SOLAR RESERVE SOUTH AFRICA (PTY) LTD

Proposed Construction of the Limestone 1 - 132kV Power Line and the associated Switchyards on Portion 0 (remaining extent) of the Farm 267, Northern Cape Province

Heritage Impact Assessment

Issue Date: 3 December 2013
Revision No.: 1
Project No.: 12155/12203/12204

Date:	03/12/2013
Document Title:	Proposed Construction of the Limestone 1 - 132kV Power Line and the associated Switchyards – Heritage Impact Assessment
Author:	Wouter Fourie
Revision Number:	1
For:	SiVEST Environmental Division

Declaration of Independence

The report has been completed by PGS Heritage an appointed Heritage Specialist for SiVest. The views stipulated in this report are purely objective and no other interests are displayed during the decision making processes discussed in the Heritage Impact Assessment Process that includes the Scoping as well as this final report

HERITAGE CONSULTANT: PGS Heritage

CONTACT PERSON: Wouter Fourie

SIGNATURE: ______________________

Executive Summary

PGS Heritage (PGS) was appointed by SiVest Environmental Division to undertake a Heritage Impact Report that forms part of the Environmental Impact Assessment (EIA) for the proposed Construction of the Limestone 1 - 132kV Power Line and the associated Switchyards on Portion 0 (remaining extent) of the Farm 267, Northern Cape Province.

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

The background research, that forms part of the HIA, has shown that the area between Postmasburg and Daniëlskuil generally referred to as the Ghaap plato has a rich history of occupation from the Stone Age with hunter gatherers to the Thlaping and Thlaro during the Iron Age period. The 1800's saw the rise of the Griqua people in the area and their loss of sovereignty after 1880 to Cape rule.

The field work yielded 1 heritage related site.

The site LS1-1 is associated with a low density of Later Stone Age material, with no context. The site has a low heritage significance and no mitigation is required.

It is recommended that an updated palaeontological desktop for the Limestone1 alignment be done to determine the palaeontological significance of the Precambrian limestones, dolomites and cherts of the Ghaap Group (Campbell Rand Subgroup). Almond (pers. Comm.) also indicated that the same geology has potential for fossil stromatolites at surface in the Lime Acres area that lies 12km to the south west of the study area.

Further to these recommendations the general Heritage Management Guideline in Sections 6 needs to be incorporated in to the EMP for the project.

The overall impact of the development on heritage resources is seen as acceptably low and can impacts can be mitigated to acceptable levels.

The following general mitigation measures are recommended:

a. A monitoring plan must be agreed upon by all the stakeholders for the different phases of the project focussing on the areas where earthmoving will occur.
b. If during construction any possible finds are made, the operations must be stopped and the qualified archaeologist be contacted for an assessment of the find.
c. Should substantial fossil remains (e.g. well-preserved fossil fish, reptiles or petrified wood) be exposed during construction, however, the ECO should carefully safeguard these, preferably in situ, and alert SAHRA as soon as possible so that appropriate action (e.g. recording, sampling or collection) can be taken by a professional palaeontologist.
d. A management plan must be developed for managing the heritage resources in the surface area impacted by operations during construction and operation of the development. This includes basic training for construction staff on possible finds, action

steps for mitigation measures, surface collections, excavations, and communication routes to follow in the case of a discovery.

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1 INTRODUCTION

PGS Heritage (PGS) was appointed by SiVest Environmental Division to undertake a Heritage Impact Report that forms part of the Environmental Impact Assessment (EIA) for the proposed Construction of the Limestone 1 - 132kV Power Line and the associated Switchyards on Portion 0 (remaining extent) of the Farm 267, Northern Cape Province.

1.1 Scope of the Study

The aim of the study is to identify possible heritage sites and finds that may occur in the proposed development area. The Heritage Impact Assessment 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 Specialist Qualifications

There Heritage Impact Assessment (Including the Scoping and this Report) was compiled by PGS Heritage & Grave Relocation Consultants (PGS).

The staff at PGS has a combined experience of nearly 60 years in the heritage consulting industry. PGS and its staff have extensive experience in managing HIA processes. PGS will only undertake heritage assessment work where they have the relevant expertise and experience to undertake that work competently.

Wouter Fourie, the Principal Heritage Specialist, is registered with the Association of Southern African Professional Archaeologists (ASAPA) as a Professional Archaeologist and is accredited as Principal Investigator; he is further an Accredited Professional Heritage Practitioner with the Association of Professional Heritage Practitioners – Western Cape (APHP).

1.3 Assumptions and Limitations

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

Such observed or located heritage features and/or objects may not be disturbed or removed in any way until such time that the heritage specialist had been able to make an assessment as to the significance of the site (or material) in question. This applies to graves and cemeteries as well. In the event that any graves or burial places are located during the development the procedures and requirements pertaining to graves and burials will apply as set out below.

1.4 Legislative Context

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

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

Table 1: Terminology and Abbreviations

Abbreviations	***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:

- 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;
- 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;
- wrecks, being any vessel or aircraft, or any part thereof, which was wrecked in South Africa, whether on land, in the internal waters, the territorial waters or in the maritime culture zone of the republic as defined in the Maritimes Zones Act, and any cargo, debris or artefacts found or associated therewith, which is older than 60 years or which SAHRA considers to be worthy of conservation;
- features, structures and 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:

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

- **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

- **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.

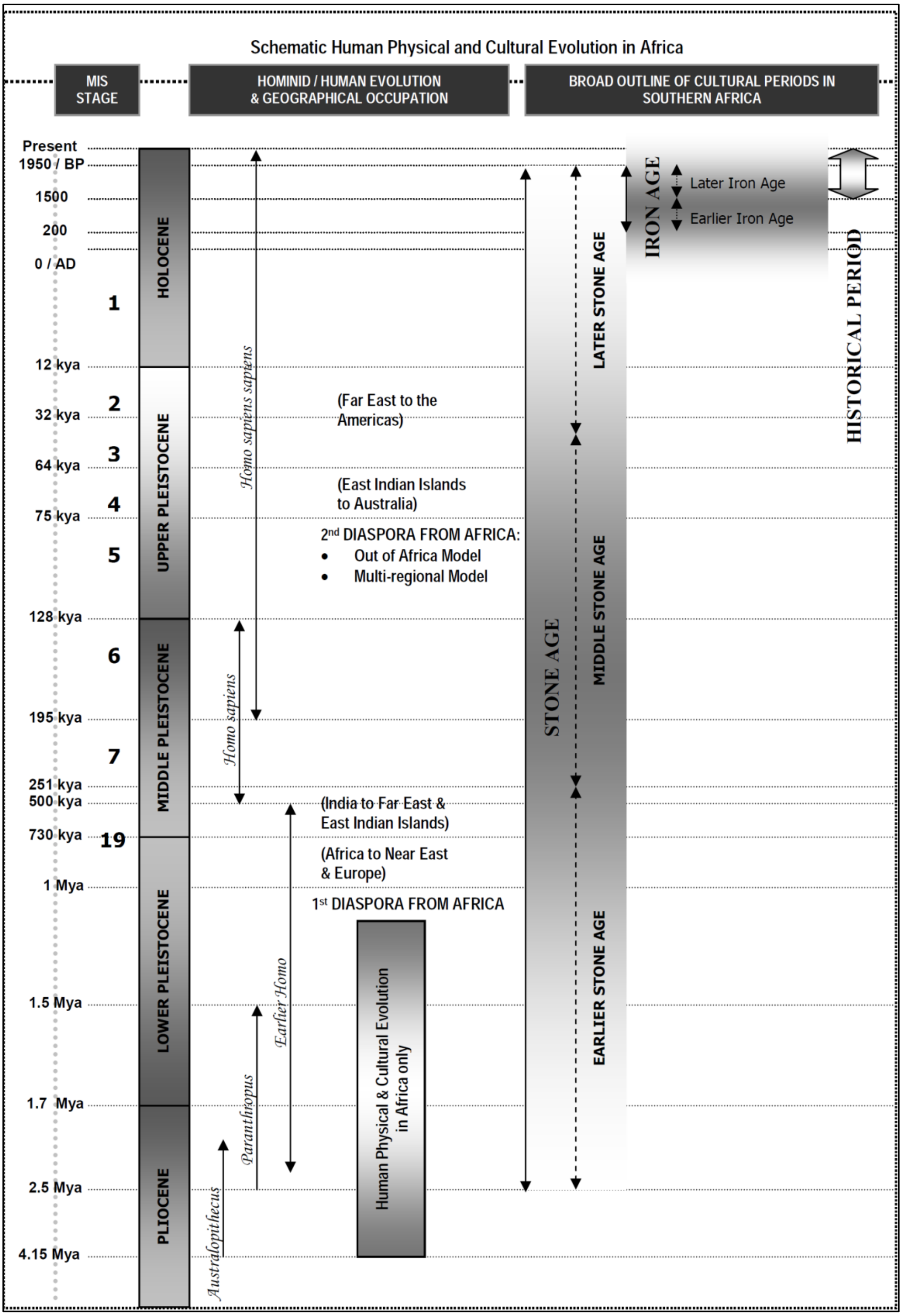

Figure 1: Human and Cultural Timeline in Africa (Morris, 2008)

2 TECHNICAL DETAILS OF THE PROJECT

2.1 Technical Project Description

SolarReserve South Africa (Pty) Ltd (hereafter referred to as, “SolarReserve”) is proposing to construct the Limestone 1 - 132kV power line that will connect to the Concentrated Solar Power (CSP) / Photovoltaic (PV) Plants on Portion 0 (remaining extent) of the Farm 267, Northern Cape Province (hereafter referred to as the, “proposed development”). The proposed development will also involve the decommissioning of the existing 132kV power line that bisects Portion 0 (remaining extent) of the Farm 267. The proposed development falls within the jurisdiction of the Kgatelopele Local Municipality, which falls under the ZF Mgcawu District Municipality (formerly known as the Siyanda District Municipality) in the Northern Cape (**Figure 2**). The proposed development will form part of the greater Eskom power network in the Northern Cape Province. As such, SolarReserve has appointed SiVEST as the independent Environmental Assessment Practitioner (EAP) to undertake the required Basic Assessment (BA) process for the above-mentioned proposed project.

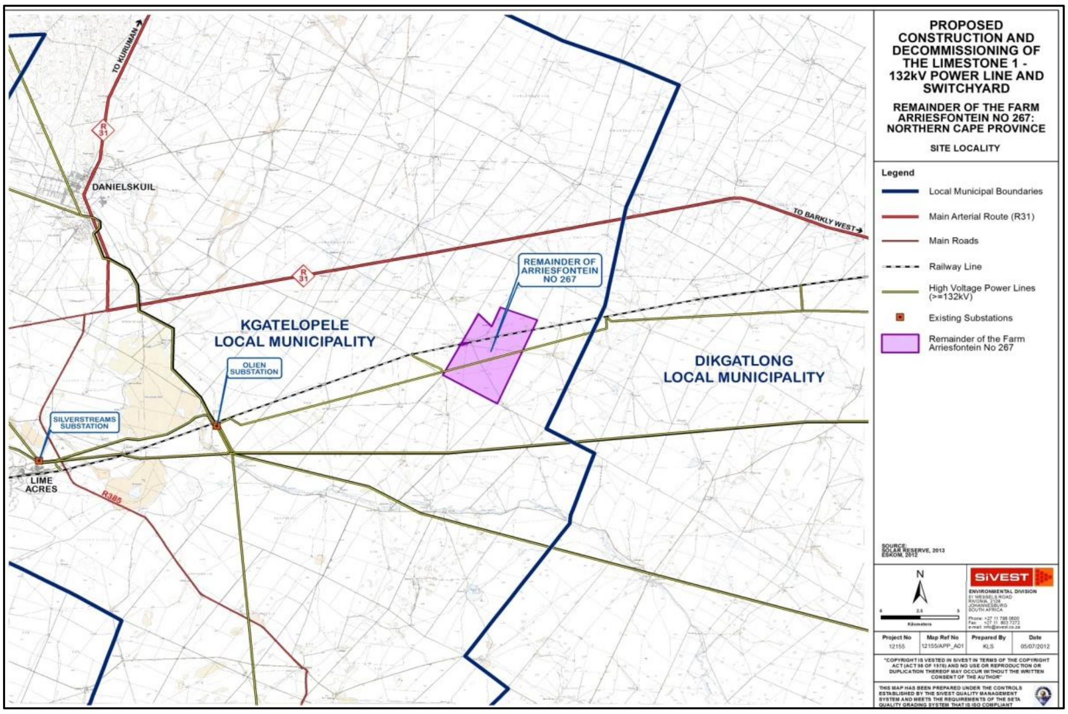

Figure 2: Locality Map

2.2 Project Description

As previously mentioned, the proposed development will entail the construction of a 132kV overhead power line to evacuate generated electricity from CSP / PV Plants on Portion 0 (remaining extent) of the Farm 267. The proposed power line will be constructed by re-routing the existing 132kV power line bisecting Portion 0 (remaining extent) of the Farm 267, by breaking into the line at the eastern boundary and re-routing around the south east and south west boundary of the site to re-connect to the existing 132kV power line (running to Olien Substation) on the western site boundary. From here, the proposed power line will run from Portion 0 (remaining extent) of the Farm 267 in a westerly direction where it will meet with Olien Substation approximately 13km away. The proposed power line will run adjacent to the existing power line that also routes to the Olien Substation. A 1km wide corridor has however been established for the proposed power line that routes off Portion 0 (remaining extent) of the Farm 267 to enable SolarReserve to manoeuvre for any technical reasons or sensitive environments. The proposed development will also entail the construction of a switchyard adjacent to the approved CSP / PV Plant substations. The proposed switchyards will be approximately 50m x 50m in size (**Figure 3**).

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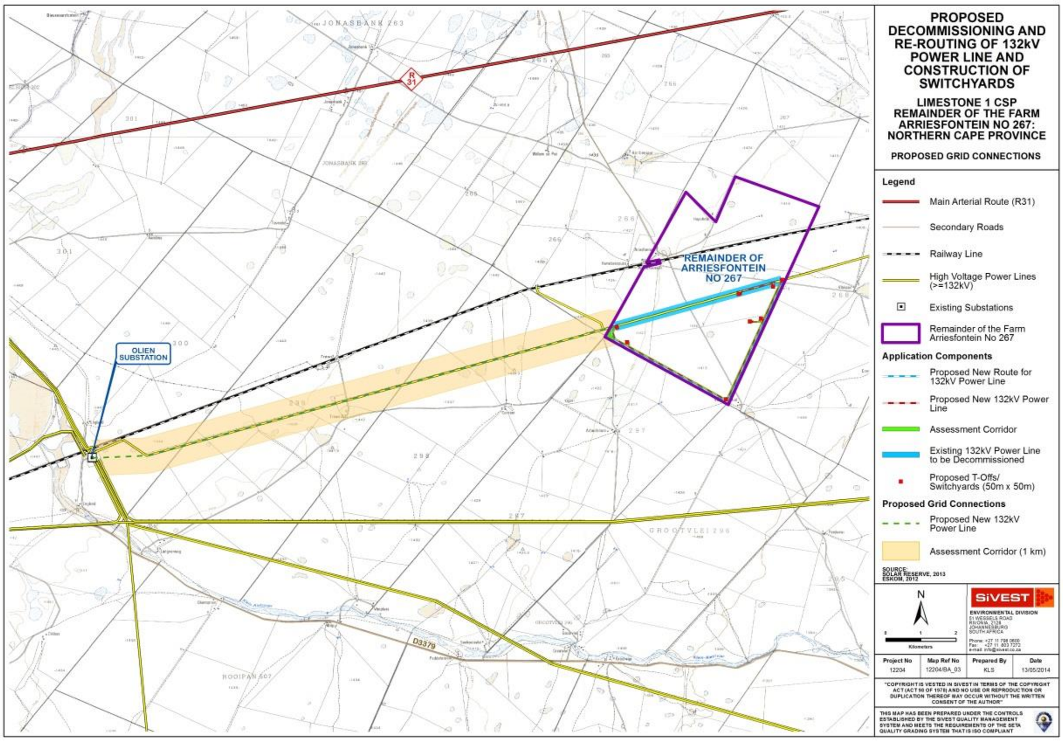

Figure 3: Project Layout

2.2.1 Tower Types

The power line will consist of a series of towers located approximately 100-250m apart, depending on the terrain and soil conditions. The exact tower type to be used will be determined (based on load and other calculations) during the final design stages of the power line. It is however likely that the bird friendly Single Steel Pole, monopole and/or lattice tower types (e.g. ESKOM D-DT 7641, D-DT 7649) will be used in combination with the Steel Lattice towers at bend points and/or where greater distances need to be spanned. The Single Steel Pole and monopole tower types are between 18m and 25m in height and the Steel Lattice tower type is between 25m and 29m in height. A typical photograph of the Single Steel Pole tower type is included in **Figure 4** below, for illustrative purposes only. The exact conductor type to be used will also vary depending on Eskom's final technical requirements during the final design stages of the power line. However, it is expected that the proposed power line will be fitted with either a Kingbird, Bare, Chicadee or equivalent and adequate conductors to carry a capacity of 20kVa. The exact location of the towers will also be determined during the final design stages of the power line.

Figure 4: Tower Type

3 ASSESSMENT METHODOLOGY

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

This Heritage Impact Assessment (HIA) report was compiled by PGS Heritage a (PGS) for the proposed project. 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) and the Minerals and Petroleum Resources Development Act (MPRDA) (28 of 2002). The HIA process consisted of three steps:

- Step I – Literature Review: The background information to the field survey relies on the previous background research completed for the larger project on the Arriesfontein farm .
- Step II – Physical Survey: A physical survey was conducted on foot through the proposed project area by qualified archaeologists (February 2011), 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

Impacts on these sites by the development will be evaluated as follows

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 2: 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

3.1 Methodology for Impact Assessment

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.

3.1.1 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.

3.1.2 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.

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

Table 3: Description

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.

4 CURRENT STATUS QUO

4.1.1 Background History

The archival research focused on available information sourced that was used to compile a background history of the study area and surrounds. This data then informed the possible heritage resources to be expected during field surveying.

Palaeontology (Refer to Annexure A for full Report)

The proposed Arriesfontein solar power plant development near Daniëlskuil is located in an area that is in part underlain by at most sparsely fossiliferous sedimentary rocks of Precambrian and Late Caenozoic age, the latter comprising mainly Quaternary to Recent calcretes and downwasted rock rubble. **Figure 5** provides an overlay of the proposed Limmestone 1 alignment in relation to the geology of the area.

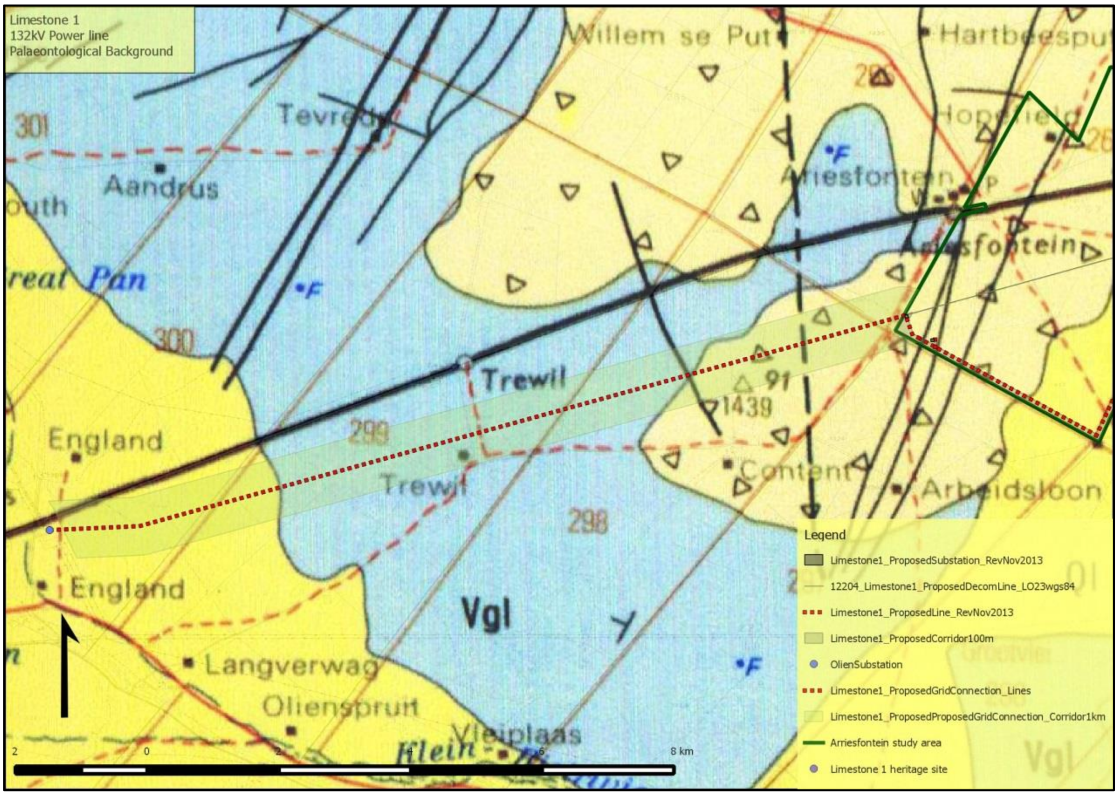

Figure 5: Extract from 1: 250 000 geological map 2822 Postmasburg (Council for Geoscience, Pretoria) showing approximate location of proposed Arriesdrift Solar Power Plant study area c. 24 km southeast of Daniëlskuil, Northern Cape Province.

Potentially fossiliferous sedimentary rock units mapped within the broader study region include:
Vgl (pale blue) = Precambrian limestones, dolomites and cherts of the Ghaap Group (Campbell Rand Subgroup)
Vgl (dark green) = Precambrian banded cherts and chert breccia of the Ghaap Group
Ql (yellow) = Late Caenozoic calcretes (Kalahari Group in part)
Buff with triangular symbols = superficial downwasted “rubble” (verweringspuin)

Archaeological background

Most archaeological material in the Northern Cape is found near water sources such as rivers, pans and springs, as well as on hills and in rock shelters. Sites usually comprise of open sites where the majority of evidence of human occupation is scatters of stone tools (Parsons 2003). The region in which Daniëlskuil is located is known as the Ghaap Plateau. The town itself is located in the foothills of the Kuruman Hills that are found to the west. It is in these hills, between Daniëlskuil and Kuruman, that the most significant archaeological site in the region is found, Wonderwerk Cave, which has material from the Earlier Stone Age to historical times. Much information about the archaeology of the region derives from this site, especially regarding chronology (Beaumont & Vogel 2006).

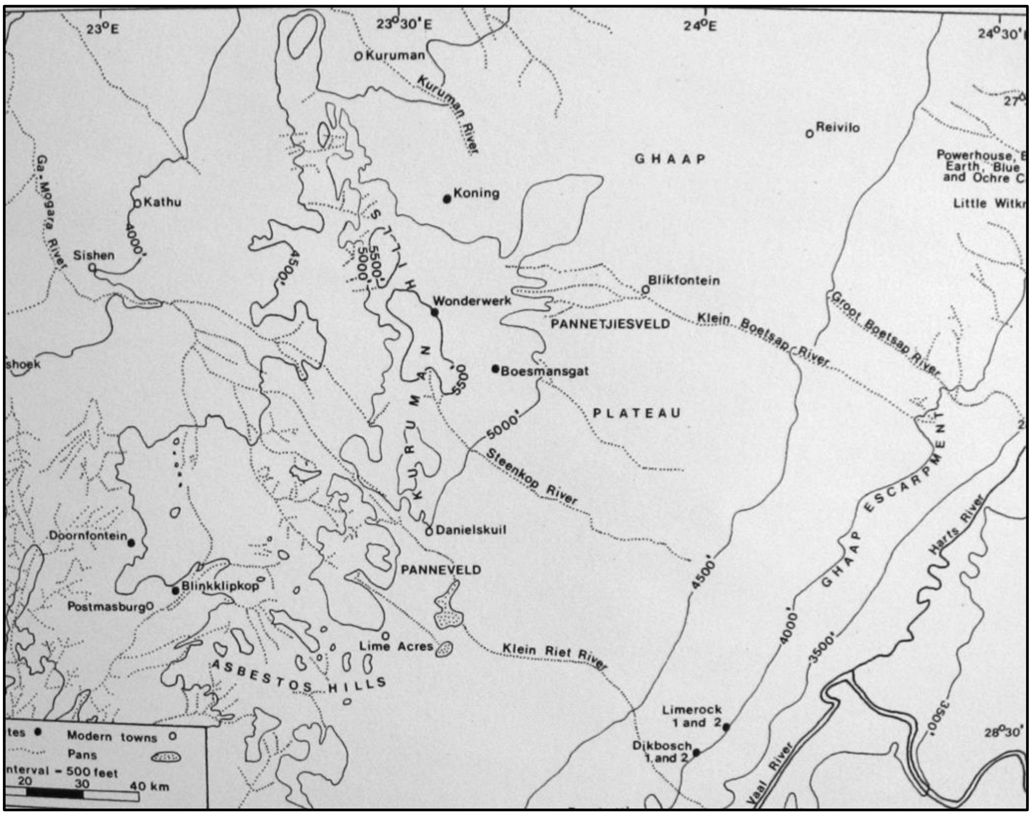

Figure 6 - Map of archaeological sites (Humphreys & Thackeray 1983)

Early Stone Age (400 000 – 2 million Before Present/BP)

The Early Stone Age at Wonderwerk dates to approximately 780 000 years old and is characterised by Acheulean stone tools such as prepared cores, bifacial cleavers and refined handaxes. A few pieces of haematite were also found in the uppermost MSA layers. Bedding material recovered indicates that the site was used as a home base by the end of the ESA. A few small irregular flakes and cores may belong to the older, Oldowan era, but the dating of this material is uncertain (Beaumont & Vogel 2006).

Middle Stone Age (30 000 – 300 000 BP)

Middle Stone Age artefacts belonging to the Fauresmith industry are also found in the region. The Fauresmith is characterised by prepared cores, long, narrow flake blades, convergent points and small, broad handaxes (Mitchell 2002). At Wonderwerk, layers with Fauresmith tools were dated to 276 00 – 510 000 BP. Associated with MSA materials were several incised stone slabs, most with curved parallel lines. Pieces of haematite were also found. The cave was abandoned between 70 000 and 12 500 BP due to significantly drier conditions. During this time, much of the region was abandoned and settlement only occurred at a few sites near permanent water sources (Beaumont & Vogel 2006).

Later Stone Age (30 000 BP – recent times)

The earlier LSA industry of the region forms part of the Oakhurst industry (some have labelled this local variant the Kuruman), characterised by rare retouched artefacts, most of which are large scrapers that are oblong with retouch on the side. The predominant raw materials are banded ironstone and dolomite. Very few adzes and blades are found, while backed artefacts and bone tools are absent. Ostrich eggshell beads and fragments are found (Humphreys & Thackeray 1983). At Wonderwerk, Oakhurst assemblages were dated to 8000 – 10 500 BP (Beaumont & Vogel 2006).

This was followed by the Wilton industry, characterised by the use of various raw materials including banded ironstone, chert, chalcedony, jasper and quartz. The main retouched tools are elongated scrapers with retouch on the end and backed artefacts such as segments and blades. Other retouched tools include adzes, unifacial points, borers and notched artefacts. At other sites, bifacial points and bifacial tanged and barbed arrowheads are found. At Wonderwerk, few bone points have been found. Ostrich eggshell beads, pendants and decorated fragments, as well as stone rings were found (Humphreys & Thackeray 1983). Wilton layers at Wonderwerk have been dated to 2000 – 8000 BP. Associated with LSA materials were 20 fine-line incised engraved stone slabs, most with schematic motifs. One example of a mammal depiction has been found. Pieces of haematite and specularite were also found in these layers (Beaumont & Vogel 2006).

Pottery made its appearance in the region by approximately 1400 BP and at Wonderwerk, Ceramic Later Stone Age layers have been dated to 900 – 2000 BP (Humphreys & Thackeray 1983; Beaumont & Vogel 2006). Two discrete, contemporary stone tool industries are associated with pottery remains in the Northern Cape: Swartkop and Doornfontein (Beaumont *et al.*1995). Swartkop is a Wilton industry characterised by acircular blades, a high proportion of backed blades, coarse undecorated pottery sherds that commonly contain grass temper, and a few iron items. It seems scrapers were favoured over blades on the Ghaap plateau (Humphreys & Thackeray 1983). These sites are usually found near water sources, such as pans and springs, or on the sides of low hills. Stone circles and ovals are sometimes also found and may represent the bases of dwellings. A late phase of this industry can be linked with the */Xam* San who lived in the Karoo. Doornfontein is characterised by the predominance of coarse irregular flakes, frequent use of quartz as a raw material, and very little retouch. Many ceramics are found, which are amphora-like in shape with grit temper and decoration on the necks and rims. Later sites contain some large ostrich eggshell beads, iron objects, and coarser sherds with grass temper. These sites are found along the Orange River and nearby permanent water sources. This tradition is probably associated with Khoekhoen groups (Beaumont *et al*. 1995).

Two prehistoric specularite mines have been excavated near Postmasburg–Doornfontein (Beaumont & Boshier 1974) and Blinklipkop (Thackeray *et al.* 1983). These sites show that specularite mining started before 1200 BP. This substance was prized as a cosmetic by hunter-gatherers, Khoekhoen pastoralists and Iron Age peoples, making it an important trade item. At Blinkklipkop, there is evidence of either trade with or occupation by Iron Age peoples by the seventeenth century. Historical sources indicate that Tlhaping Sotho-Tswana peoples occupied the mine in 1801 (Thackeray *et al.* 1983).

Rock Art

Rock engravings are principally found in the interior of South Africa and are plentiful in the Northern Cape. Engravings are found on rocky outcrops, river beds and boulders. They are made by pecking away the surface of the rock with another rock, incising it with a sharp stone or scraping it off with another stone. Unfortunately, there are no scientific methods for securely dating engravings and research into this is still at an experimental stage.

Most engravings were made by the San and were associated with their religious beliefs and rituals. San shamans went into trance to perform certain tasks such as controlling game, protecting the group and rainmaking. Certain animals were believed to hold supernatural power and thus many of the engraved animals can be seen as both sources and symbols of supernatural power. The places where engravings were made were also sources of supernatural power, especially in rainmaking rituals. Certain geometrics such as zigzags and dots are likely to have been associated with forms called entoptics seen whilst in trance (Dowson 1992).

Some engravings–particularly those featuring nonentoptic geometrics and aprons–were probably made by Khoekhoen people. Similar motifs are found in finger painted Khoekhoen rock art sites in certain regions of the Northern Cape, especially in the Vaal-Harts region to the east. Khoekhoen rock art is typified by finger paintings and roughly pecked engravings of geometrics that are located near water sources (Smith & Ouzman 2004). The rock paintings found in the Kuruman hills (Morris 1988) are probably of Khoekhoen authorship. Korana rock art–mostly painted–has also been identified in the Vaal-Harts region but may stretch into the Daniëlskuil region (Ouzman 2005). These depictions are characterised by finger painted and rough brush painted horses, human figures, geometrics, aprons, guns and finger dots. They are painted in shelters that are either hidden or not easily accessible. The complex issues of ethnicity and authorship of rock art–especially engravings–are still being researched.

There are several engraving sites in the Daniëlskuil area–notably Townlands (Collins 1973) that is pecked on a flat mass of limestone above a river bed just northeast of the town and Ouplaas 2 south of the town, which is engraved on exposed dolerite slabs (Morris & Beaumont 1994). These sites share a similar repertoire of subjects depicted, mainly of nineteenth century origin. This includes horses, often with a human figure riding them, human figures wearing hats or dresses, and wagons. There are also images of ostriches and geometrics such as rough rectangles with subdivisions and roughly grid-shaped designs resembling brickwork. A fat-tailed sheep, a handprint and few initials were also found. They may have been made by nineteenth century people of Khoekhoen descent such as the Korana (Morris & Beaumont 1994). Rock engravings are also found near Lime Acres southwest of Daniëlskuil (Morris 2008).

Iron Age

Sotho-Tswana agro-pastoralist peoples settled in the eastern portion of the Northern Cape in the seventeenth century (Humphreys & Thackeray 1983), possibly as far west as the Langeberg. They were driven further northeast by the arrival of the Korana in the eighteenth century and settled in the Kuruman area and further north (Humphreys 1976). By the early nineteenth century, they were mostly hunters and pastoralists and they dominated trade between the north and south of the interior (Shillington 1985). This included control over the specularite mine at Blinkklipkop (Legassick 1969).

Historical background

By the beginning of the nineteenth century, the Ghaap Plateau was inhabited by San hunter-gatherers, Khoekhoen people (mostly Korana), and Tlhaping and Tlharo Sotho-Tswana peoples in the northeast (Humphreys & Thackeray 1983). Small Korana groups started moving into the area in the eighteenth century, disrupting the Sotho-Tswana as they extended their influence over the area (Legassick 1989).

The Korana were originally descended from Khoekhoen groups living in the south-western Cape, who moved into the interior in the eighteenth century and became known as !Kora. There were also indigenous !Kora groups living on the Middle Orange and at the Vaal-Orange confluence. To distinguish between the two, Korana is used for post-frontier !Kora groups.

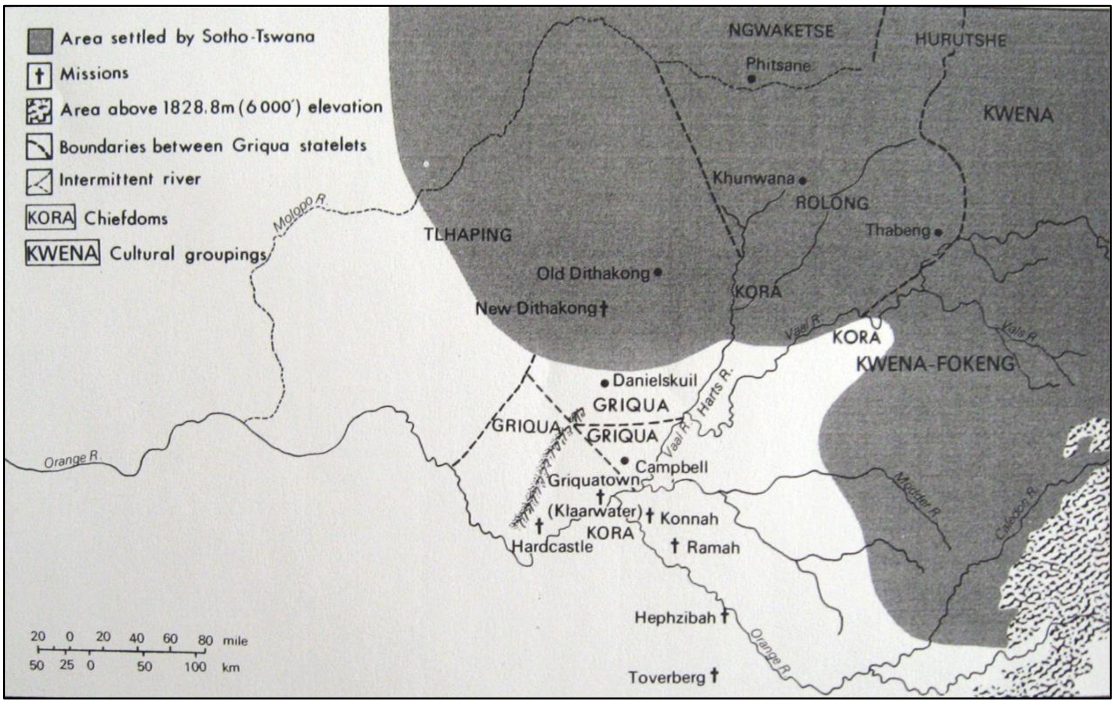

Figure 7 - Central Transorangia during the nineteenth century (Legassick 1989)

Eighteenth century Korana groups were armed and mounted and attracted people of other descent such as colonial fugitives, escaped slaves, San, Sotho-Tswana and Griqua individuals. The Tlhaping interacted closely with the Korana and many chiefs had Korana wives (Legassick 1989). A key part of Korana identity was their lifestyle of nomadic cattle herding and raiding (Ouzman 2005). The main Korana chiefs in central Transorangia were Abraham Kruger, Piet Witvoet, Knecht Windvogel and Jan Bloem (Ross 1976). Jan Bloem was a German deserter from the navy and fugitive from the Cape colony who moved from the Middle Orange region–with a mostly Korana following–to Transorangia in the late eighteenth century and built up a following amongst the Korana and San. They raided over a vast area, often targeting Sotho-Tswana groups. In about 1800, Bloem was poisoned and was succeeded by his son Jan Bloem II, who being half Korana, became chief of the Springbok Korana (Legassick 1969).

Towards the end of the eighteenth century, Oorlams, Bastaards and other groups started moving from the Karoo, to the Middle Orange and then to central Transorangia. Oorlams were Khoekhoen people who had attached themselves to European frontiersmen. Bastaards were people of mixed white, Khoekhoen and slave descent who enjoyed a higher social status in the colony, were Christianised and spoke low Dutch. One of these was Adam Kok I, a freed slave, as well as Klaas Berends. The Kok and Berends families moved to central Transorangia in the beginning of the nineteenth century. They had each acquired large followings and were quite wealthy. The Bastaards soon established trade relationships with the Tlhaping, who sold them cattle, ivory and metal items in exchange for sheep, tobacco, dagga and beads.

By the early nineteenth century, an illegal arms trade had started in Transorangia, which caused much disruption in the region. Many followers left the Bastaards in favour of Korana and Sotho-Tswana groups. This was exacerbated when mixed Xhosa-led groups from the Eastern Frontier began operating in the region between 1805 and 1814. Coenraad de Buys, the famous European frontier rebel, moved into the area in 1815 and led the most infamous raiding group in the region. He later moved north out of Transorangia. This incessant raiding by armed horsemen led to the breakdown of existing social structures.

In the midst of this turmoil, the Bastaards were strengthening their community. They received their first missionary, William Anderson of the London Missionary Society, in about 1801. Under his influence, Klaarwater was established in 1804, where houses were built and crops planted. This community was led by Adam Kok II and Berend Berends, as well as several magistrates. At the suggestion of visiting missionary John Campbell, they started calling themselves the Griqua, their capital was renamed Griquatown and they adopted a constitution in 1813. However, dissension broke out the following year after colonial authorities demanded Griqua conscription. There was a rebellion in 1815 and a group of dissenters, the Hartenaars, moved to the Vaal-Harts river region. There was much hostility towards the leading Griqua families and in 1816, Berend Berends and Peter David moved to Daniëlskuil and most of the Koks under Cornelis Kok II moved to Campbell (Legassick 1969). The LMS established a mission station at Kuruman amongst the Tlhaping in 1816 under James Read, who was replaced by Robert Moffat in 1821 (Shillington 1985). Read was travelling between Griquatown and Dithakong in 1816 when he encountered a natural crater, in which there was a dead springbuck, hence he named it Daniel's den or *kuil* (Snyman 1985).

A missionary outpost had been established among the San at Kramersfontein 10km north of Daniëlskuil a few months prior to Berend's move there. Both the LMS and Wesleyans were involved in the Daniëlskuil area. The settlement of the Griqua here caused initial conflict between the San and both the Griqua and the Sotho-Tswana (Snyman 1988). Many San were eventually reduced to clients who tended Griqua cattle (Legassick 1969). The Sotho-Tswana name for Daniëlskuil was *Tlhaka le tlou* 'reeds of the elephant' and the Korana knew it as *Xaub* (Snyman 1985). Many Korana and other Khoesan people were incorporated into the Daniëlskuil community (Snyman 1988). At the end of the 1820s, Berends moved from Daniëlskuil to Boetsap and later to the Vaal-Harts region (Legassick 1989).

In 1820, Andries Waterboer–of San descent–was elected as the new Griqua *kaptyn* (Legassick 1989). However, many resented his appointment, as well as the appointment of a government agent. In 1822, the Bergenaar rebellion broke out, causing much turmoil in the region. Dissidents gathered on the Modder River, along with Korana and San groups (Legassick 1969). From here, they raided Tlhaping and Tlharo groups around Kuruman mission station (Shillington 1985). In 1826, Adam Kok II and his followers (mostly Bergenaars) moved to Philippolis (Ross 1976).

The area was also affected by the turmoil of the *Dfecane* in the 1820s and 1830s and several Bantu-speaking raiding groups targeted the area (Legassick 1989). In 1823, Waterboer led a commando to defend the Tlhaping at Old Dithakong against Southern Sotho attackers (Legassick 1969). Conditions were exacerbated by a drought in the 1830s, which caused many Griquas to leave Griquatown. Waterboer attempted to extend his sphere of influence over the Tlhaping and make them his clients. This met with limited success. In 1834, he signed a treaty with colonial authorities recognising his authority over central Transorangia but without defining its northern limits where the Tlhaping lived (Legassick 1969).

Part of Waterboer's expansion policy included stationing Griqua families at Daniëlskuil, which brought him into conflict with Berends who still had claim to the land. He eventually bought the land from Berends (Legassick 1969). In 1831, a school was established at Daniëlskuil and European traders started to move into the area at the same time. Daniëlskuil became part of the "Missionary Road" between Griquatown, Campbell and Kuruman (Snyman 1985). Greater numbers of Tlhaping and Tlharo started settling at nearby Kramersfontein, resulting in the displacement and ultimate extermination of the local San (Snyman 1988).

During the 1840s, there were further contests over land in central Transorangia. In 1841, an agreement was made between Waterboer and Kok formalising the boundaries between Campbell and Griquatown. The following year, Waterboer made an agreement with the Tlhaping chief Mahura defining their relative spheres of influence and borders. This marked the end of Griqua expansion and the start of Griquatown's decline. Furthermore, at the end of the 1840s, Cornelius Kok II started allowing European farmers to purchase land near Campbell, hastening the expansion of the Orange Free State into central Transorangia.

By the 1860s, European farmers were encroaching on the region (Legassick 1969). This was intensified by the discovery of diamonds on the lower Vaal in the late 1860s. The diamond trade was initially controlled by the Sotho-Tswana but by 1870s, Europeans had gained control of diamond prospecting and trading. Desire for control of the diamond fields caused border disputes between the different Griqua polities and the Tlhaping polities, in addition to the British and the Boer polities of the Transvaal and Orange Free State (Legassick 1969; Shillington 1985). At the end 1871, Griqualand West was established and the area was brought under British control. The Tlhaping resisted colonial authority. A few skirmishes occurred near Daniëlskuil. In 1877, chiefly authority was brought to an end in Griqualand West when the Thlaping were placed in locations, one being to the northwest of Daniëlskuil. In the process, many Sotho-Tswana such as the Thlaping, Korana and Griqua lost their independence, resulting in a rebellion in 1878 (Snyman 1985). This rebellion did nothing to stop the advance of colonial rule and Griqualand West was officially annexed by the Cape in 1880 (Shillington 1985). In 1892, Daniëlskuil was established as a European town (Snyman 1985).

During the South African War (1899-1902), most of the farmers in the Daniëlskuil area supported the Boers and joined their forces. In 1900, the British, fearing the rebels would jeopardise their western flank, appointed a task force under Sir Charles Warren to rid Griqualand West of Boer rebels. They occupied Daniëlskuil in June, forcing the bulk of the rebels to surrender. The remaining rebels were captured and tried for treason. The British built a fort overlooking the town as well as a system of trenches around the town. Early the following year, Boer forces tried to recapture the town but the attack failed (Snyman 1988).

Farm History

The Warren report (1877) paved the way for the proclamation of farms in the Daniëlskuil area. Sir Bartle Frere envisaged the establishment of a considerable township around Daniëlskuil and commissioned Warren to allocated 163 hectares to white farmers, 122 000 hectares to Griqua farmers and a further 32 600 hectares as location area

The farm Arriesfontein was allocated to I. Johnson as part of a large land grant to the white farmers, most of who was of English decent with substantial trade influence (Snyman 1988).

The current owners Mr and Mrs Cloete have been staying on the farm since the early 1970's when Mrs Cloete inherited the farm from her farther Mr Venter. Mr Venter inherited the farm from his step-father a Mr Roux.

The Roux family have been associated with the farm since the late 1800's, this fact is confirmed by the family cemetery on the farm with two of the three headstone bearing Roux names dating to 1932 and earlier (**Figure 8**).

4.1.1 Findings of the heritage research

The findings can be compiled as follow and is combined to produce a heritage sensitivity map for the project:

Palaeontology

The study area for the proposed Arriesfontein solar power plant and surrounds near Daniëlskuil is underlain at depth by Early Precambrian marine carbonate sediments of the Ghaap Group that are only sparsely fossiliferous (e.g. microbial mounds or stromatolites). Most of the study area is mantled by Late Caenozoic superficial deposits including Quaternary to Recent calcretes (pedogenic limestones) and downwasted rock rubble of comparable age, all of which are of low to very low palaeontological sensitivity. Extensive, deep excavations are unlikely to be involved in this sort of solar power plant project.

Figure 8 – Headstone in cemetery dating to 1932

The overall impact significance of the proposed development is therefore likely to be LOW and no no-go areas or buffer zones for palaeontological heritage resources have been identified by this desktop study. No further specialist palaeontological studies, monitoring or mitigation are recommended for this development.

Archaeology

The possibility of archaeological finds in the study area has been indicated by previous research and field work in the greater Daniëlskuil area.

Mr Cloete indicated that a local teacher, and tenant on his farm, had a great interest in archaeology and spent numerous hours on Arriesfontein investigating the pan areas and identifying Stone Age Scatters.

This fact along with the evidence of stone artefacts found during the site visit indicates the possibility of sensitive archaeological areas being present in the study area.

Historical

Discussion with the current owner Mr Gerrie Cloete, also revealed a rich history around Portion 0 (remaining extent) of the farm 267 with the Arriesfontein fountain (**Figure 9**) playing a major role on the transport routes in the area. The fountain was utilised as an outspan when the transport route followed the current rail line that passes just to the south of the fountain and farmstead.

Figure 9 – View of the fountain on Arriesfontein

4.1.2 Field work findings

A survey of the proposed corridor for the Limestone 1, 132kV power line provided for the study was conducted at the end of November 2013. Due to the nature of cultural remains, with the majority of artefacts occurring below surface, an intensive foot-survey that covered the study area was conducted. The fieldwork consisted of a walk down of the Corridor of the by a team of Archaeologists and heritage specialist from PGS.

The field work was focussed on the corridor between Portion 0 (remaining extent) of the farm 267 and the Olien Substation with selective checking of the wider 500 meter buffer for each Corridor. Any major deviation from this 100 meter buffer will require the evaluation of the pylon foot print and access route areas by an archaeologist before construction commence.

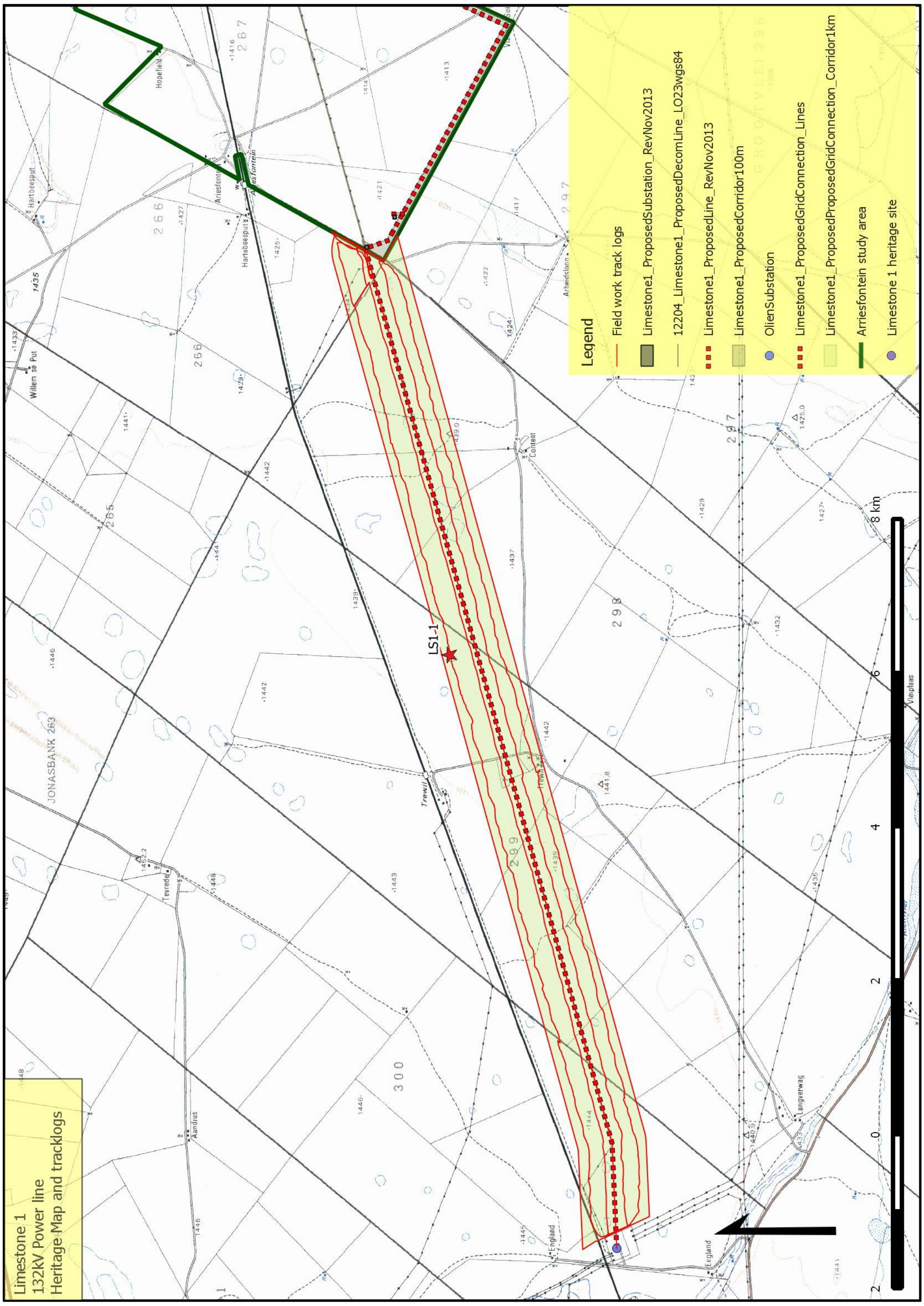

Figure 10 – Tracklogs and heritage finds relative to corridor

The site is predominantly covered in Savannah grassland, falls within Northern Cape Savannah Biome and it is generally flat dominated by plains (**Figure 11**). While the middle section of Corridor B is characterised by mountainous terrain (**Figure 12**).

Figure 11: View of study area in north western section of Corridor

Figure 12: Low shrub patches in the mid-section of Corridor

Figure 13: Olien Substation

4.1.3 Heritage Sites

The survey yielded one Stone Age find spots of low significance

Refer to **Figure 10** and ***Appendix A*** for positions relative to the Corridor.

Site LS1-1

GPS: 28 18 36,5 S 23 42 07,6 E

A low density scatter of stone tools was identified in the area (± 2-5 artefacts in 10m x10m). The site was situated on the edge of a small pan which was situated in a large extended plain. The artefacts were identified in a clearing which was exposed by sheet erosion. The stone tools consisted mostly of Later Stone Age scrapers and a few weathered cores and were scattered over an area of approximately 40m in diameter. The artefacts were of low quality and were made of poor quality materials. No sample was taken.

Site size: Approximately 40m in diameter.

Site significance: The site is of low heritage significance and graded as Grade 4C. Non deposits or context exist for the low density scatter of lithics.

Recommended mitigation: No further mitigation required

Figure 14: View of site LS1-1

Figure 15: Examples of LSA material found on site

Palaeontology

The original study for the Arriesfontein project focused on the Arriesfontein farm itself and the geology has been shown to have a low palaeontological significance.

Almond (2011) (refer to Appendix B) notes *"that since the 1: 250 000 geological maps were produced, the Campbell Rand succession has been subdivided into a series of formations, some of which were previously included within the older Schmidtsdrift Formation or Subgroup (Beukes 1980, 1986, Eriksson et al. 2006). It is unclear exactly which of these newer units are represented in the Arriesfontein study areas. However, this resolution is not critical for the current report since the carbonate facies are only seen at surface in a small part of the study area, around Arriesfontein station, and they are unlikely to be seriously impacted by the proposed development."*

It is recommended that an updated palaeontological desktop for the Limestone1 alignment be done to determine the palaeontological significance of the Precambrian limestones, dolomites and cherts of the Ghaap Group (Campbell Rand Subgroup). Almond (pers. Comm.) also indicated that the same geology has potential for fossil stromatolites at surface in the Lime Acres area that lies 12km to the south west of the study area.

5 IMPACT ASSESSMENT

5.1 Impact Matrix

Table 4: Rating Matrix for impacts in the Construction phase

Chance finds

IMPACT TABLE FORMAT	
Environmental Parameter	*Discovery of previously unidentified heritage sites (archaeological, historical or grave sites)*
Issue/Impact/Environmental Effect/Nature	*During construction activity and earthmoving archaeological material could be unearthed that was previously unidentified due to its position.*
Extent	*In most cases confined to small areas on the site*
Probability	*Due to the close proximity to water course, localised archaeological finds may possibly occur*
Reversibility	*In most cases where such finds are made damaged is irreversible*
Irreplaceable loss of resources	*Significant loss but in most cases the scientific data recovered will mitigate such losses*
Duration	*Permanent*
Cumulative effect	*Low cumulative impact*

IMPACT TABLE FORMAT		
Intensity/magnitude	*Medium*	
Significance Rating	*The impact is anticipated as being low and localised but will vary due to type of heritage find that could be made*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	2	1
Reversibility	4	2
Irreplaceable loss	4	3
Duration	4	4
Cumulative effect	1	1
Intensity/magnitude	1	1
Significance rating	-16 (Low negative)	-12 (low negative)
Mitigation measures	*A heritage monitoring program that will identify finds during construction will be able to mitigate the impact on the finds through scientific documentation of finds and provide valuable data on any finds made.*	

Known Heritage Sites

IMPACT TABLE FORMAT	
Environmental Parameter	*Identified heritage sites and areas*
Issue/Impact/Environmental Effect/Nature	*Due to the nature of the development it is possible that some sites will be impacted and impossible to avoid in the layout plan of the project*
Extent	*In most cases confined to small areas on the site*
Probability	*Possible impact on identified site*
Reversibility	*In most cases where a site cannot be excluded and needs to be destructed the impact is irreversable*
Irreplaceable loss of resources	*Significant loss but in most cases the scientific data recovered will mitigate such losses*
Duration	*Permanent*
Cumulative effect	*Low cumulative impact*
Intensity/magnitude	*Low*
Significance Rating	*The impact is anticipated as being low and localised but will vary due to type of heritage find that could be made*

IMPACT TABLE FORMAT		
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	2	1
Reversibility	4	4
Irreplaceable loss	4	4
Duration	4	4
Cumulative effect	1	1
Intensity/magnitude	1	1
Significance rating	-16 (low negative)	-15 (low negative)
Mitigation measures	*None required*	

Palaeontology

IMPACT TABLE		
Environmental Parameter	*Impact on palaeontological resources*	
Issue/Impact/Environmental Effect/Nature	*The possibility of uncovering significant subsurface palaeontological deposits*	
Extent	*In most cases confined to small areas on the site*	
Probability	*Medium probability of impact on palaeontology*	
Reversibility	*In most cases where a site cannot be excluded and needs to be destructed the impact is irreversible*	
Irreplaceable loss of resources	*Significant loss but in most cases the scientific data recovered will mitigate such losses*	
Duration	*Permanent*	
Cumulative effect	*Low cumulative impact*	
Intensity/magnitude	*Low*	
Significance Rating	*The impact is anticipated as being low and localised*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	2	1
Probability	2	1
Reversibility	2	2
Irreplaceable loss	2	3
Duration	4	4

IMPACT TABLE		
Cumulative effect	2	2
Intensity/magnitude	2	1
Significance rating	-28(Medium negative)	-13 (low negative)
Mitigation measures	*Refer to Section 6*	

5.2 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.

5.3 Cumulative Impacts

None foreseen

5.4 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 MITIGATION MEASURES

6.1 Management Guidelines

1. The National Heritage Resources Act (Act 25 of 1999) states that, any person who intends to undertake a development categorised as-

(a) the construction of a road, wall, transmission line, pipeline, canal or other similar form of linear development or barrier exceeding 300m in length;

(b) the construction of a bridge or similar structure exceeding 50m in length;

(c) any development or other activity which will change the character of a site-

- (i) exceeding 5 000 m^2 in extent; or
- (ii) involving three or more existing erven or subdivisions thereof; or
- (iii) involving three or more erven or divisions thereof which have been consolidated within the past five years; or

(iv) the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority;

(d) the re-zoning of a site exceeding 10 000 m^2 in extent; or

(e) any other category of development provided for in regulations by SAHRA or a provincial heritage resources authority, must at the very earliest stages of initiating such a development, notify the responsible heritage resources authority and furnish it with details regarding the location, nature and extent of the proposed development.

In the event that an area previously not included in an archaeological or cultural resources survey is to be disturbed, the South African Heritage Resources Agency (SAHRA) needs to be contacted. An enquiry must be lodged with them into the necessity for a Heritage Impact Assessment.

2. In the event that a further heritage assessment is required it is advisable to utilise a qualified heritage practitioner preferably registered with the Cultural Resources Management Section (CRM) of the Association of Southern African Professional Archaeologists (ASAPA).
   This survey and evaluation must include:
   (a) The identification and mapping of all heritage resources in the area affected;
   (b) An assessment of the significance of such resources in terms of the heritage assessment criteria set out in section 6 (2) or prescribed under section 7 of the National Cultural Resources Act;
   (c) An assessment of the impact of the development on such heritage resources;
   (d) An evaluation of the impact of the development on heritage resources relative to the sustainable social and economic benefits to be derived from the development;
   (e) The results of consultation with communities affected by the proposed development and other interested parties regarding the impact of the development on heritage resources;
   (f) If heritage resources will be adversely affected by the proposed development, the consideration of alternatives; and
   (g) Plans for mitigation of any adverse effects during and after the completion of the proposed development.
3. It is advisable that an information section on cultural resources be included in the SHEQ training given to contractors involved in surface earthmoving activities. These sections must include basic information on:
   a. Heritage;
   b. Graves;
   c. Archaeological finds; and
   d. Historical Structures.

   This module must be tailor made to include all possible finds that could be expected in that area of construction.
4. In the event that a possible find is discovered during construction, all activities must be halted in the area of the discovery and a qualified archaeologist contacted.
5. The archaeologist needs to evaluate the finds on site and make recommendations towards possible mitigation measures.

6. If mitigation is necessary, an application for a rescue permit must be lodged with SAHRA.
7. After mitigation an application must be lodged with SAHRA for a destruction permit. This application must be supported by the mitigation report generated during the rescue excavation. Only after the permit is issued may such a site be destroyed.
8. If during the initial survey sites of cultural significance is discovered, it will be necessary to develop a management plan for the preservation, documentation or destruction of such a site. Such a program must include an archaeological/palaeontological monitoring programme, timeframe and agreed upon schedule of actions between the company and the archaeologist.
9. In the event that human remains are uncovered or previously unknown graves are discovered a qualified archaeologist needs to be contacted and an evaluation of the finds made.
10. If the remains are to be exhumed and relocated, the relocation procedures as accepted by SAHRA needs to be followed. This includes an extensive social consultation process.

The definition of an archaeological/palaeontological monitoring programme is a formal program of observation and investigation conducted during any operation carried out for non-archaeological reasons. This will be within a specified area or site on land, inter-tidal zone or underwater, where there is a possibility that archaeological deposits may be disturbed or destroyed. The programme will result in the preparation of a report and ordered archive.

The purpose of an archaeological/palaeontological monitoring programme is:

- To allow, within the resources available, the preservation by record of archaeological/palaeontological deposits, the presence and nature of which could not be established (or established with sufficient accuracy) in advance of development or other potentially disruptive works
- To provide an opportunity, if needed, for the watching archaeologist to signal to all interested parties, before the destruction of the material in question, that an archaeological/palaeontological find has been made for which the resources allocated to the watching brief itself are not sufficient to support treatment to a satisfactory and proper standard.
- A monitoring is not intended to reduce the requirement for excavation or preservation of known or inferred deposits, and it is intended to guide, not replace, any requirement for contingent excavation or preservation of possible deposits.
- The objective of the monitoring is to establish and make available information about the archaeological resource existing on a site.

Table 5: Roles and responsibilities of archaeological and heritage management

ROLE	RESPONSIBILITY	IMPLEMENTATION
A responsible specialist needs to be allocated and should sit in at all relevant meetings, especially when changes in	The client	Archaeologist and a competent archaeology supportive team

design are discussed, and liaise with SAHRA.		
If chance finds and/or graves or burial grounds are identified during construction or operational phases, a specialist must be contacted in due course for evaluation.	The client	Archaeologist and a competent archaeology supportive team
Comply with defined national and local cultural heritage regulations on management plans for identified sites.	The client	Environmental Consultancy and the Archaeologist
Consult the managers, local communities and other key stakeholders on mitigation of archaeological sites.	The client	Environmental Consultancy and the Archaeologist
Implement additional programs, as appropriate, to promote the safeguarding of our cultural heritage. (i.e. integrate the archaeological components into employee induction course).	The client	Environmental Consultancy and the Archaeologist,
If required, conservation or relocation of burial grounds and/or graves according to the applicable regulations and legislation.	The client	Archaeologist, and/or competent authority for relocation services
Ensure that recommendations made in the Heritage Report are adhered to.	The client	The client
Provision of services and activities related to the management and monitoring of significant archaeological sites.	The client	Environmental Consultancy and the Archaeologist
After the specialist/archaeologist has been appointed, comprehensive feedback reports should be submitted to relevant authorities during each phase of development.	Client and Archaeologist	Archaeologist

6.2 All phases of the project

6.2.1 Archaeology and Palaeontology

Based on the findings of the HIA, all stakeholders and key personnel should undergo an archaeological/palaeontological induction course during this phase. Induction courses generally form part of the employees' overall training and the archaeological component can easily be integrated into these training sessions. Two courses should be organised – one aimed more at managers and supervisors, highlighting the value of this exercise and the appropriate communication channels that should be followed after chance finds, and the second targeting the actual workers and getting them to recognize artefacts, features and significant sites. This needs to be supervised by a qualified archaeologist. This course should be reinforced by posters reminding operators of the possibility of finding archaeological/palaeontological sites.

The project will encompass a range of activities during the construction phase, including ground clearance, establishment of construction camps area and small scale infrastructure development associated with the project.

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

During the construction phase, it is important to recognize any significant material being unearthed, making and to make the correct judgment on which actions should be taken. A responsible archaeologist/palaeontologist must be appointed for this commission. This person does not have to be a permanent employee, but needs to sit in at relevant meetings, for example when changes in design are discussed, and notify SAHRA of these changes. The archaeologist would inspect the site and any development recurrently, with more frequent visits to the actual workface and operational areas.

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

6.2.2 Graves

In the case where a grave is identified during construction the following measures must be taken.

Mitigation of graves will require a fence around the cemetery with a buffer of at least 20 meters.

If graves are accidentally discovered during construction, activities must cease in the area and a qualified archaeologist be contacted to evaluate the find. To remove the remains a rescue permit must be applied for with SAHRA and the local South African Police Services must be notified of the find.

Where it is then recommended that the graves be relocated a full grave relocation process that includes comprehensive social consultation must be followed.

The grave relocation process must include:

i. A detailed social consultation process, that will trace the next-of-kin and obtain their consent for the relocation of the graves, that will be at least 60 days in length;
ii. Site notices indicating the intent of the relocation
iii. Newspaper Notice indicating the intent of the relocation
iv. A permit from the local authority;
v. A permit from the Provincial Department of health;
vi. A permit from the South African Heritage Resources Agency if the graves are older than 60 years or unidentified and thus presumed older than 60 years;
vii. An exhumation process that keeps the dignity of the remains intact;
viii. An exhumation process that will safeguard the legal implications towards the developing company;
ix. The whole process must be done by a reputable company that are well versed in relocations;
x. The process must be conducted in such a manner as to safeguard the legal rights of the families as well as that of the developing company.

7 CONCLUSIONS AND RECOMMENDATIONS

The background research, that forms part of the HIA, has shown that the area between Postmasburg and Daniëlskuil generally referred to as the Ghaap plato has a rich history of occupation from the Stone Age with hunter gatherers to the Thlaping and Thlaro during the Iron Age period. The 1800's saw the rise of the Griqua people in the area and their loss of sovereignty after 1880 to Cape rule.

The survey yielded 1 heritage related site.

The site LS1-1 is associated with a low density of Later Stone Age material, with no context. The site has a low heritage significance and no mitigation is required.

It is recommended that an updated palaeontological desktop for the Limestone1 alignment be done to determine the palaeontological significance of the Precambrian limestones, dolomites and cherts of the Ghaap Group (Campbell Rand Subgroup). Almond (pers. Comm.) also indicated that the same geology has potential for fossil stromatolites at surface in the Lime Acres area that lies 12km to the south west of the study area.

Further to these recommendations the general Heritage Management Guideline in Sections 6 needs to be incorporated in to the EMP for the project.

The overall impact of the development on heritage resources is seen as acceptably low and can impacts can be mitigated to acceptable levels.

The following general mitigation measures are recommended:

a. A monitoring plan must be agreed upon by all the stakeholders for the different phases of the project focussing on the areas where earthmoving will occur.
b. If during construction any possible finds are made, the operations must be stopped and the qualified archaeologist be contacted for an assessment of the find.
c. Should substantial fossil remains (e.g. well-preserved fossil fish, reptiles or petrified wood) be exposed during construction, however, the ECO should carefully safeguard these, preferably in situ, and alert SAHRA as soon as possible so that appropriate action (e.g. recording, sampling or collection) can be taken by a professional palaeontologist.
d. A management plan must be developed for managing the heritage resources in the surface area impacted by operations during construction and operation of the development. This includes basic training for construction staff on possible finds, action steps for mitigation measures, surface collections, excavations, and communication routes to follow in the case of a discovery.

8 REFERENCES

BEAUMONT, P.B. AND BOSHIER, A.K. 1974. Report on Test Excavations in a Prehistoric Pigment Mine near Postmasburg, Northern Cape. South African Archaeological Bulletin 29: 41-59.

BEAUMONT, P.B., SMITH, A.B., AND VOGEL, J.C. 1995. Before the Einiqua: the archaeology of the frontier zone. A.B. Smith (ed.). Einiqualand: studies of the Orange River frontier p236-264. Cape Town: UCT Press.

BEAUMONT, P.B. AND VOGEL, J.C. 2006. On a timescale for the past million years of human history in central South Africa. South African Journal of Science 102: 217-228.

COLLINS, S. 1973. Rock-Engravings of the Daniëlskuil Townlands. South African Archaeological Bulletin 28: 49-57.

DOWSON, T.N. 1992. The rock engravings of southern Africa. Johannesburg: Witwatersrand University Press.

HUMPHREYS, A.J.B. 1976. Note on the Southern Limits of Iron Age Settlement in the Northern Cape. South African Archaeological Bulletin 31: 54-57.

HUMPHREYS, A.J.B. AND THACKERAY, A.I. 1983. Ghaap and Gariep: Later Stone Age studies in the Northern Cape. Cape Town: South African Archaeological Society Monograph Series No 2.

LEGASSICK, M.C. 1970. The Griqua, the Sotho-Tswana, and the missionaries, 1780-1840: the politics of a frontier zone. PhD Dissertation. University of California, Los Angeles.

– 1989. The northern frontier to c. 1840: the rise and decline of the Griqua people. Elphick, R. & Giliomee, H. (eds) The Shaping of South African Society, 1652-1840 p358-420. Middletown: Wesleyan University Press.

MITCHELL, P.J. 2002. The archaeology of Southern Africa. Cambridge: Cambridge University Press.

MORRIS, D. 1988. Engraved in place and time: a review of variability in the rock art of the Northern Cape and Karoo. South African Archaeological Bulletin 43: 109-121.

– 2008. Archaeological and Heritage Impact Assessment on Remainder of Carter Block 458, near Lime Acres, Northern Cape. McGregor Museum.

MORRIS, D. AND BEAUMONT, P.B. 1994. Ouplaas 2: Rock engravings, Daniëlskuil. McGregor Museum.

OUZMAN, S. 2005. The magical art of a raider ration: central South Africa's Korana rock art. South African Archaeological Society Goodwin Series 9: 101-113.

PARSONS, I. 2003. Lithic expressions of Later Stone Age lifeways in the Northern Cape. South African Archaeological Bulletin 58: 33-37.

ROSS, R. 1976. Adam Kok's Griquas: a study in the development of stratification in South Africa. Cambridge: Cambridge University Press,

SHILLINGTON, K. 1985. The Colonisation of the Southern Tswana, 1870-1900. Braamfontein: Ravan Press.

SMITH, B.W.S. AND OUZMAN, S. 2004. Taking stock: identifying Khoekhoen herder rock art in southern Africa. Current Anthropology 45(4): 499-526.

SNYMAN, P.H.R. 1985. Daniëlskuil: die trunk mite. Contree 17: 21-24.

– 1988. Daniëlskuil: van Griekwa-buitepos tot dienssentrum. Pretoria: HSRC.

THACKERAY, A.I, THACKERAY, J.F. AND BEAUMONT, P.B. 1983. Excavations at the Blinkklipkop Specularite Mine near Postmasburg, Northern Cape. South African Archaeological Bulletin 38:17-25.

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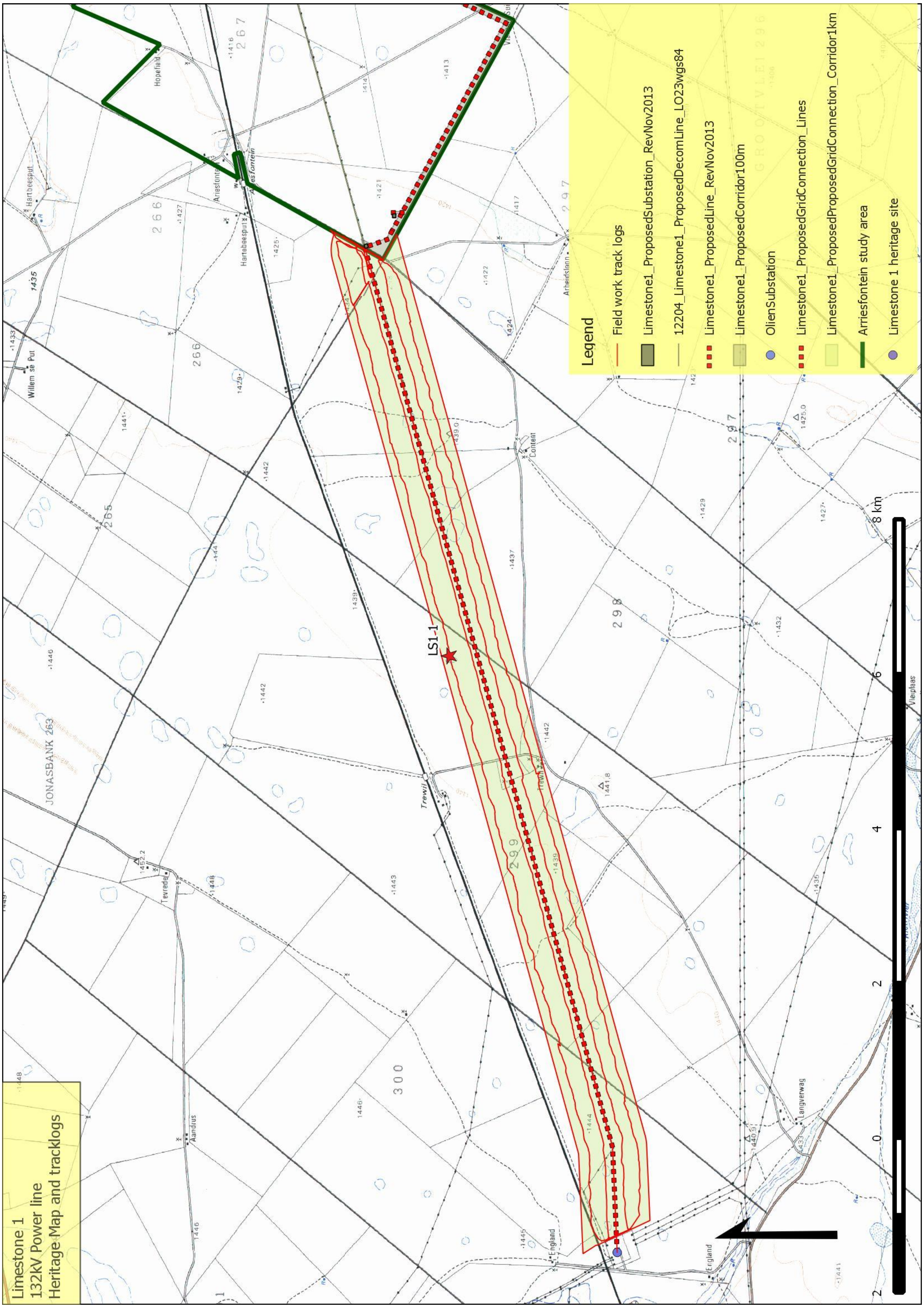
Appendix A

MAP OF HERITAGE SITE


Legend
Field work track logs
Limestone1_ProposedSubstation_RevNov2013
12204_Limestone1_ProposedDecomLine_LO23wgs84
Limestone1_ProposedLine_RevNov2013
Limestone1_ProposedCorridor100m
OlienSubstation
Limestone1_ProposedGridConnection_Lines
Limestone1_ProposedProposedGridConnection_Corridor1km
Arriesfontein study area
Limestone 1 heritage site
LS1-1
Limestone 1
132kV Power line
Heritage Map and tracklogs
0
2
4
6
8 km

Appendix B

PALAEONTOLOGICAL STUDY FOR ARRIESFONTEIN PROJECT

PALAEONTOLOGICAL SPECIALIST STUDY: DESKTOP ASSESSMENT

Proposed Solar Thermal Energy Power Park on Farm Arriesfontein, near Daniëlskuil, Postmasburg District, Northern Cape Province

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November 2011

SUMMARY

The company SolarReserve SA (Pty) LTD is proposing to construct a 325 MW Solar Power Park on the Farm Arriesfontein, Barkley West Regional District, Siyanda District Municipal Region in the Northern Cape. The planned solar park will comprise both photovoltaic (PV) and concentrated solar power (CSP) components. The proposed development site is situated in flat terrain on the eastern side of the Asbesberge, approximately 24 km southeast of the town of Daniëlskuil and 110 km northwest of the city of Kimberley.

The study area for the proposed Arriesfontein solar power plant near Daniëlskuil is underlain at depth by Early Precambrian marine carbonate sediments of the Ghaap Group that are only sparsely fossiliferous (*e.g.* microbial mounds or stromatolites). Most of the study area is mantled by Late Caenozoic superficial deposits including Quaternary to Recent calcretes (pedogenic limestones) and downwasted rock rubble of comparable age, all of which are of low to very low palaeontological sensitivity. Extensive, deep excavations are unlikely to be involved in this sort of solar power plant project. The overall impact significance of the proposed development is therefore likely to be LOW and no fatal flaws, no-go areas or buffer zones for palaeontological heritage resources have been identified by this desktop study. No further specialist palaeontological studies, monitoring or mitigation are recommended for this development.

During the construction phase of the solar power plant the ECO responsible for the development should be aware of the possibility of important fossils being present or unearthed on site and should monitor all substantial excavations into fresh (*i.e.* unweathered) sedimentary bedrock for fossil remains. In the case of any significant fossil finds (*e.g.* vertebrate teeth, bones, burrows, petrified wood, calcretised termitaria) during construction, these should be safeguarded - preferably *in situ* - and reported by the ECO as soon as possible to the relevant heritage management authority (SAHRA) so that any appropriate mitigation by a palaeontological specialist can be considered and implemented, at the developer's expense.

These recommendations should be incorporated into the EMP for the solar power plant development.

1. INTRODUCTION

The company SolarReserve SA (Pty) LTD is proposing to construct a 325 MW Solar Power Park on the Farm Arriesfontein, Barkly West Regional District, Siyanda District Municipal Region in the Northern Cape. The planned solar park will comprise both photovoltaic (PV) and concentrated solar power (CSP) components. The proposed development site is situated in flat terrain on the eastern side of the Asbesberge, approximately 24 km southeast of the town of Daniëlskuil and 110 km northwest of the city of Kimberley (Figs. 1 & 2). The development site is located within the institutional boundaries of the Kgatelopele Local and Siyanda District Municipalities.

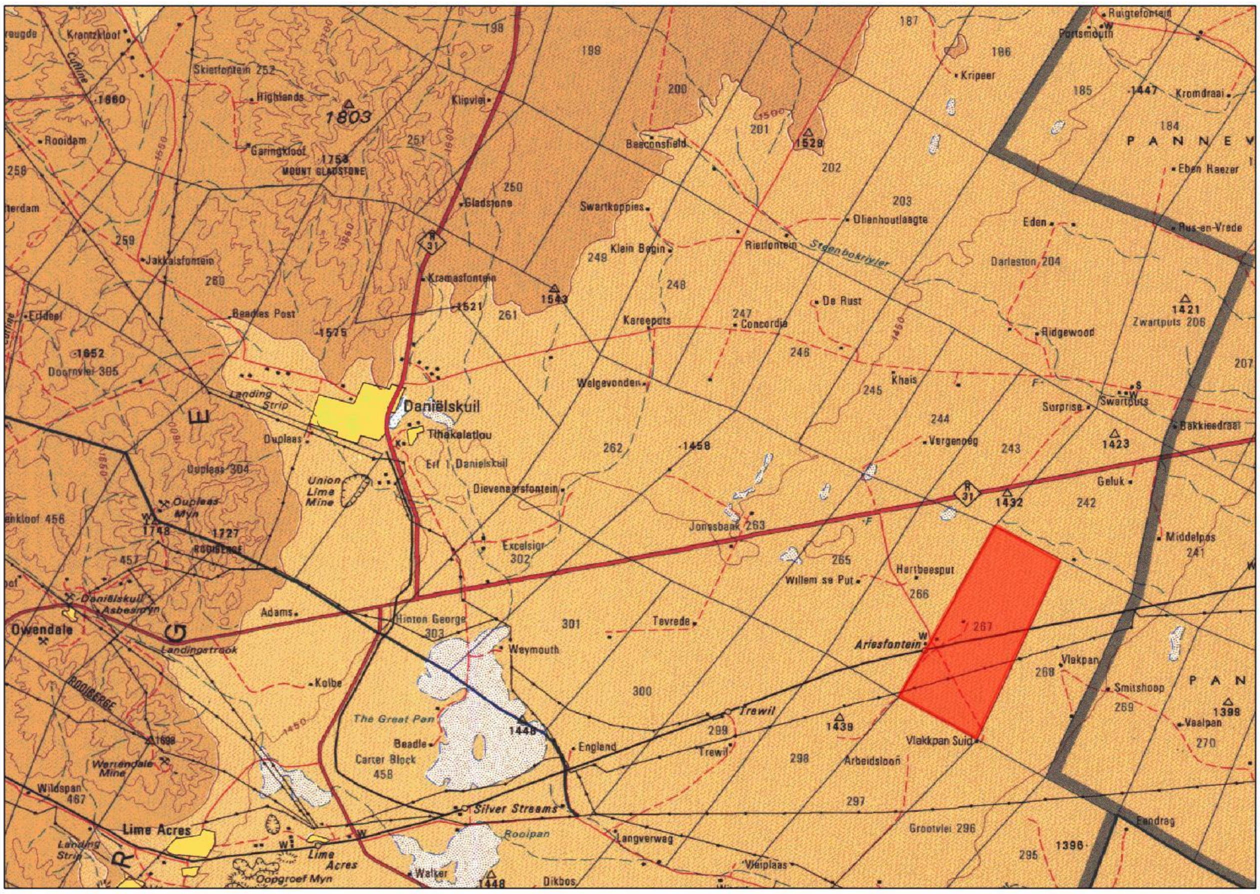

Fig. 1. Extract from 1: 250 000 topographical map 3822 Postmasburg showing location of the proposed Arriesfontein Solar Power Plant study area (red polygon) located *c*. 24 km southeast of Daniëlskuil, Northern Cape (Image kindly provided by PGS (Pty) Ltd).

The following brief project description for the solar plant has been abstracted from the Background Information Document prepared by WorleyParsons RSA (Pty) Ltd, PO Box 93155, Menlo Park 0102, South Africa, dated October 2011:

1. The **CSP plant** being considered is a molten salt-type, central receiver (tower) technology. The plant requires approximately 6 km^2 of low-relief terrain and will primarily comprise the following four components:

   - **Solar Field** - consists of all services and infrastructure related to the management and operation of the heliostats (reflective mirrors). It is estimated that approximately 17 000 heliostats with an area of approximately 65 m^2 each will be required for the solar field in order to obtain a power output of approximately 100 MW;

   - **Molten Salt Circuit** - includes the thermal storage tanks for storing liquid salt, a concentration receiver/tower, pipelines and heat exchangers;

- **The Power Block –** housing the steam turbine;

- **Auxiliary facilities and infrastructure** - includes a condenser-cooling system, electricity transmission lines to allow for grid connection, access routes, water treatment and supply amenities and a CSP plant start-up energy supply unit (gas or diesel generators).

2. The **PV development** will consist of photo-voltaic solar panels that will occupy up to 450 ha of the site area in total. The PV will be developed in three blocks of 150 ha. Each block of 150 ha will produce 75 MW. The PV development will produce 225 MW of power in total. The panels will be situated in rows extending across the site in lines. PV panels are typically up to 15 m^2 in size and the rows will be approximately 1 km in length, made up of approximately 100 m sections depending on the final design and layout of the development. The panels will be mounted on metal frames with a maximum height of approximately 3 m above the ground, supported by concrete or screw pile foundations, and they will face north in order to capture the maximum sunlight. The facility will either be a fixed PV plant where the solar panels are stationary or a tracking PV plant where the solar panels rotate to track the sun's movement (the exact type of PV plant system will be determined following on-site solar resource modelling and detailed development design). A detailed technical description for this project has not yet been developed.

The proposed development area is underlain at depth by Early Precambrian marine sediments but also features a variety of Late Caenozoic superficial sediments, some of which may contain sparse fossil remains.

The extent of the proposed development (over 5000 m^2) falls within the requirements for a Heritage Impact Assessment (HIA) as required by Section 38 (Heritage Resources Management) of the South African Heritage Resources Act (Act No. 25 of 1999). The various categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act include, among others:

- geological sites of scientific or cultural importance
- palaeontological sites
- palaeontological objects and material, meteorites and rare geological specimens

Minimum standards for the palaeontological component of heritage impact assessment reports are currently being developed by SAHRA. The latest version of the SAHRA guidelines is dated May 2007.

SolarReserve SA (Pty) LTD has appointed Worley Parsons RSA as independent Environmental Assessment Practitioners in support of an application for Environmental Authorisation and a Waste Management License. The Heritage Impact Assessment for this project is being conducted by Professional Grave Solutions (Pty) Ltd, PO Box 32542, Totiusdal, 0134, RSA who have commissioned the present desktop palaeontological study.

2. APPROACH & METHODOLOGY

2.1. Details of specialist

Dr John Almond has an Honours Degree in Natural Sciences (Zoology) as well as a PhD in Palaeontology from the University of Cambridge, UK. He has been awarded post-doctoral research fellowships at Cambridge University and in Germany, and has carried out palaeontological research in Europe, North America, the Middle East as well as North and South

Africa. For eight years he was a scientific officer (palaeontologist) for the Geological Survey / Council for Geoscience in the RSA. His current palaeontological research focuses on fossil record of the Precambrian - Cambrian boundary and the Cape Supergroup of South Africa. He has recently written palaeontological reviews for several 1: 250 000 geological maps published by the Council for Geoscience and has contributed educational material on fossils and evolution for new school textbooks in the RSA.

Since 2002 Dr Almond has also carried out palaeontological impact assessments for developments and conservation areas in the Western, Eastern and Northern Cape, Free State and Mpumalanga under the aegis of his Cape Town-based company *Natura Viva* cc. He is a long-standing member of the Archaeology, Palaeontology and Meteorites Committee for Heritage Western Cape (HWC) and an advisor on palaeontological conservation and management issues for the Palaeontological Society of South Africa (PSSA), HWC and SAHRA. He is currently compiling technical reports on the provincial palaeontological heritage of Western, Northern and Eastern Cape as well as the Free State, Gauteng and Limpopo for SAHRA and HWC. Dr Almond is an accredited member of PSSA and APHP (Association of Professional Heritage Practitioners – Western Cape).

2.2. General approach used for palaeontological impact desktop studies

In preparing a palaeontological desktop study the potentially 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, previous palaeontological impact studies in the same region, and the author's field experience (Consultation with professional colleagues as well as examination of institutional fossil collections may play a role here, or later during the compilation of the final report). This data is then used to assess the palaeontological sensitivity of each rock unit to development (Provisional tabulations of palaeontological sensitivity of all formations in the Western, Eastern and Northern Cape have already been compiled by J. Almond and colleagues; *e.g.* Almond & Pether 2008). The likely impact of the proposed development on local fossil heritage is then determined on the basis of (1) the palaeontological sensitivity of the rock units concerned and (2) the nature of the development itself, most notably the extent of fresh bedrock excavation envisaged.

When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a field-based assessment by a professional palaeontologist is usually warranted. Most detrimental impacts on palaeontological heritage occur during the construction phase when fossils may be disturbed, destroyed or permanently sealed-in during excavations and subsequent construction activity. Where specialist palaeontological mitigation is recommended, this may take place before construction starts or during the construction phase while fresh, portentially fossiliferous bedrock is still exposed for study. Mitigation usually involves the judicious sampling, collection and recording of fossils as well as of relevant contextual data concerning the surrounding sedimentary matrix. It should be emphasised that, *provided* appropriate mitigation is carried out, many developments involving bedrock excavation actually have a *positive* impact on our understanding of local palaeontological heritage. Constructive collaboration between palaeontologists and developers should therefore be the expected norm.

2.3. Information sources

The information used in this fossil heritage screening study was based on the following:

1. A short project outline in the BID document prepared by WorleyParsons RSA (Pty) Ltd ;

2. A review of the relevant scientific literature, including published geological maps and accompanying sheet explanations;

3. Previous palaeontological assessments for developments in the Postmasburg region by the author (*e.g.* Almond 2010a, 2010b).

2.4. Assumptions & limitations

The accuracy and reliability of palaeontological specialist studies as components of heritage impact assessments are generally limited by the following constraints:

1. Inadequate database for fossil heritage for much of the RSA, given the large size of the country and the small number of professional palaeontologists carrying out fieldwork here. Most development study areas have *never* been surveyed by a palaeontologist.

2. Variable accuracy of geological maps which underpin these desktop studies. For large areas of terrain these maps are largely based on aerial photographs alone, without ground-truthing. The maps generally depict only significant ("mappable") bedrock units as well as major areas of superficial "drift" deposits (alluvium, colluvium) but for most regions give little or no idea of the level of bedrock outcrop, depth of superficial cover (soil *etc*), degree of bedrock weathering or levels of small-scale tectonic deformation, such as cleavage. All of these factors may have a major influence on the impact significance of a given development on fossil heritage and can only be reliably assessed in the field.

3. Inadequate sheet explanations for geological maps, with little or no attention paid to palaeontological issues in many cases, including poor locality information;

4. The extensive relevant palaeontological "grey literature" - in the form of unpublished university theses, impact studies and other reports (*e.g*. of commercial mining companies) - that is not readily available for desktop studies;

5. Absence of a comprehensive computerized database of fossil collections in major RSA institutions which can be consulted for impact studies. A Karoo fossil vertebrate database is now accessible for impact study work.

In the case of palaeontological desktop studies without supporting field assessments these limitations may variously lead to either:

(a) *underestimation* of the palaeontological significance of a given study area due to ignorance of significant recorded or unrecorded fossils preserved there, or

(b) *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 tectonism or weathering, or are buried beneath a thick mantle of unfossiliferous "drift" (soil, alluvium *etc*).

Since most areas of the RSA have not been studied palaeontologically, a palaeontological desktop study usually entails *inferring* the presence of buried fossil heritage within the study area from relevant fossil data collected from similar or the same rock units elsewhere, sometimes at localities far away. Where substantial exposures of bedrocks or potentially fossiliferous superficial sediments are present in the study area, the reliability of a palaeontological impact assessment may be significantly enhanced through field assessment by a professional palaeontologist.

In the present case the main factor constraining the reliability of the assessment of fossil heritage within the development area is the lack of geological information concerning the rock unit mapped as "rubble" within the study area (but not described in the brief sheet explanation printed on the map).

3. DESCRIPTION OF THE STUDY AREA

3.1. Location and brief description of study area

The Arriesfontein Farm study area is located in very flat-lying terrain at 1420-1430m amsl extending from the eastern edge of the Asbesberge near the mining town of Daniëlskuil. It is transected by the Kimberley – Postmasburg – Sishen railway line and lies some 6 km south of the R31 road between Barkly West and Postmasburg (Figs. 1, 2). The shallow WNW-ESE trending water courses of the Steenbokrivier and Klein-Rietrivier run across the semi-arid plains some 12 km to the north and south of the study area. Several small pans are visible on satellite images of the area (Fig. 2), designated as *panneveld* on many maps, and the much larger Groot Pan and Rooipan lie less than 20 km to the west.

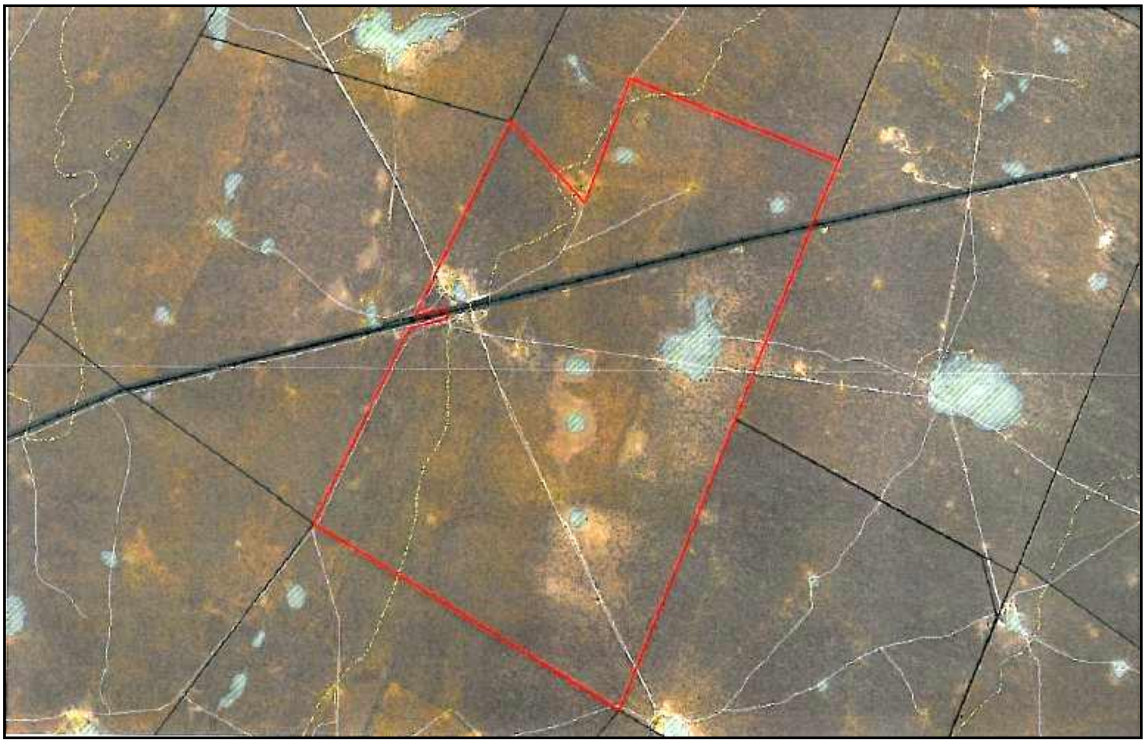

Fig. 2. Satellite image of the Arriesfontein Solar Power Plant study area (red polygon) showing flat terrain, the Kimberley-Sishen railway (black line) and numerous small pans (pale blue-grey areas) (Image abstracted from BID prepared by Worley Parsons RSA (Pty) Ltd).

3.2. Geology of the study area

The geology of the study area to the east of Daniëlskuil is shown on the 1: 250 000 geology map 2822 Postmasburg (Council for Geoscience, Pretoria; Fig. 3 herein). This map is now out of print is not accompanied by a detailed geological sheet explanation (A very brief explanation is printed on the map, however). Relevant earlier 1: 125 000 sheet explanations include those by Truter *et al.* (1938) on the Olifantshoek area and by Visser (1958) on the Griquatown area.

Geological units represented within the study area are listed below the geological map in Fig. 3. Since these various geological maps were published, there have been considerable revisions to the stratigraphic subdivision and assignment of the Precambrian rock units represented within the Postmasburg study region. Where possible, the recent stratigraphic account for the Transvaal Supergroup given by Eriksson *et al.* (2006) is followed here, but correlations for all the subdivisions indicated on the older maps are not always clear.

According to the 1: 250 000 geology map (Fig. 3) the flat-lying region within which the proposed Arriesfontein solar power plant is to be situated is underlain at depth by Early Precambrian sedimentary rocks of the **Ghaap Group** of the Griqualand West Basin, Ghaap Plateau Subbasin (Late Archaean to Early Proterozoic; **Vgl** on geological map). Useful reviews of the stratigraphy and sedimentology of these Transvaal Supergroup rocks have been given by Moore *et al.* (2001), Eriksson and Altermann (1998) as well as Eriksson *et al.* (1993, 1995, 2006). The Ghaap Group represents some 200 Ma of chemical sedimentation - notably iron and manganese ores, cherts and carbonates - within the Griqualand West Basin that was situated towards the western edge of the Kaapvaal Craton (See also fig. 4.19 in McCarthy & Rubidge 2005).

The **Campbell Rand Subgroup** (previously included within the Ghaapplato Formation) of the Ghaap Group is a very thick (1.6-2.5 km) carbonate platform succession of dolomites, dolomitic limestones and cherts with minor tuffs that was deposited on the shallow submerged shelf of the Kaapvaal Craton roughly 2.6 to 2.5 Ga (billion years ago; see readable general account by McCarthy & Rubidge, pp. 112-118 and Fig. 4.10 therein). A range of shallow water facies, often forming depositional cycles reflecting sea level changes, are represented here, including stromatolitic limestones and dolomites, oolites, oncolites, laminated calcilutites, cherts and marls, with subordinate siliclastics (shales, siltstones) and minor tuffs (Eriksson *et al.* 2006). Exposure levels of these rocks are often very low.

Campbell Rand carbonates (Vgl) underlie the entire Arriesfontein study area at depth. Underlying bedded cherts and chert breccia are mapped some 5km to the southeast (Vgl, dark green on the geological map, Fig. 3) but not within the study area itself. The outcrop area of the latter chert-rich unit is largely covered in downwasted, siliceous rock rubble (Key to Postmasburg sheet).

Note that since the 1: 250 000 geological maps were produced, the Campbell Rand succession has been subdivided into a series of formations, some of which were previously included within the older Schmidtsdrift Formation or Subgroup (Beukes 1980, 1986, Eriksson *et al.* 2006). It is unclear exactly which of these newer units are represented in the Arriesfontein study areas. However, this resolution is not critical for the current report since the carbonate facies are only seen at surface in a small part of the study area, around Arriesfontein station, and they are unlikely to be seriously impacted by the proposed development.

The greater part of the Arriesfontein study area is mantled by **superficial sediments** of probable Late Caenozoic (*i.e.* Late Tertiary or Neogene to Recent) age, mapped as surface limestone (**Ql**, yellow; *i.e.* calcrete and downwasted limestone rubble) as well as "*verweringspuin*" or downwasted rock rubble (pale buff with triangle symbol on map).

Mappable exposures of **surface limestone** (**Ql**) occur along the eastern edge of the study area. Patches of pedogenic calcrete occur extensively overlying the Campbell Rand carbonates and may also underlie Kalahari sands in the Postmasburg region. These deposits reflect seasonally arid climates in the region over the last five or so million years and are briefly described by Truter *et al.* (1938) as well as Visser (1958). The surface limestones may reach thicknesses of over 20m, but are often much thinner, and are locally conglomeratic with clasts of reworked calcrete as well as exotic pebbles. The limestones may be secondarily silicified and incorporate blocks of the underlying Precambrian carbonate rocks.

Little can be said at the desktop level concerning the geology of the **rock rubble** that is mapped over most of the western and central portions of the Arriesfontein study area, since this is not described in the very short geological explanation for the Postmasburg 1: 250 000 sheet. It is likely that downwasted siliceous blocks weathered out from cherty horizons within the underlying Campbell Rand Subgroup make up a large proportion of this surface rubble. Other, more exotic, resistant lithologies represented in the broader region that might also be found here include quartzite, agate, jasper and banded ironstone (*cf* Truter *et al.* 1938, p. 40). A degree of secondary silicification and impregnation by manganese minerals might be expected here.

Pan sediments in the Northern Cape and elsewhere have been briefly treated by Partridge & Scott (2000) and Partridge *et al.* (2006). They typically comprise pale, fine-grained silts, sands and clays, sometimes with an evaporite component. Most are of Pleistocene age or younger. Truter et al. (1938, p. 39) refer to a "tuffaceous limestone" that is usually found in small pans in the Olifants Hoek area.

Much of the arid terrain within the study area is doubtless mantled with a spectrum of other coarse to fine-grained **surface deposits** such as rocky soils, sheet wash and alluvium of intermittently flowing streams. Since these deposits are generally young and largely unfossiliferous, they will not be treated further here.

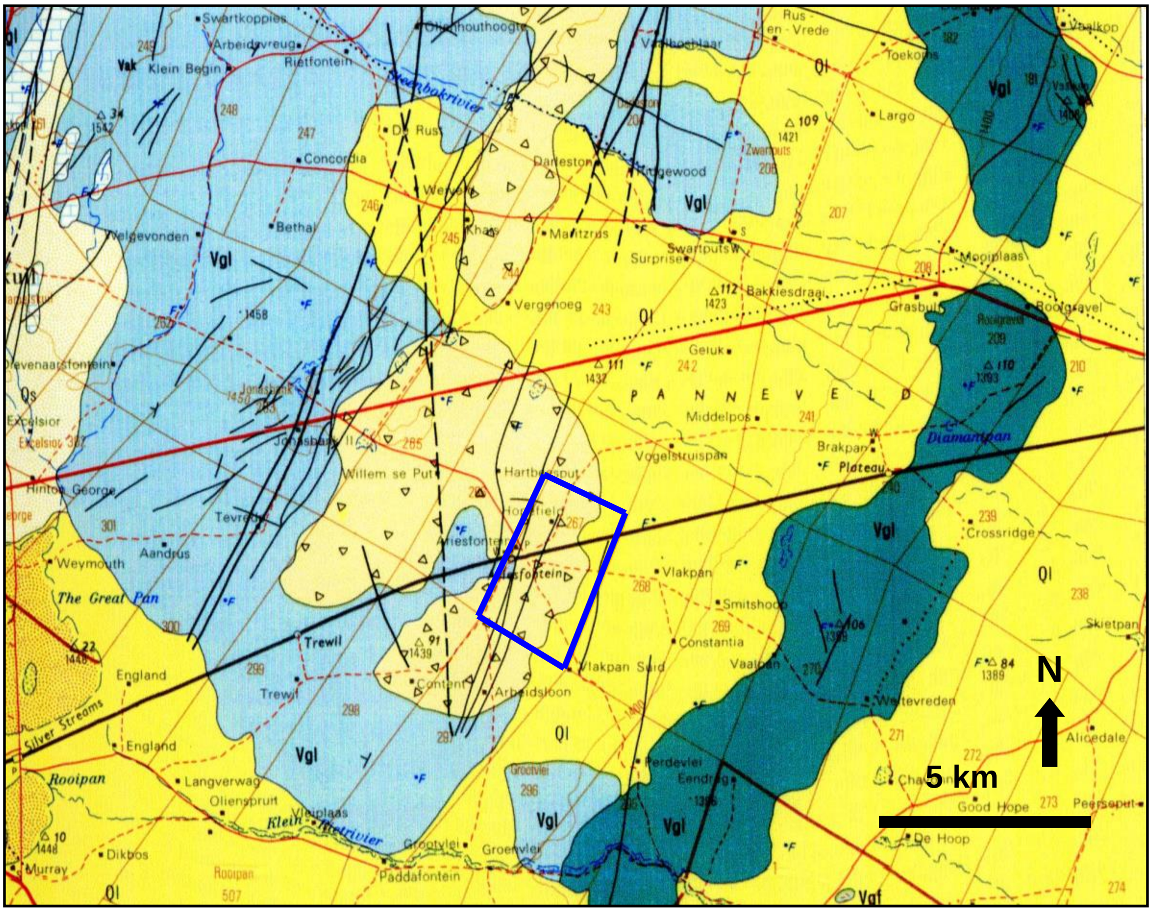

Fig. 3. Extract from 1: 250 000 geological map 2822 Postmasburg (Council for Geoscience, Pretoria) showing *approximate* location of proposed Arriesdrift Solar Power Plant study area *c.* 24 km southeast of Daniëlskuil, Northern Cape Province (blue polygon). Potentially fossiliferous sedimentary rock units mapped within the broader study region include:

Vgl (pale blue) = Precambrian limestones, dolomites and cherts of the Ghaap Group (Campbell Rand Subgroup)

Vgl (dark green) = Precambrian banded cherts and chert breccia of the Ghaap Group

Ql (yellow) = Late Caenozoic calcretes (Kalahari Group in part)

Buff with triangular symbols = superficial downwasted "rubble" (*verweringspuin*)

The overall palaeontological sensitivity of the entire study area is LOW.

4. PALAEONTOLOGICAL HERITAGE

The fossil record of the Precambrian and much younger Caenozoic sediments of the Northern Cape has been very briefly reviewed by Almond & Pether (2008).

4.1. Fossils within the Transvaal Supergroup

The shallow shelf and intertidal sediments of the carbonate-dominated lower part of the **Ghaap Group** (*i.e.* Schmidtsdrif and Campbell Rand Subgroups) are famous for their rich fossil biota of *stromatolites* or microbially-generated, finely laminated sheets, mounds and branching structures. Some stromatolite occurrences on the Ghaap Plateau of the Northern Cape are spectacularly well-preserved (*e.g.* Boetsap locality northeast of Daniëlskuil figured by McCarthy & Rubidge 2005, Eriksson *et al.* 2006; Fig. 4). Detailed studies of these 2.6-2.5 Ga carbonate sediments and their stromatolitic biotas have been presented by Young (1932), Beukes (1980, 1983), Eriksson & Truswell (1974), Eriksson & Altermann (1998), Eriksson *et al* (2006), Altermann and Herbig (1991), and Altermann and Wotherspoon (1995). Some of the oldest known (2.6Ga) fossil microbial assemblages with filaments and coccoids have been recorded from stromatolitic cherty limestones of the Lime Acres Member, Kogelbeen Formation at Lime Acres which is situated just south of Daniëlskuil (Altermann & Schopf 1995). The oldest, Archaean stromatolite occurrences from the Ghaap Group have been reviewed by Schopf (2006, with full references therein). The Tsineng Formation at the top of the Campbell Rand carbonate succession has yielded both stromatolites (previously assigned to the Tsineng Member of the Gamohaan Formation) as well as filamentous microfossils named *Siphonophycus* (Klein *et al.*1987, Altermann & Schopf 1995).

Fig. 4. Stromatolite domes (*c*. 1m diameter) within the Ghaap Group at the famous Boetsap locality, northeast of Daniëlskuil, Northern Cape Province (From Macarthy & Rubidge 2005).

4.2. Fossils within the Late Caenozoic superficial sediments

In areas underlain by Ghaap Group carbonate rocks migrating lime-rich groundwaters may have led to the rapid calcretisation within overlying "drift" deposits of organic structures such as burrows and root casts. Occasional terrestrial fossil remains that might be expected within surface limestones include calcretized rhizoliths (root casts) and termitaria (*e.g. Hodotermes*, the harvester termite), ostrich egg shells (*Struthio*) and shells of land snails (*e.g. Trigonephrus*) (Almond 2008, Almond & Pether 2008). Other fossil groups such as freshwater bivalves and gastropods (*e.g. Corbula, Unio*), ostracods (seed shrimps), charophytes (stonewort algae), diatoms (microscopic algae within siliceous shells) and stromatolites (laminated microbial limestones) are associated with watercourses and pans. Abundant small terrestrial gastropod shells are recorded from pan sediments in the Olifantshoek area by Truter *et al.* (1938, p. 39), while coquinas of Late Pleistocene freshwater gastropods are reported from pans in the Loeriesfontein sheet area in the northern Cape (Almond 2008). Microfossils such as diatoms may be blown by wind into nearby dune sands (Du Toit 1954, Dingle *et al*., 1983).

Mammalian bones, teeth and horn cores (also tortoise remains, and fish, amphibian or even crocodiles in wetter depositional settings) may be expected occasionally expected within ancient alluvial gravels, downwasted rock rubble and pan sediments (*cf* Almond 2008, Partridge & Scott 2000). However, these fossil assemblages are generally sparse, low in diversity, and occur over a wide geographic area, so the palaeontological sensitivity of the superficial sediments within the study area is rated as low.

5. INDENTIFICATION OF POTENTIAL IMPACTS *plus* RECOMMENDED MITIGATION

The proposed Arriesfontein solar power plant development near Daniëlskuil is located in an area that is in part underlain by at most sparsely fossiliferous sedimentary rocks of Precambrian and Late Caenozoic age, the latter comprising mainly Quaternary to Recent calcretes and downwasted rock rubble.

The construction phase of the solar power plant will entail fresh excavations into the superficial sediment cover (soils, alluvium *etc*) and perhaps also into the underlying bedrock. These notably include excavations for the solar panel foundations, buried cables (probably around 1m deep), new gravel roads with drainage trenches, and associated building infrastructure (*e.g.* concentration tower, power block, administration buildings). In addition, sizeable areas of bedrock may be sealed-in or sterilized by infrastructure such as the CSP solar field, ancillary buildings as well as a new gravel road system.

All these developments may adversely affect fossil heritage at or near the surface within the study area by destroying, disturbing or permanently sealing-in fossils that are then no longer available for scientific research or other public good.

Once constructed, the operational and decommissioning phases of the solar energy facility will not involve further adverse impacts on palaeontological heritage, however.

The overall impact significance of the proposed solar park development is likely to be LOW because:

- Most of the study area is underlain by sparsely fossiliferous Precambrian sediments or mantled by superficial sediments (calcretes, rock rubble, alluvium *etc*) of low palaeontological sensitivity;
- Extensive, deep excavations are unlikely to be involved in this sort of solar park project.

Significant negative impacts on local fossil heritage are therefore unlikely to result from the proposed solar power plant development and in the author's opinion no further specialist palaeontological studies for this project are necessary.

During the construction phase of the solar power plant:

- The ECO responsible for the development should be aware of the possibility of important fossils being present or unearthed on site and should monitor all substantial excavations into fresh (*i.e.* unweathered) sedimentary bedrock for fossil remains;

- In the case of any significant fossil finds (*e.g.* vertebrate teeth, bones, burrows, petrified wood, calcretised termitaria) during construction, these should be safeguarded - preferably *in situ* - and reported by the ECO as soon as possible to the relevant heritage management authority (SAHRA) so that any appropriate mitigation by a palaeontological specialist can be considered and implemented, at the developer's expense;

- These recommendations should be incorporated into the EMP for the solar park development.

5. RELEVANT LEGISLATIVE AND PERMIT REQUIREMENTS

According to the National Heritage Resources Act (Act 25 of 1999, Sections 3 and 35) all geological sites of scientific or cultural importance, palaeontological sites, palaeontological objects and material, meteorites and rare geological specimens are regarded as part of the National Estate and are protected by law.

According to Section 35 of the Act, no person may, without a permit issued by the responsible heritage resources authority:

- destroy, damage, excavate, alter, deface or otherwise disturb any palaeontological site;
- destroy, damage, excavate, remove from its original position, collect or own any palaeontological material or object;
- trade in, sell for private gain, export or attempt to export from the Republic any category of palaeontological material or object; or
- bring onto or use at a palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of palaeontological material or objects.

The extent of the proposed solar park development (over 5000 m^2) falls within the requirements for a Heritage Impact Assessment (HIA) as required by Section 38 (Heritage Resources Management) of the South African Heritage Resources Act (Act No. 25 of 1999). Where fossil heritage may be present, a specialist palaeontological study forms an integral part of such a HIA and its conclusions and recommendations would need to be combined with those of other heritage specialists as an integrated heritage study.

6. DISCUSSION & CONCLUSIONS

The study area for the proposed Arriesfontein solar power plant near Daniëlskuil is underlain at depth by Early Precambrian marine carbonate sediments of the Ghaap Group that are only sparsely fossiliferous (*e.g.* microbial mounds or stromatolites). Most of the study area is mantled by Late Caenozoic superficial deposits including Quaternary to Recent calcretes (pedogenic limestones) and downwasted rock rubble of comparable age, all of which are of low to very low palaeontological sensitivity. Extensive, deep excavations are unlikely to be involved in this sort of solar power plant project. The overall impact significance of the proposed development is therefore likely to be LOW and no no-go areas or buffer zones for palaeontological heritage resources have been identified by this desktop study. No further specialist palaeontological studies, monitoring or mitigation are recommended for this development.

7. ACKNOWLEDGEMENTS

Mr Wouter Fourie of Professional Grave Solutions (Pty) Ltd, PO Box 32542, Totiusdal, is thanked for commissioning this study and for kindly providing all the necessary background information.8.

8. REFERENCES

ALMOND, J.E. 2008. Fossil record of the Loeriesfontein sheet area (1: 250 000 geological sheet 3018). Unpublished report for the Council for Geoscience, Pretoria, 32 pp.

ALMOND, J.E. 2010a. Proposed photovoltaic power station adjacent to Welcome Wood Substation, Owendale near Postmasburg, Northern Cape Province: desktop palaeontological assessment, 13 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2010b. Prospecting application for iron ore and manganese between Sishen and Postmasburg, Northern Cape Province: farms Jenkins 562, Marokwa 672, Thaakwaneng 675, Driehoekspan 435, Doringpan 445 and Macarthy 559: desktop palaeontological assessment, 20 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. & PETHER, J. 2008. Palaeontological heritage of the Northern Cape. Interim SAHRA technical report, 124 pp. Natura Viva cc., Cape Town.

ALTERMANN, J. & HERBIG 1991. Tidal flats deposits of the Lower Proterozoic Campbell Group along the southwestern margin of the Kaapvaal Craton, Northern Cape province, South Africa. Journal of African Earth Science 13: 415-435.

ALTERMANN, W. & SCHOPF, J.W. 1995. Microfossils from the Neoarchaean Campbell Group, Griqualand West Sequence of the Transvaal Supergroup, and their paleoenvironmental and evolutionary implications. Precambrian Research 75, 65-90.

ALTERMANN, W. & WOTHERSPOON, J. McD. 1995. The carbonates of the Transvaal and Griqualand West sequences of the Kaapvaal craton, with special reference to the Limje Acres limestone deposit. Mineralium Deposita 30, 124-134.

BERTRAND-SARFATI, J. 1977. Columnar stromatolites from the Early Proterozoic Schmidtsdrift Formation, Northern Cape Province, South Africa – Part 1: systematic and diagnostic features. Palaeontologia Africana 20, 1-26.

BEUKES, N.J. 1980. Stratigraphie en litofasies van die Campbellrand-Subgroep van die Proterofitiese Ghaap-Group, Noord-Kaapland. Transactions of the Geological Society of South Africa 83, 141-170.

BEUKES, N.J. 1983. Stratigraphie en litofasies van die Campbellrand-Subgroep van die proterofitiese Ghaap-Groep, Noord-Kaapland. Transactions of the Geological Society of South Africa 83: 141-170.

BEUKES, N.J. 1986. The Transvaal Sequence in Griqualand West. In: Anhaeusser, C.R. & Maske, S. (Eds.) Mineral deposits of Southern Africa, Volume 1, pp. 819-828. Geological Society of South Africa.

COETZEE, L.L., BEUKES, N.J. & GUTZMER, J. 2006. Links of organic carbon cycling and burial to depositional depth gradients and establishment of a snowball Earth at 2.3 Ga. Evidence from the Timeball Hill Formation, Transvaal Supergroup, South Africa. South African Journal of geology 109, 109-122.

DINGLE, R.V., SIESSER, W.G. & NEWTON, A.R. 1983. Mesozoic and Tertiary geology of southern Africa. viii + 375 pp. Balkema, Rotterdam.

DU TOIT, A. 1954. The geology of South Africa. xii + 611pp, 41 pls. Oliver & Boyd, Edinburgh.

ERIKSSON, K.A. & TRUSWELL, J.F. 1973. High inheritance elongate stromatolitic mounds from the Transvaal Dolomite. Palaeontologia Africana 15, 23-28.

ERIKSSON, K.A. & TRUSWELL, J.F. 1974. Tidal flat associations from a Lower Proterozoic carbonate sequence in South Africa. Sedimentology 21: 293-309.

ERIKSSON, K.A., TRUSWELL, J.F. & BUTTON, A. 1976. Paleoenvironmental and geochemical models from an Early Proterozoic carbonate succession in South Africa. In: Walter, M.R. (Ed.) Stromatolites, 635-643. Blackwell, Oxford.

ERIKSSON, P.G., SCHWEITZER, J.K., BOSCH, P.J.A., SCHREIBER, U.M., VAN DEVENTER, J.L. & HATTON, C. 1993. The Transvaal Sequence: an overview. Journal of African Earth Science 16, 25-51.

ERIKSSON, P.G., HATTINGH, P.J. & ALTERMANN, W. 1995. An overview of the geology of the Transvaal Sequence and the Bushveld Complex, South Africa. Mineralium Deposita 30, 98-111.

ERIKSSON, P.G. & ALTERMANN, W. 1998. An overview of the geology of the Transvaal Supergroup dolomites (South Africa). Environmental Geology 36, 179-188.

ERIKSSON, P.G., ALTERMANN, W. & HARTZER, F.J. 2006. The Transvaal Supergroup and its precursors. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa, pp. 237-260. Geological Society of South Africa, Marshalltown.

HENDEY, Q.B. 1984. Southern African late Tertiary vertebrates. In: Klein, R.G. (Ed.) Southern African prehistory and paleoenvironments, pp 81-106. Balkema, Rotterdam.

KLEIN, C., BEUKES, N.J. & SCHOPF, J.W. 1987. Filamentous microfossils in the early Proterozoic Transvaal Supergroup: their morphology, significance, and palaeoenvironmental setting. Precambrian Research 36, 81-94.

MACRAE , C. 1999. Life etched in stone. Fossils of South Africa. 305 pp. The Geological Society of South Africa, Johannesburg.

MCCARTHY, T. & RUBIDGE, B. 2005. The story of Earth and life: a southern African perspective on a 4.6-billion-year journey. 334pp. Struik, Cape Town.

MOORE, J.M., TSIKOS, H. & POLTEAU, S. 2001. Deconstructing the Transvaal Supergroup, South Africa: implications for Palaeoproterozoic palaeoclimate models. African Earth Sciences 33, 437-444.

PARTRIDGE, T.C., BOTHA, G.A. & HADDON, I.G. 2006. Cenozoic deposits of the interior. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa, pp. 585-604. Geological Society of South Africa, Marshalltown.

SCHOPF, J.W. 2006. Fossil evidence of Archaean life. Philosophical Transactions of the Royal Society of London B 361, 869-885.

TANKARD, A.J., JACKSON, M.P.A., ERIKSSON, K.A., HOBDAY, D.K., HUNTER, D.R. & MINTER, W.E.L. 1982. Crustal evolution of southern Africa – 3.8 billion years of earth history, xv + 523pp. Springer Verlag, New York.

TRUTER, F.C., WASSERSTEIN, B., BOTHA, P.R., VISSER, D.L.J., BOARDMAN, L.G. & PAVER, G.L. 1938. The geology and mineral deposits of the Olifants Hoek area, Cape Province. Explanation of 1: 125 000 geology sheet 173 Olifants Hoek, 144 pp. Council for Geoscience, Pretoria.

VISSER, D.L.J. 1958. The geology and mineral deposits of the Griquatown area, Cape Province. Explanation to 1: 125 000 geology sheet 175 Griquatown, 72 pp. Council for Geoscience, Pretoria.

YOUNG, R.B. 1932. The occurrence of stromatolitic or algal limestones in the Campbell Rand Series, Griqualand West. Transactions of the Geological Society of South Africa 53: 29-36.

Declaration of Independence

I, John E. Almond, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed solar power plant development projects, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

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