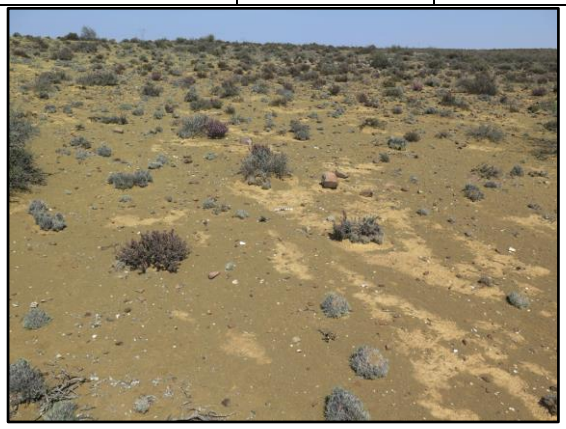
Site Number	Lat	Lon	Type Find	Description	Significance	Heritage Rating
DR04	-30.4465	19.6371	Site	LSA site on hilltop overlooking pan. Some O/E, no beads. Lots of waste material.	Medium	3B
 **Figure 12: Stone LSA artifacts and associated ostrich eggshell from DR04**				 **Figure 13: View of DR04 looking east towards the pan**		
DR05	-30.4472	19.6212	Site	LSA site with O/E. Waste material, no retouced artifacts	Medium	3C
 **Figure 14: Stone artifacts and ostrich eggshell from DR05**				 **Figure 15: View of DR05. The small white stones are artifacts and ostrich eggshell**		
DR06	-30.4476	19.6212	Site	Two stone mounds of unknow origin. Not significant	Low	4C
DR11	-30.4896	19.6051	Site	Several LSA flakes & cores. Small knapping site	Low	4B

Figure 16: Small LSA artefacts from DR11

Figure 17: View of DR11

DR12	-30.4894	19.6059	Site	Small number of LSA flakes. Very small knapping site	Low	4C

Figure 18: LSA flake from DR12

Figure 19: View of DR12. As usual the white stones in the photograph are LSA artefacts

DR13	-30.4912	19.6453	Site	4 LSA artefacts (2 cores & 2 flakes)	Low	4C

Figure 20 - LSA cores and flakes from DR13

Figure 21 - View of DR13

DR18	-30.5016	19.6730	Site	LSA knapping site with O/E and microliths	Medium	3C

Figure 22: LSA artefacts from DR18

Figure 23: View of DR18

DR21	-30.5376	19.6792	Site	Small LSA site. Some waste material & one scraper and a utilised backed flake	Low	4A

Figure 24: LSA artefacts and associated ostrich eggshell from DR21

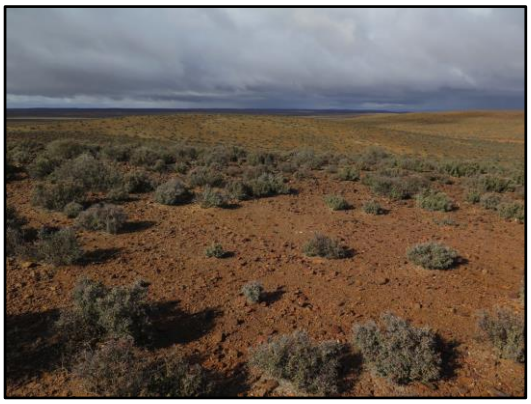


Figure 25: View of DR21 looking north

DR22	-30.5405	19.6732	Site	LSA knapping site with O/E	Medium	3C

Figure 26 - LSA flakes and core from DR22

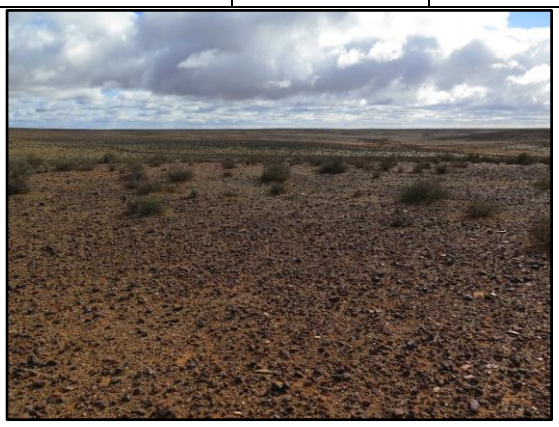


Figure 27 - View of DR22 looking west

DR24	-30.5383	19.6821	Site	3 buried ostrich eggshells with holes	Medium	3B

				(used for water). 1 broken and 2 whole.		

Figure 28: The tops of three ostrich eggshell flask are just visible above the surface. At this stage it was unclear if they were in fact flasks since no holes were visible

Figure 29: View of the two intact flasks. The man-made holes can clearly be seen in this picture

5.3.2 Historical

Four heritage sites (**Table 6**) of historical significance were identified during the field work. Three of the sites (**DR01**, **DR02** and **DR03**) date to the later part of the 19th and early 20th Century. The historic homestead (**DR01**) probably older than 100 years built from locally sourced rock. According to Mr. Alber Nel, the contact person for the Nel family, the house (**DR01**) was built in the late 1800's/early 1900's by his great-grandfather. After the house was abandoned in favour of the current homestead (on an adjacent property) it was inhabited by farm labourers, some of which were buried just to the south of the house in a small informal cemetery (**DR03**).

Further structures associated with **DR01** are the stone and cement build dam (**DR02**) as well as two hand dug wells (colloquially known as 'puts').

Further to southern end of the study area a granite monument for A.J. Nel (Lange) 10.07.1987 was erected.. The purpose of this monument is unknown but it is highly unlikely to be a grave. It might mark the spot where this person died (he was one of the previous owners of the property).

The farmstead ruin and associated cemetery provides an insight into the European settlement history on the farm and a heritage significance rating of medium to high is given to these sites.

Table 6: Historical Sites

Site Number	Lat	Lon	Type Find	Description	Significance	Heritage Rating
DR01	-30.4468	19.6512	Site	Historic house older than 100 years	Medium	3B
 **Figure 30: View of the house from the north**				 **Figure 31: Outside cooking area situated on the northern side of the house**		
DR02	-30.4479	19.6524	Site	Historic dam and two 'puts' (wells)	Medium	3B
 **Figure 32: Dam built from rocks and lined with cement.**				 **Figure 33: One of the two wells at the site**		
DR03	-30.4494	19.6501	Site	3 Historic graves, two with headstones. 'Willie Beukes d 1949'	High	3A
 **Figure 34: Small informal cemetery containing three graves, two of which are unmarked. The pan can be seen in the background**				 **Figure 35: Headstone of late Willie Beukes**		

DR23	-30.5444	19.6763	Site	Granite monument for AJ Nel (Lange) 10.07.1987.	High	3A

Figure 36: Granite monument in the memory of AJ Nel (one of the previous owners of the farm)

6 IMPACT ASSESSMENT

The impact rating and analysis was done based on the methodology as explained and summarised in **Appendix C** of this report. The design process and methodology followed by the developer for this project enabled the heritage assessment to provide input into the proposed layouts before the impact assessment. This resulted in cognisance being taken of the positions of the heritage sites and thus the reduction of impacts at an early design phase. Analysis of the impact matrix tables will reflect this. It must be noted that the only heritage aspect not utilised during the design stages are the palaeontology (Table 7), this purely due to the extent of the palaeontological sensitive formations covering nearly 90% of the proposed study area. However the opportunity to implement a palaeontological management plan pre- and during construction provides the means of mitigating any envisaged impacts.

6.1 Impact matrix

Table 7: Impact rating - Palaeontology

IMPACT TABLE		
Environmental Parameter	*Palaeontological sensitive rock formations*	
Issue/Impact/Environmental Effect/Nature	*The Permian aged Tierberg Formation underlies significant sections of the study area and monitoring of the fossil heritage must be planned for these areas. The significantly fossil-rich Whitehill Formation underlies two restricted areas and if development falls within these areas (coloured red in* **Figure 7***), the areas must be considered as highly sensitive for palaeontological heritage. Areas overlain by dolerite scree is allocated a low palaeontological sensitivity and if fossils area recorded in shales underlying the scree, these need to recorded.* *Due to the igneous nature of dolerite, no fossils will be found and areas underlain by dolerite have been allocated a Very Low palaeontological sensitivity.* *Areas underlain by pan and alluvium deposits are allocated a moderate palaeontological sensitivity and if fossils are recorded a qualified palaeontologist must be appointed to collect and record these finds.*	
Extent	*Localised to deep excavations into bedrock*	
Probability	*High probability of encountering fossils exist*	
Reversibility	*Fossils are none renewable.*	
Irreplaceable loss of resources	*A brief description of the degree in which irreplaceable resources are likely to be lost*	
Duration	*The loss of the fossil record will be permanent*	
Cumulative effect	*Medium cumulative impact over the site*	
Intensity/magnitude	*Magnitude of the impact pre-mitigation is rated as high, however the implementation of the recommended mitigation measures changes this to a Low magnitude of impact.*	
Significance Rating	*High negative before mitigation and low negative after mitigation for both the expanded and the constrained layout.*	
	EXPANDED LAYOUT	**CONSTRAINED LAYOUT**
	Pre-mitigation impact rating	
Extent	1	1
Probability	3	3
Reversibility	4	4
Irreplaceable loss	2	2

Duration	4	4
Cumulative effect	3	3
Intensity/magnitude	3	3
Significance rating	-51 (high negative)	-51 (medium negative)
	Post mitigation impact rating	
Extent	1	1
Probability	3	3
Reversibility	4	4
Irreplaceable loss	2	2
Duration	4	4
Cumulative effect	1	1
Intensity/magnitude	1	1
Significance rating	-15 (low negative)	-15 (low negative)
Mitigation measures	*1. The EAP as well as the ECO for this project must be made aware of the fact that the Ecca Group sediments contains significant fossil remains, albeit mostly trace fossil assemblages. Several types of fossils have been recorded from this Group in the Karoo Basin of South Africa, with special mention of the very important Whitehill Formation. The Whitehill Formation outcrops are however very restricted in this study area.* *2. In areas that are allocated a Very High and High Palaeontological sensitivity and specifically where deep excavation into bedrock is envisaged (following the geotechnical investigation), or where fossils are recorded during the geotechnical investigations, a qualified palaeontologist must be appointed to assess and record fossils at specific footprints of infrastructure developments (Phase 1 PIA).* *3. If significant fossil finds (e.g. vertebrate teeth, bones, burrows, petrified wood) are recorded during excavations for infrastructure such as road developments, the palaeontologist must apply for a collection permit to collect the fossils according the SAHRA specifications.*	

Table 8: Impact rating – Archaeological Sites

IMPACT TABLE	
Environmental Parameter	*Stone age find spots and Sites*
Issue/Impact/Environmental Effect/Nature	*Two types of archaeological finds have been identified during the field work. Find spots that were rated as having low archaeological significance and archaeological sites rated as having medium archaeological significance.*

	All the identified find spots could be impacted by construction activities however the impact is seen as negligible. None of the archaeological site will be impacted directly by any of the proposed layouts and thus a low impact rating is given with the implementation of a few precautionary mitigation measures.
Extent	*Localised*
Probability	*Low*
Reversibility	*Non- renewable.*
Irreplaceable loss of resources	*Archaeological sites are irreplaceable*
Duration	*Permanent*
Cumulative effect	*Low*
Intensity/magnitude	*Low*
Significance Rating	*Low negative before mitigation and low negative after mitigation for both the expanded and the constrained layout.*

	EXPANDED LAYOUT	**CONSTRAINED LAYOUT**
	Pre-mitigation impact rating	
Extent	1	1
Probability	1	1
Reversibility	4	4
Irreplaceable loss	4	4
Duration	4	4
Cumulative effect	1	1
Intensity/magnitude	1	1
Significance rating	-15 (low negative)	-15 (low negative)
	Post mitigation impact rating	
Extent	1	1
Probability	1	1
Reversibility	4	4
Irreplaceable loss	4	4
Duration	4	4
Cumulative effect	1	1
Intensity/magnitude	1	1
Significance rating	-15 (low negative)	-15 (low negative)
Mitigation measures	*1. Demarcate sites as no-go areas* *2. Demarcate and fence during construction if construction activities area to happened within 100 meters from a site.* *3. Monitor find spot areas if construction is going to take place through them.*	

	4. *A management plan for the heritage resources needs then to be compiled and approved for implementation during construction and operations.*

Table 9: Impact rating – Historical/Recent history

IMPACT TABLE		
Environmental Parameter	*Historical structures*	
Issue/Impact/Environmental Effect/Nature	*The historical sites and cemeteries are localised in the north eastern part of the study area away for the proposed development. While the memorial is situated close to an access road on the property.*	
Extent	*Localised*	
Probability	*Low*	
Reversibility	*Non- renewable.*	
Irreplaceable loss of resources	*Archaeological sites are irreplaceable*	
Duration	*Permanent*	
Cumulative effect	*Low*	
Intensity/magnitude	*Low*	
Significance Rating	*Low negative before mitigation and low negative after mitigation for both the expanded and the constrained layout.*	
	EXPANDED LAYOUT	**CONSTRAINED LAYOUT**
	Pre-mitigation impact rating	
Extent	1	1
Probability	1	1
Reversibility	4	4
Irreplaceable loss	4	4
Duration	4	4
Cumulative effect	1	1
Intensity/magnitude	1	1
Significance rating	-15 (low negative)	-15 (low negative)
	Post mitigation impact rating	
Extent	1	1
Probability	1	1
Reversibility	4	4
Irreplaceable loss	4	4
Duration	4	4
Cumulative effect	1	1

Intensity/magnitude	1	1
Significance rating	-15 (low negative)	-15 (low negative)
Mitigation measures	1. *Demarcate sites as no-go areas* 2. *Demarcate and fence during construction if construction activities area to happened within 100 meters from a site.* 3. *Monitor find spot areas if construction is going to take place through them.* 4. *A management plan for the heritage resources needs then to be compiled and approved for implementation during construction and operations.*	

Table 10: Impact rating – chance finds

IMPACT TABLE		
Environmental Parameter	*Unidentified heritage structures*	
Issue/Impact/Environmental Effect/Nature	*Due to the size of the area assessed and the design process requiring field work before identification of the layout. The possibility of encountering heritage features in unsurveyed areas does exist.*	
Extent	*Localised and in most cases no more than 1000m^2*	
Probability	*Possible*	
Reversibility	*Heritage resources are non-renewable.*	
Irreplaceable loss of resources	*A brief description of the degree in which irreplaceable resources are likely to be lost*	
Duration	*Permanent*	
Cumulative effect	*Medium*	
Intensity/magnitude	*Low*	
Significance Rating	*Medium negative before mitigation and low negative after mitigation for both the expanded and the constrained layout.*	
	EXPANDED LAYOUT	**CONSTRAINED LAYOUT**
	Pre-mitigation impact rating	
Extent	1	1
Probability	2	2
Reversibility	4	4
Irreplaceable loss	2	2
Duration	4	4
Cumulative effect	3	3
Intensity/magnitude	2	2
Significance rating	-32 (medium negative)	-32(medium negative)

	Post mitigation impact rating	
Extent	1	1
Probability	2	2
Reversibility	4	4
Irreplaceable loss	2	2
Duration	4	4
Cumulative effect	4	4
Intensity/magnitude	1	1
Significance rating	-17 (low negative)	-17 (low negative)
Mitigation measures	1. *A walk down of the final approved layout will be required before construction commence;* 2. *Any heritage features of significance identified during this walk down will require formal mitigation or where possible a slight change in design could accommodate such resources.* 3. *A management plan for the heritage resources needs then to be compiled and approved for implementation during construction and operations.*	

6.2 Confidence in Impact Assessment

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 area. Various factors account for this, including the subterranean nature of some heritage sites.

The impact assessment conducted for heritage sites assumes the possibility of finding heritage resources during the project life and has been conducted as such.

6.3 Cumulative Impacts

The only cumulative impact that is foreseen is on the cultural landscape with the implementation of an additional wind energy facility along with the other three WEF and 3 Solar project in the region. However the area is not seen as a major tourism zone and the low population density accounts for an overall low cumulative impact rating.

6.4 Reversibility of Impacts

Although heritage resources are seen as non-renewable the mitigation of impacts on possible finds through scientific documentation will provided sufficient mitigation on the impacts on possible heritage resources.

6.5 Comparative Assessment of Alternatives

The comparative assessment of the alternatives have shown that an overall low impact on heritage is foreseen, as all of the heritage sites identified fall outside the proposed alternative foot prints.

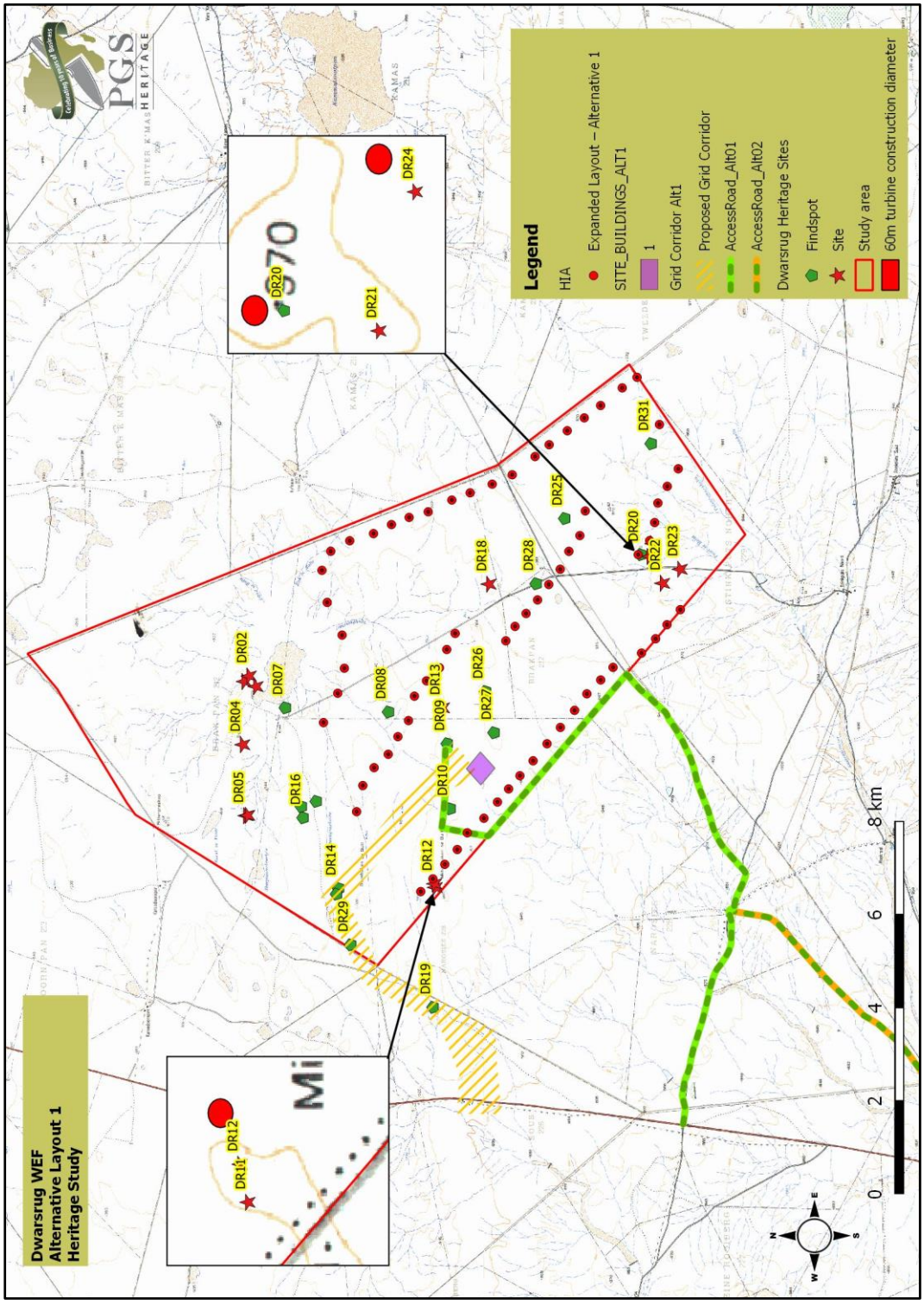


Figure 37: Alternative layout 1 with heritage resources indicated

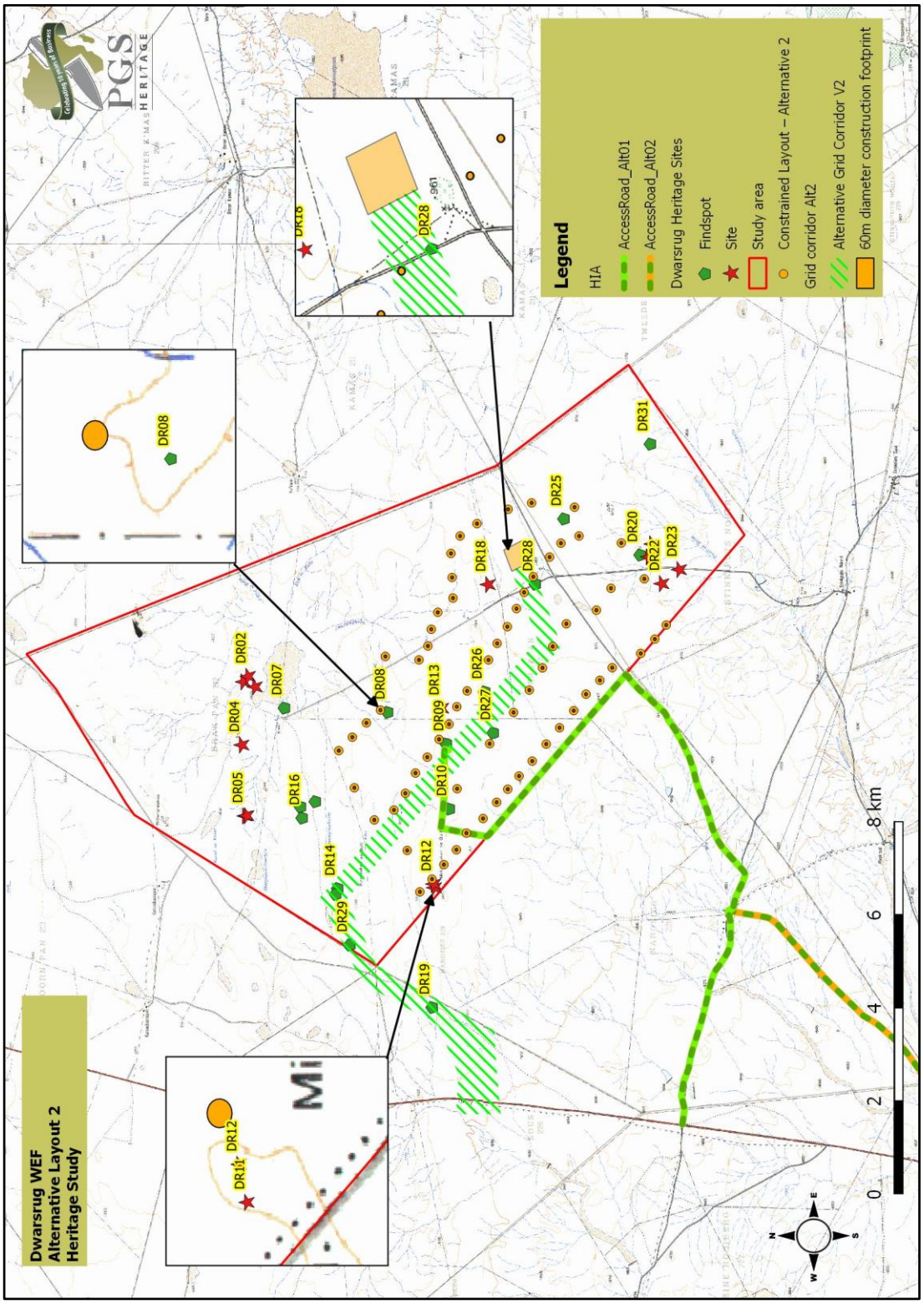


Figure 38: Alternative layout 2 with heritage resources indicated

6.5.1 Wind Turbine Layouts

Allowing for a 60m diameter construction foot print for on all turbine positions has shown that al the find spots and sites fall outside and in most case more than 100 meters way from any construction activities.

6.5.2 Access roads

None of the proposed access roads will have any impact on known heritage resources.

6.5.3 Gridline corridors

The two grid line alternatives intersect 4 of the same find spots (rated as having low heritage significance). Gridline Alternative 2 intersects an additional heritage find spot (rated as having low heritage significance). This additional impact is negligible.

6.5.4 Associated Infrastructure

No heritage resources will be impacted by any of the infrastructure alternatives.

Key

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

Alternative	Preference	Reasons
WIND FARM TURBINE LAYOUT		
Expanded Layout – Alternative 1	No preference	The alternative will result in equal impacts
Constrained Layout – Alternative 2	No preference	The alternative will result in equal impacts
ACCESS ROAD		
Access Road Alternative 1	No preference	The alternative will result in equal impacts
Access Road Alternative 2	No preference	The alternative will result in equal impacts
GRID LINE		
Grid Line Alternative 1 (orange kml)	No preference	The alternative will result in equal impacts
Grid Line Alternative 2 (green kml)	No preference	The alternative will result in equal impacts
ASSOCIATED INFRASTRUCTURE		

Alternative	Preference	Reasons
Associated Infrastructure Alternative 1 (purple kml)	No preference	The alternative will result in equal impacts
Associated Infrastructure Alternative 2 (orange kml)	No preference	The alternative will result in equal impacts

7 CONCLUSIONS AND RECOMMENDATIONS

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

The Heritage Scoping Report completed in May 2014 has shown that the proposed Dwarsrug site to be developed as a Wind Energy Facility (WEF) may have heritage resources present on the property. This has been confirmed through archival research and evaluation of aerial photography of the sites.

The subsequent field work completed for the HIA component in September 2014, has confirmed the presence of 17 archaeological find spots, 4 historical sites and 7 archaeological sites. The archaeological sites are associated with the Middel (MSA) and Later Stone Age (LSA) and are representative of archaeological sites with a medium significance. The historical sites and cemeteries were rated as having a medium to high local heritage significance.

The design process and methodology followed by the developer for this project enabled the heritage assessment to provide input into the proposed layouts before the impact assessment. This resulted in cognisance being taken of the positions of the heritage sites and thus the reduction of impacts at an early design phase. Analysis of the impact matrix tables will reflect this. It must be noted that the only heritage aspect not utilised during the design stages are the palaeontology (Table 7), this purely due to the extent of the palaeontological sensitive formations covering nearly 90% of the proposed study area. However the opportunity to implement a palaeontological management plan pre-and during construction provides the means of mitigating any envisaged impacts.

The mitigation measures proposed is a follows:

7.1 Pre-Construction

1. *A walk down of the final approved layout will be required before construction commences;*
2. *Any heritage features of significance identified during this walk down will require formal mitigation or where possible a slight change in design could accommodate such resources;*

3. *A management plan for the heritage resources needs then to be compiled and approved for implementation during construction and operations.*

7.2 Palaeontology

1. *The EAP as well as the ECO for this project must be made aware of the fact that the Ecca Group sediments contains significant fossil remains, albeit mostly trace fossil assemblages. Several types of fossils have been recorded from this Group in the Karoo Basin of South Africa, with special mention of the very important Whitehill Formation. The Whitehill Formation outcrops are however very restricted in this study area.*
2. *In areas that are allocated a Very High and High Palaeontological sensitivity and specifically where deep excavation into bedrock is envisaged (following the geotechnical investigation), or where fossils are recorded during the geotechnical investigations, a qualified palaeontologist must be appointed to assess and record fossils at specific footprints of infrastructure developments (Phase 1 PIA).*
3. *If significant fossil finds (e.g. vertebrate teeth, bones, burrows, petrified wood) are recorded during excavations for infrastructure such as road developments, the palaeontologist must apply for a collection permit to collect the fossils according the SAHRA specifications.*

7.3 Archaeological Sites

1. *Demarcate sites as no-go areas*
2. *Demarcate and fence during construction if construction activities area to happened within 100 meters from a site.*
3. *Monitor find spot areas if construction is going to take place through them.*
4. *A management plan for the heritage resources needs then to be compiled and approved for implementation during construction and operations.*

7.4 Historical sites

1. *Demarcate sites as no-go areas*
2. *Demarcate and fence during construction if construction activities area to happened within 100 meters from a site.*
3. *A management plan for the heritage resources needs then to be compiled and approved for implementation during construction and operations.*

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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 Dwarsrug WEF 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 11: 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

1 ENVIRONMENTAL IMPACT ASSESSMENT METHODOLOGY

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.

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 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.

1.2 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.

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 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:

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.

Appendix D

Palaeontological Desktop Assessment

PALAEONTOLOGICAL DESKTOP ASSESSMENT FOR THE CONSTRUCTION OF THE DWARSRUG WIND ENERGY FARM ON THE FARMS BRAKPAN 212 AND STINKPUTS NORTH 229, NEAR LOERIESFONTEIN, NAMAQUA DISTRICT MUNICIPALITY, NORTHERN CAPE PROVINCE.

For:

HIA CONSULTANTS

DATE: 07 October 2014

By

Gideon Groenewald
082 339 9202

EXECUTIVE SUMMARY

Gideon Groenewald was appointed by PSG Heritage and Grave Relocation Consultants to undertake a desktop survey, assessing the potential palaeontological impact of the proposed construction of the Dwarsrug wind energy farm on the farms Brakpan 212 and Stinkputs north 229, near Loeriesfontein, Namaqua District Municipality, Northern Cape Province.

This report forms part of the Basic Environmental Impact Assessment and complies with the requirements of the South African National Heritage Resource Act No 25 of 1999. In accordance with Section 38 (Heritage Resources Management), a Heritage Impact Assessment (HIA) is required to assess any potential impacts to palaeontological heritage within the development footprint of the development.

The proposed project would comprise of the following:

- Approximately 35-95 wind turbines with a total generation capacity of approximately 140MW, utilising turbines with a range of 1.5 to 4MW generation capacity;
- Each turbine will have a hub height of between 80 to 140m and a rotor diameter of 80 to 140m;
- An approximate foundation footprint of 20 x 20m per turbine, approximately 4m deep;
- Hard standing areas of approx. 2 800m² for crane usage per turbine;
- Medium voltage cables up to 1m deep connecting all turbines to the substation;
- One new substation with transformers of up to 275kV, with high voltage (HV) yard footprints of approximately 90m x 120m;
- A 132kV power line with a length of up to 15km connecting the wind farm with the national distribution network at Helios substation;
- Internal access roads between 6m and 10m wide;
- Upgrading existing access roads;
- A maximum of 10 000m² temporary lay down area including an access road and contractor's site office area of up to 5 000m²;
- Administration and warehouse buildings with a footprint of 5 000m²;
- Fencing, linking stations and borrow pits if required.

The study area is underlain by shales of the Permian aged Tierberg Formation, as well as two very small outcrops of Permian aged shales of the Whitehill Formation, Ecca Group of the Karoo Supergroup. Large areas are covered in dolerite scree whilst small areas are covered in Quaternary aged alluvium and pan sediments.

The very high and high fossiliferous potential of the Ecca Group strata warrants an allocation of a Very High and High Palaeontological sensitivity to the areas underlain by the rocks of these formations. The pan sediments and alluvium is allocated a Moderate palaeontological sensitivity whereas areas underlain by dolerite scree and dolerite are allocated Low and Very Low Palaeontological sensitivities.

Recommendations:

1. The EAP as well as the ECO for this project must be made aware of the fact that the Ecca Group sediments contains significant fossil remains, albeit mostly trace fossil assemblages. Several types of fossils have been recorded from this Group in the Karoo Basin of South Africa, with special mention of the very important Whitehill Formation. The Whitehill Formation outcrops are however very restricted in this study area.
2. In areas that are allocated a Very High and High Palaeontological sensitivity and specifically where deep excavation into bedrock is envisaged (following the geotechnical investigation),

or where fossils are recorded during the geotechnical investigations, a qualified palaeontologist must be appointed to assess and record fossils at specific footprints of infrastructure developments (Phase 1 PIA).

3. If significant fossil finds (*e.g.* vertebrate teeth, bones, burrows, petrified wood) are recorded during excavations for infrastructure such as road developments, the palaeontologist must apply for a collection permit to collect the fossils according the SAHRA specifications.
4. These recommendations should form part of the EMP of the project

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1 INTRODUCTION

1.1 Background

Gideon Groenewald was appointed by PSG Heritage and Grave Relocation Consultants to undertake a desktop survey, assessing the potential palaeontological impact of the proposed construction of the Dwarsrug wind energy farm on the farms Brakpan 212 and Stinkputs north 229, near Loeriesfontein, Namaqua District Municipality, Northern Cape Province.

This report forms part of the Basic Environmental Impact Assessment and complies with the requirements of the South African National Heritage Resource Act No 25 of 1999. In accordance with Section 38 (Heritage Resources Management), a Heritage Impact Assessment (HIA) is required to assess any potential impacts to palaeontological heritage within the development footprint of the development.

Categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act, and which therefore fall under its protection, include:

- geological sites of scientific or cultural importance;
- objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens;
- objects with the potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage.

1.2 Aims and Methodology

Following the *"SAHRA APM Guidelines: Minimum Standards for the Archaeological & Palaeontological Components of Impact Assessment Reports"* the aims of the palaeontological impact assessment are:

- to identify exposed and subsurface rock formations that are considered to be palaeontologically significant;
- to assess the level of palaeontological significance of these formations;
- to comment on the impact of the development on these exposed and/or potential fossil resources and
- to make recommendations as to how the developer should conserve or mitigate damage to these resources.

In preparing a palaeontological desktop study the potential fossiliferous rock units (groups, formations etc.) represented within the study area are determined from geological maps. The known fossil heritage within each rock unit is inventoried from the published scientific literature and previous palaeontological impact studies in the same region.

The likely impact of the proposed development on local fossil heritage is determined on the basis of the palaeontological sensitivity of the rock units concerned and the nature and scale of the development itself, most notably the extent of fresh bedrock excavation envisaged. The different sensitivity classes used are explained in Table 1.1 below.

Table 1 Palaeontological Sensitivity Analysis Outcome Classification

PALAEONTOLOGICAL SIGNIFICANCE/VULNERABILITY OF ROCK UNITS	
The following colour scheme is proposed for the indication of palaeontological sensitivity classes. This classification of sensitivity is adapted from that of Almond et al 2008.	
RED	Very High Palaeontological sensitivity/vulnerability. Development will most likely have a very significant impact on the Palaeontological Heritage of the region. Very high possibility that significant fossil assemblages will be present in all outcrops of the unit. Appointment of professional palaeontologist, desktop survey, phase I Palaeontological Impact Assessment (PIA) (field survey and recording of fossils) and phase II PIA (rescue of fossils during construction) as well as application for collection and destruction permit compulsory.
ORANGE	High Palaeontological sensitivity/vulnerability. High possibility that significant fossil assemblages will be present in most of the outcrop areas of the unit. Fossils most likely to occur in associated sediments or underlying units, for example in the areas underlain by Transvaal Supergroup dolomite where Cenozoic cave deposits are likely to occur. Appointment of professional palaeontologist, desktop survey and phase I Palaeontological Impact Assessment (field survey and collection of fossils) compulsory. Early application for collection permit recommended. Highly likely that aPhase II PIA will be applicable during the construction phase of projects.
GREEN	Moderate Palaeontological sensitivity/vulnerability. High possibility that fossils will be present in the outcrop areas of the unit or in associated sediments that underly the unit. For example areas underlain by the Gordonia Formation or undifferentiated soils and alluvium. Fossils described in the literature are visible with the naked eye and development can have a significant impact on the Palaeontological Heritage of the area. Recording of fossils will contribute significantly to the present knowledge of the development of life in the geological record of the region. Appointment of a professional palaeontologist, desktop survey and phase I PIA (ground proofing of desktop survey) recommended.
BLUE	Low Palaeontological sensitivity/vulnerability. Low possibility that fossils that are described in the literature will be visible to the naked eye or be recognized as fossils by untrained persons. Fossils of for example small domal Stromatolites as well as micro-bacteria are associated with these rock units. Fossils of micro-bacteria are extremely important for our understanding of the development of Life, but are only visible under large magnification. Recording of the fossils will contribute significantly to the present knowledge and understanding of the development of Life in the region. Developer and HIA consultant must take note of possible fossils and make professional recommendations on the impact of development on significant palaeontological finds recorded in the literature. SAHRA must be notified if new fossils are recorded and collection of a representative sample of potential fossiliferous material recommended.

GREY	Very Low Palaeontological sensitivity/vulnerability. Very low to no possibility that fossils will be present in the bedrock of these geological units. The rock units are associated with intrusive igneous activities and no life would have been possible during implacement of the rocks. It is however essential to note that the geological units mapped out on the geological maps are invariably overlain by Cenozoic aged sediments that might contain significant fossil assemblages and archaeological material. Examples of significant finds occur in areas underlain by granite, just to the west of Hoedspruit in the Limpopo Province, where significant assemblages of fossils and clay-pot fragments are associated with large termite mounds. Developer and HIA consultant must note archaeological reports for possible descriptions of palaeontological finds in Cenozoic aged surface deposits.

1.3 Scope and Limitations of the Desktop Study

The study will include: i) an analysis of the area's stratigraphy, age and depositional setting of fossil-bearing units; ii) a review of all relevant palaeontological and geological literature, including geological maps, and previous palaeontological impact reports; iii) data on the proposed development provided by the developer (e.g. location of footprint, depth and volume of bedrock excavation envisaged) and iv) where feasible, location and examination of any fossil collections from the study area (e.g. museums).

The key assumption for this scoping study is that the existing geological maps and datasets used to assess site sensitivity are correct and reliable. However, the geological maps used were not intended for fine scale planning work and are largely based on aerial photographs alone, without ground-truthing. There is also an inadequate database for fossil heritage for much of the RSA, due to the small number of professional palaeontologists carrying out fieldwork in RSA. Most development study areas have never been surveyed by a palaeontologist.

These factors may have a major influence on the assessment of the fossil heritage significance of a given development and without supporting field assessments may lead to either:

- an underestimation of the palaeontological significance of a given study area due to ignorance of significant recorded or unrecorded fossils preserved there, or
- an overestimation of the palaeontological sensitivity of a study area, for example when originally rich fossil assemblages inferred from geological maps have in fact been destroyed by weathering, or are buried beneath a thick mantle of unfossiliferous "drift" (soil, alluvium etc.).

2 DESCRIPTION OF THE PROPOSED DEVELOPMENT

The study area is located approximately 50km north of Loeriesfontein, Namaqua District Municipality, Northern Cape Province (Figure 2.1).

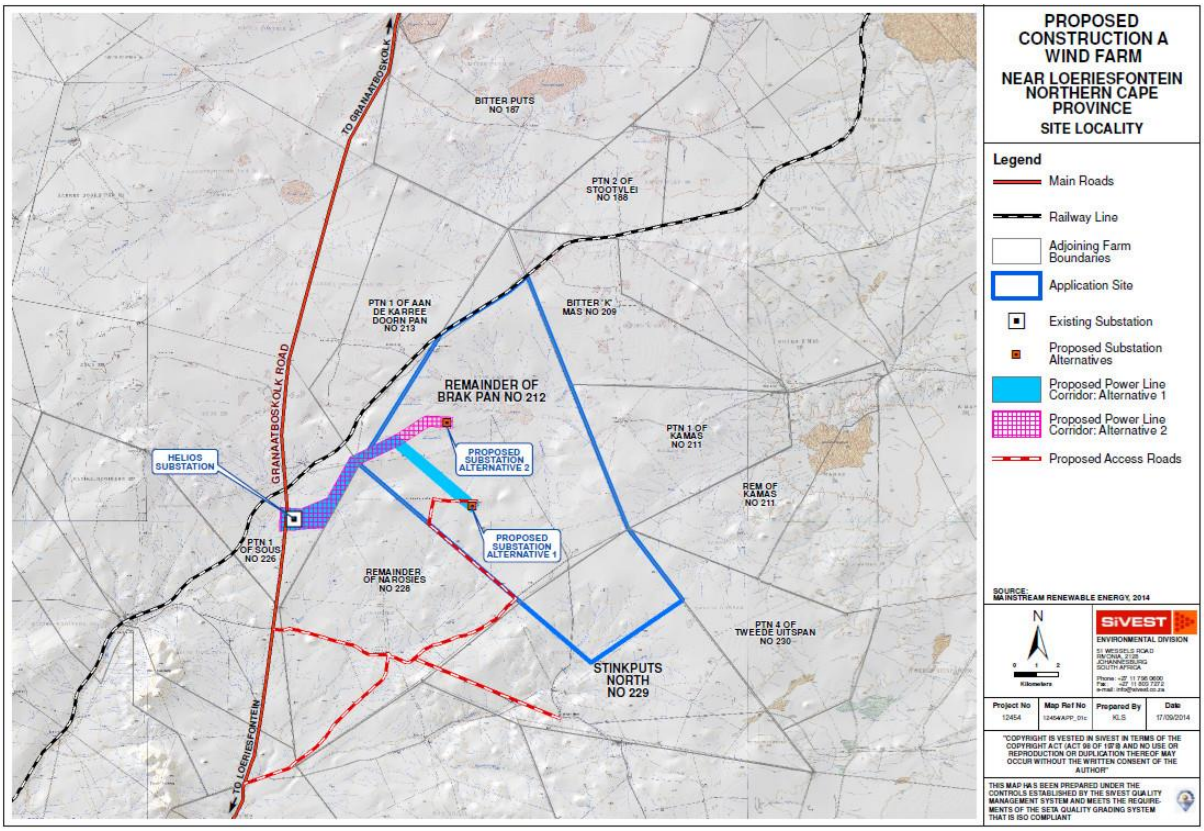

Figure 0.1 Locality of the study area

The proposed project would comprise of the following:

- Approximately 35-95 wind turbines with a total generation capacity of approximately 140MW, utilising turbines with a range of 1.5 to 4MW generation capacity;
- Each turbine will have a hub height of between 80 to 140m and a rotor diameter of 80 to 140m;
- An approximate foundation footprint of 20 x 20m per turbine, approximately 4m deep;
- Hard standing areas of approx. 2 800m² for crane usage per turbine;
- Medium voltage cables up to 1m deep connecting all turbines to the substation;
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- Internal access roads between 6m and 10m wide;
- Upgrading existing access roads;
- A maximum of 10 000m² temporary lay down area including an access road and contractor's site office area of up to 5 000m²;
- Administration and warehouse buildings with a footprint of 5 000m²;
- Fencing, linking stations and borrow pits if required.

3 GEOLOGY

The study area is underlain by shales of the Permian aged Tierberg Formation, as well as two very small outcrops of Permian aged shales of the Whitehill Formation, Ecca Group of the Karoo Supergroup. Large areas are covered in dolerite scree whilst small areas are covered in Quaternary aged alluvium and pan sediments (Figure 3.1).

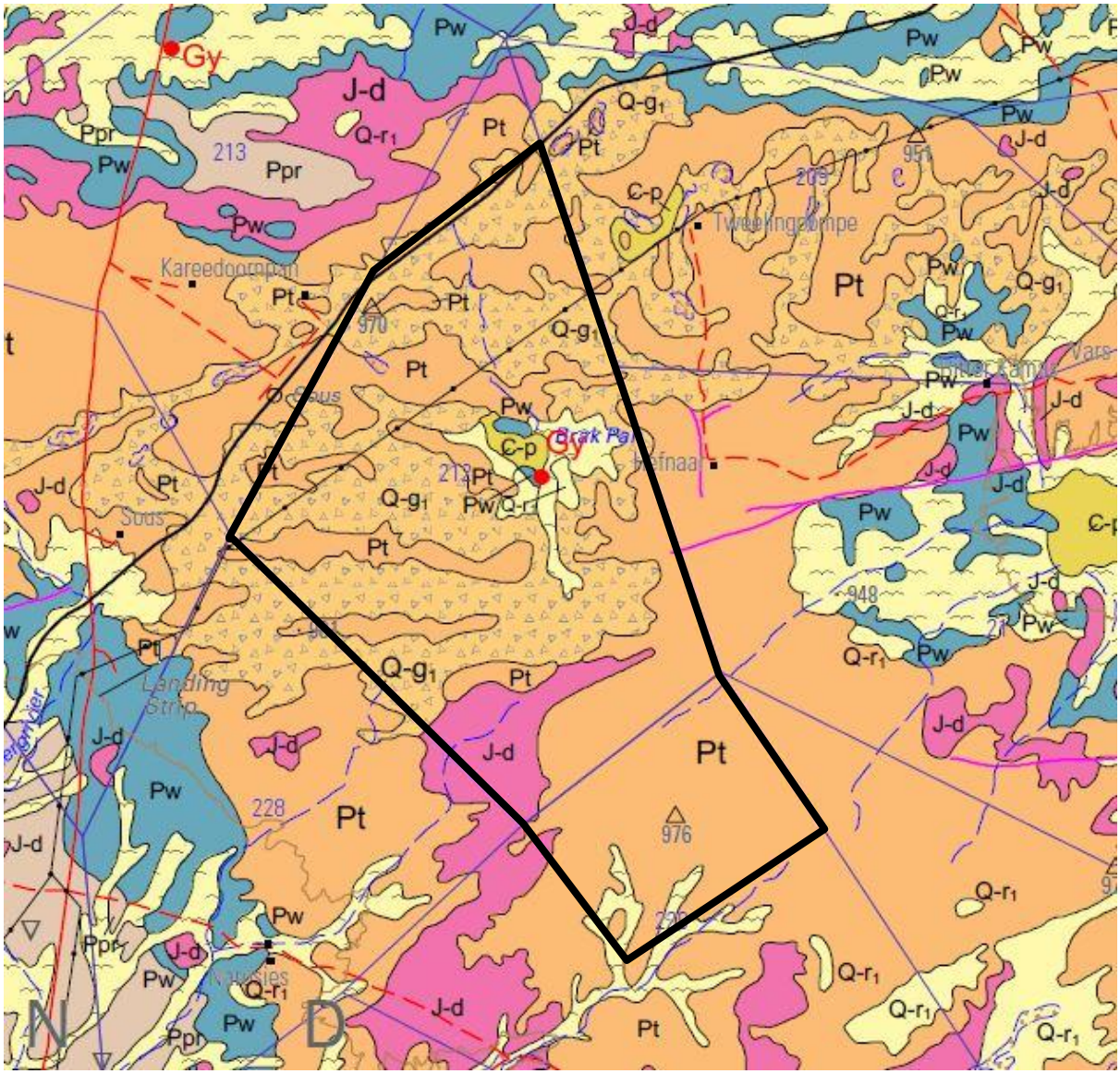

Figure 0.2 Geology of the study area. Pt - Tierberg Formation, Pw - Whitehill Formation, Jd – Dolerite, Q-g1 - Dolerite scree, C-p - Pan sediments and Alluvium (yelow)

3.1 Tierberg Formation (Pt)

The Tierberg Formation is a dominantly shale and mudrock unit, consisting predominantly of dark grey, well laminated carbonaceous shales with subordinate sandstone (Johnson et al, 2006)

3.2 Whitehill Formation (Pw)

The Whitehill Formation only occurs at two localised sites in the study area and this relatively thin succession of well-laminated carbon-rich mudrocks. The mudstone weathers to a distinctive pale grey to creamy white colour (Johnson et al, 2006)

3.3 Dolerite (Jd)

Dolerite is a mafic intrusive igneous rock and occurs as dykes or sills in the study area. The Jurassic aged dolerite in the study area is associated with the "koppies" or high-lying areas in the region

3.4 Dolerite Scree (Q-g1)

Large parts of the study area is underlain by dolerite scree that covers most of the primary geology.

3.5 Pan Sediments (C-p)

A small area is underlain by Quaternary aged pan sediments.

3.6 Alluvium

Alluvium underlies a restricted area in the development site.

4 PALAEONTOLOGY OF THE AREA

4.1 Tierberg Formation

The Permian aged Tierberg Formation is mainly interpreted as a deep water deposit and fossils are mainly associated with event beds, with the commonest fossils being sparse to locally concentrated assemblages of trace fossils (Johnson et al 2006). Body fossils are very rarely recorded.

4.2 Whitehill Formation

The Permian aged Whitehill Formation is well-known for a abundance of trace fossils as well as body fossils.

According to Almond (2011), "the main groups of Early Permian fossils found within the Whitehill Formation include:

- aquatic **mesosaurid reptiles** (the earliest known sea-going reptiles)
- rare **cephalochordates** (ancient relatives of the living lancets)
- a variety of **palaeoniscoid fish** (primitive bony fish)
- highly abundant small **eocarid crustaceans** (bottom-living shrimp-like forms)
- **insects** (mainly preserved as isolated wings, but some intact specimens also found)
- a low diversity of **trace fossils** (*e.g.* king crab trackways, possible shark coprolites / faeces)
- **palynomorphs** (organic-walled spores and pollens)
- **petrified wood** (mainly of primitive gymnosperms, silicified or calcified)
- other sparse **vascular plant remains** (*Glossopteris* leaves, lycopods *etc*)".

4.3 Dolerite

Due to the igneous nature of dolerite, no fossils will be found in the rock units.

4.4 Dolerite Scree

Due to the igneous nature of dolerite, no fossils are expected in the dolerite Where the scree overlies shales of the Ecca Group, fossils might be associated with the shale.

4.5 Pan Sediments and Alluvium

Quaternary aged pan sediments can contain local concentrations of more recent fossils. According to Almond (2011) “Caenozoic fossil biotas from these superficial deposits include non-marine molluscs (bivalves, gastropods), ostrich egg shells, trace fossils (*e.g.* calcretised termitaria, coprolites), and plant remains such as peats or palynomorphs (pollens, spores) in organic-rich alluvial horizons (Scott 2000) and siliceous diatoms in pan sediments. In Quaternary deposits, fossil remains may be associated with human artefacts such as stone tools and are also of archaeological interest (*e.g.* Smith 1999 and refs. therein). Stone artefacts of Pleistocene and younger age may additionally prove useful in constraining the age of superficial deposits such as gravelly alluvium within which they are occasionally embedded.”

5 PALAEONTOLOGICAL SENSITIVITY

The likely impact of the proposed development on local fossil heritage is determined on the basis of the palaeontological sensitivity of the rock units concerned and the nature and scale of the development itself, most notably the extent of fresh bedrock excavation envisaged (Figure 5.1). The different sensitivity classes used are explained in Table 1 above.

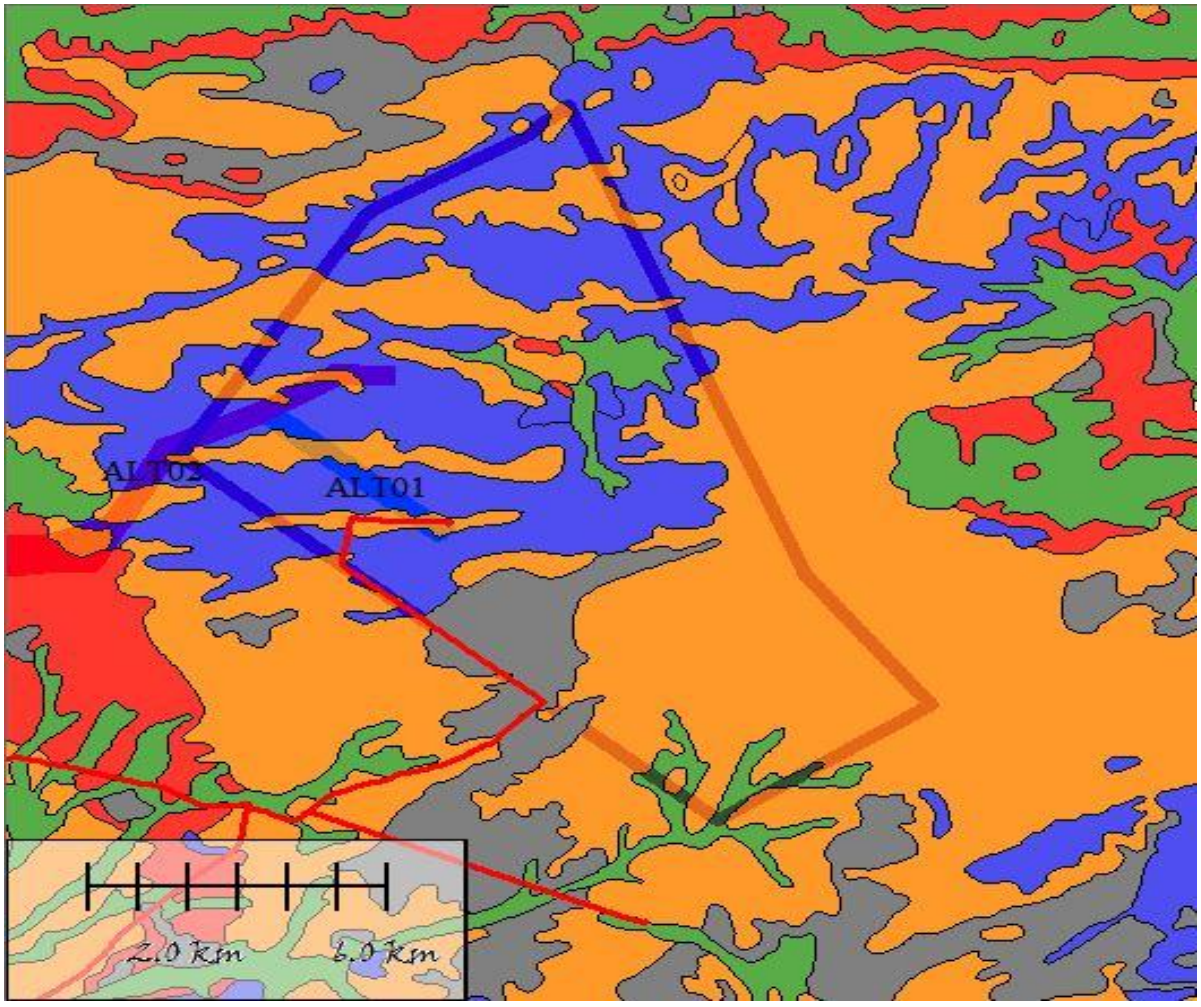

Figure 0.3 Paleontological sensitivity of the geological formations in the study area. Colours are explained in Table 1 above.

The Permian aged Tierberg Formation underlies significant sections of the study area and monitoring of the fossil heritage must be planned for these areas. The significantly fossil-rich Whitehill Formation underlies two restricted areas and if development falls within these areas (coloured red in Figure 5.1), the areas must be considered as highly sensitive for palaeontological heritage. Areas overlain by dolerite scree is allocated a low palaeontological sensitivity and if fossils area recorded in shales underlying the scree, these need to recorded.

Due to the igneous nature of dolerite, no fossils will be found and areas underlain by dolerite have been allocated a Very Low palaeontological sensitivity.

Areas underlain by pan and alluvium deposits are allocated a moderate palaeontological sensitivity and if fossils are recorded a qualified palaeontologist must be appointed to collect and record these finds.

6 CONCLUSION AND RECOMMENDATIONS

The Dwarsrug Study Area is mainly underlain by Permian aged rocks of the Ecca Group, Jurassic aged dolerite sills and Quaternary aged dolerite scree, pan sediments and alluvium.

The very high and high fossiliferous potential of the Ecca Group strata warrants an allocation of a High palaeontological sensitivity to the areas underlain by the rocks of these formations. The pan sediments and alluvium is allocated a Moderate palaeontological sensitivity whereas areas underlain by dolerite scree and dolerite are allocated Low and Very Low Palaeontological sensitivities.

Recommendations:

1. The EAP as well as the ECO for this project must be made aware of the fact that the Ecca Group sediments contains significant fossil remains, albeit mostly trace fossil assemblages. Several types of fossils have been recorded from this Group in the Karoo Basin of South Africa, with special mention of the very important Whitehill Formation. The Whitehill Formation outcrops are however very restricted in this study area.
2. In areas that are allocated a Very High and High Palaeontological sensitivity and specifically where deep excavation into bedrock is envisaged (following the geotechnical investigation), or where fossils are recorded during the geotechnical investigations, a qualified palaeontologist must be appointed to assess and record fossils at specific footprints of infrastructure developments (Phase 1 PIA).
3. If significant fossil finds (*e.g.* vertebrate teeth, bones, burrows, petrified wood) are recorded during excavations for infrastructure such as road developments, the palaeontologist must apply for a collection permit to collect the fossils according the SAHRA specifications.
4. These recommendations should form part of the EMP of the project.

7 REFERENCES

Almond JE. 2011. Proposed Mainstream wind farm near Loeriesfontein, Namaqua District Municipality, Northern Cape Province. Internal Desktop Report.

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8 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

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).

9 DECLARATION OF INDEPENDENCE

I, Gideon Groenewald, declare that I am an independent specialist consultant and have no financial, personal or other interest in the proposed development, nor the developers or any of their subsidiaries, apart from fair remuneration for work performed in the delivery of palaeontological heritage assessment services. There are no circumstances that compromise the objectivity of my performing such work.

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