MAINSTREAM RENEWABLE POWER SOUTH AFRICA

CONCENTRATED SOLAR POWER EIA–DE AAR

Heritage Impact Assessment

Issue Date: 13 April 2012
Revision No.: 1……………………
Project No.: 10273…………………………….

Date:	13/04/2012
Document Title:	De Aar Solar Park – Heritage Impact Assessment
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Revision Number:	2 (First Revision – 11 April 2012)
Checked by:	
For:	SiVEST Environmental Division

Declaration of Independence

The report has been completed by PGS Heritage & Grave Relocation Consultants 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 & Grave Relocation Consultants

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SIGNATURE: ______________________________

Executive Summary

PGS Heritage & Grave Relocation Consultants was appointed by SiVest Environmental Division to undertake a Heritage Impact Report that forms part of the Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) for the Concentrated Solar Project for Mainstream Renewable Power South Africa, on the farm Paarde Valley 145 close to De Aar in the Northern Cape Province.

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

The survey yielded eight archaeological sites of which 4 fall directly in the development area. Refer to Appendix B for positions relative to the development. In Appendix B, Figure B1 indicates the heritage sites in relation to the original proposed layout. Figure B2 shows the proposed layout after implementation of management measures on all environmental issues raised, including heritage.

Archaeological Site – Mitigation
Sites 1-4 and 7
No further mitigation required as they fall outside the development footprint.

Site 5 and 6

- *Preservation of the site in situ and fencing of the site during construction, if this is not possible;*
- *Documentation of the site layout and test excavations to determine the cultural context before an application for a destruction permit can be lodged with SAHRA.*
- *Monitoring during construction*

Site 8 (**Impacted by Option 1 but not Option 2)**

- *Preservation of the site in situ and fencing of the site during construction,*
- ***If the site is to be impacted** - Further research into the structure will be required through, documentation of the site layout and test excavations to determine the cultural context before an application for a destruction permit can be lodged with SAHRA.*
- *Monitoring during construction*

Palaeontology
The Ecca and Beaufort Group sediments in the general vicinity of the study area generally have a moderate to high palaeontological sensitivity. Given the limited effective palaeontological potential of rocks in the region due to nearby dolerite intrusions, the comparatively small footprint of the proposed developments and the shallow excavations envisaged here, no further palaeontological mitigation is recommended for this development. Should substantial fossil remains be exposed during construction, however, the ECO should

alert SAHRA so that appropriate action (e.g. recording, sampling or collection) can be taken by a professional palaeontologist.

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.

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

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1 INTRODUCTION

PGS Heritage & Grave Relocation Consultants was appointed by SiVest Environmental Division to undertake a Heritage Impact Report that forms part of the Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) for the Concentrated Solar Project for Mainstream Renewable Power South Africa, on the farm Paarde Valley 145 close to De Aar in the 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 40 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, Principal Archaeologist for this project, and the two field archaeologist, Henk Steyn and Marko Hutton are registered with the Association of Southern African Professional Archaeologists (ASAPA) and has CRM accreditation within the said organisation.

Since 2002 Dr Almond has also carried out palaeontological impact assessments for developments and conservation areas in the Western, Eastern and Northern Cape 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 for SAHRA and HWC. Dr Almond is an accredited member of PSSA and APHAP (Association of Professional Heritage Assessment Practitioners – Western Cape).

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 NEMA (No 107 of 1998) states that an integrated environmental management plan should (23:2 (b)) "…identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage". In accordance with legislative requirements and EIA rating criteria, the regulations of SAHRA and Association of Southern African Professional Archaeologists (ASAPA) have also been incorporated to ensure that a comprehensive legally compatible AIA report is compiled.

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:

i. material remains resulting from human activity which are in a state of disuse and are in or on land and which are older than 100 years including artefacts, human and hominid remains and artificial features and structures;

ii. rock art, being any form of painting, engraving or other graphic representation on a fixed rock surface or loose rock or stone, which was executed by human agency and which is older than 100 years, including any area within 10m of such representation;

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

iv. features, structures and artefacts associated with military history which are older than 75 years and the site on which they are found.

Cultural significance

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

Development

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

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

Heritage resources

This means any place or object of cultural significance

2 TECHNICAL DETAILS OF THE PROJECT

2.1 Site Location and Description

De Aar – Paarde Valley

Location	(Lat -30.6472; Long 24.0356), The land is within 2km North of De Aar in the Northern Cape on the farm Paarde Valley 145
Land	The area is approximately 6700 Hectares but only a portion (as per Figure 1) is planned for the proposed development. The land owner is Emthanjeni Local Municipality.
Land Description	The land is greenfield veld (bush) type, zoned for agricultural use however used at present for grazing, while some centre pivot irrigation is planned to the northeast of the Paarde Valley farm section.

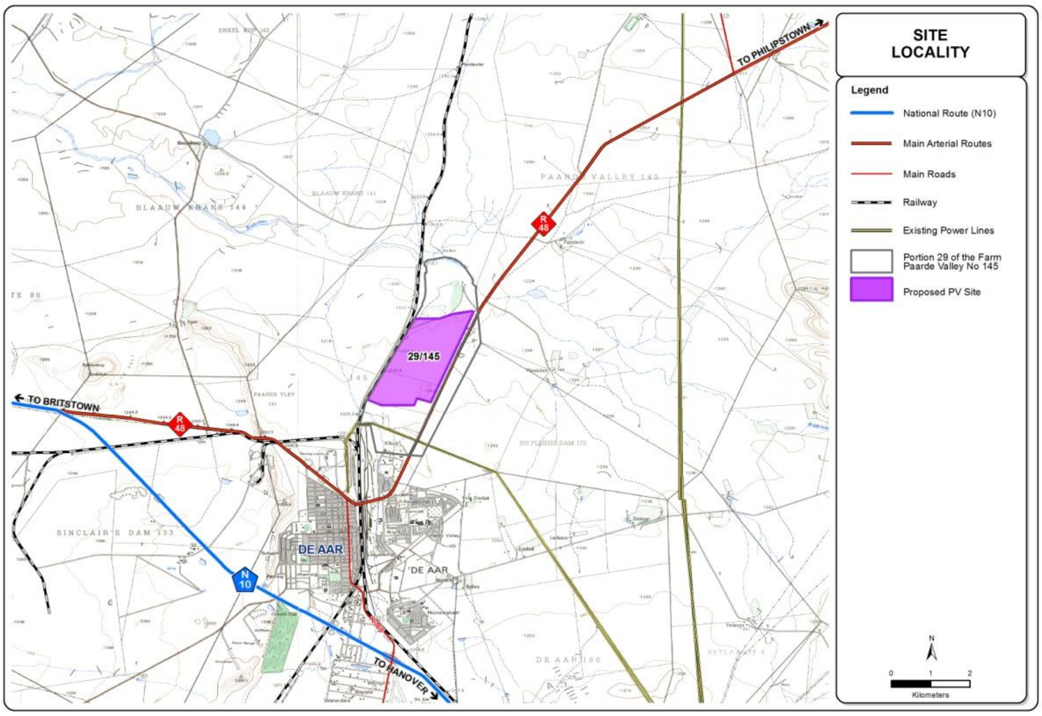

Figure 1: De Aar Solar Park locality

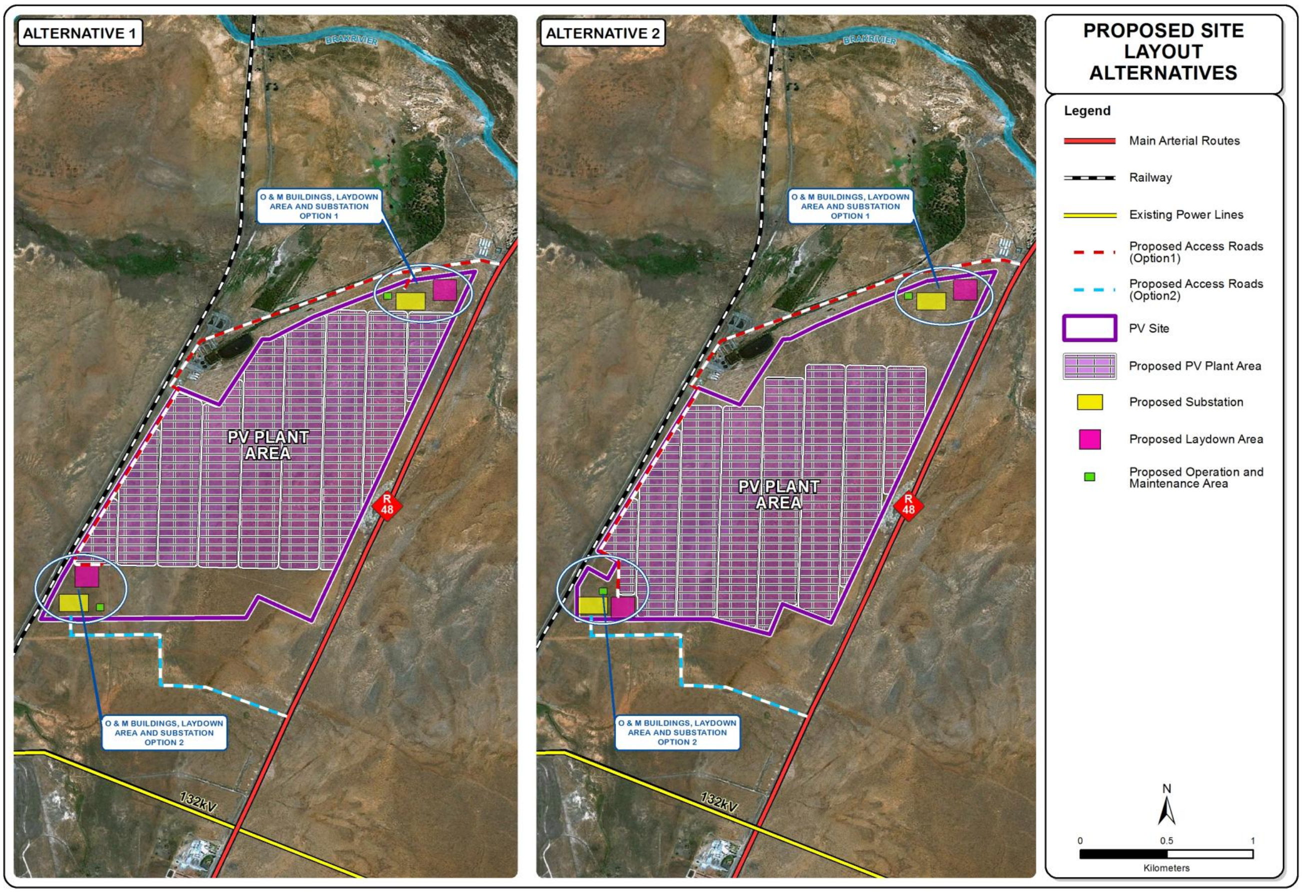

Figure 2: De Aar Solar Park Layout Options

2.2 Technical Project Description

The PV components are described in detail below

2.2.1 CPV/PV Project Description

The PV will consist of two components:

a. CPV/ PV Power Plant

b. Associated infrastructure

- CPV/PV Solar Power Plant

The PV plant will consist of the following infrastructure

a. Solar field

b. Buildings

These are described in detail below:

a. Solar field

Concentrated Photovoltaic (CPV) or Photovoltaic (PV) panel arrays with approximately 318 000 panels will be installed. An area of approximately 3.6km^2 is likely to be required for the CPV/PV. The area required does not need to be cleared or graded however no tall vegetation such as trees can remain on the site. Not tall vegetation is present on the site.

The panel arrays are approximately 15m x 4m in area. These are mounted into metal frames which are usually aluminium. Concrete or screw pile foundations are used to support the panel arrays. The arrays are either fixed on a tracking system (CPV is always on a tracking system) or tilted at a fixed angle equivalent to the latitude at which the site is located n order to capture the most sun (Figure 3). Arrays usually reach up to between 5m and 10m above ground level. Either a CPV or PV plant will be installed. The difference between a PV and CPV is that the CPV panel is slightly different in that it contains small mirrors which focus more solar energy on the PV cells.

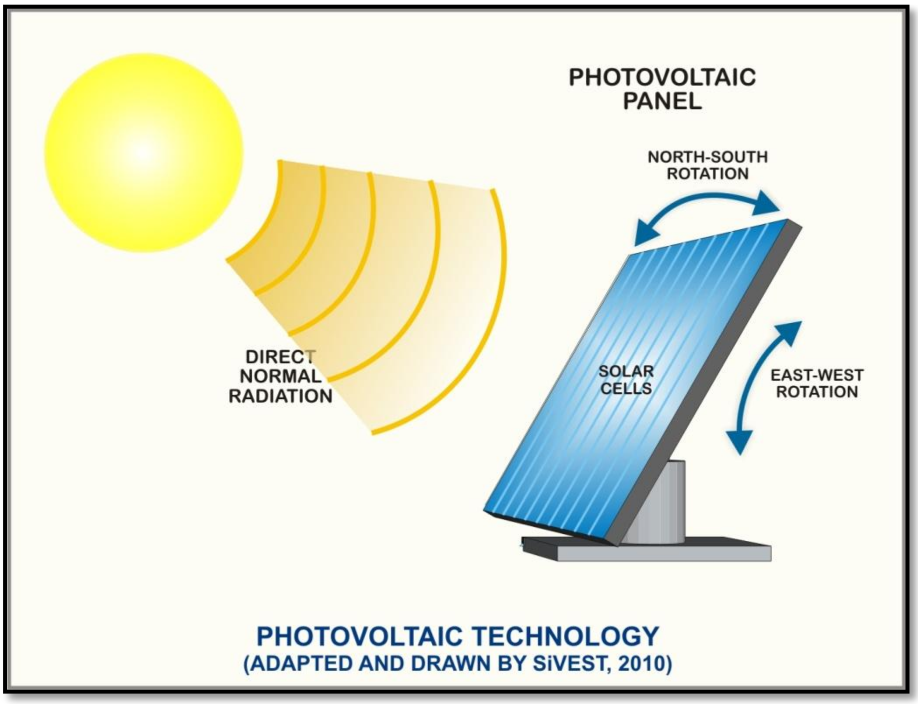

Figure 3: Illustration of how a CPV panel operates

b. Building infrastructure

The solar field will require on site buildings which will relate to the daily operation of the plant. The plant will require administration buildings (office) and possibly a warehouse for storage. The buildings will likely be a single storey building with warehouse / workshop space & access (e.g. 5m high, 20m long, 20m wide). The office will be used for telecoms and ablution facilities will be included. Security will be required.

- Associated infrastructure

  a. Electrical Infrastructure

The PV arrays are typically connected to each other in strings and the strings connected to DC to AC inverters (Figure 4). The DC to AC inverters may be mounted on the back of the panel's support substructures / frames or alternatively in a central inverter station. The strings are connected to the inverters by low voltage DC cables. Power from the inverters is collected in medium voltage transformers through AC cables. Cables may be buried or pole-mounted depending on voltage level and site conditions.
For a 75MW AC facility between 75 and 93 inverters will be required, depending on DC oversizing. Inverters, like the substation transforms, also contain oil.

The medium voltage transformers can be compact transformers distributed throughout the solar field or alternatively located in a central sub-station. It is likely to be a central substation in this instance.

The distribution substation will be approximately 90m x 120m in size and will ideally be located in close proximity to the existing power lines or in the position that facilitates the closest point for a new power line to connect to the Eskom infrastructure.. The substation will be a distribution substation and will include transformer bays which will contain transformer oils. Bunds will be constructed to ensure that any oil spills are suitably attenuated and not released into the environment. The substation will be securely fenced. The substation will be operated by Eskom.

The PV substation will be located adjacent to the existing power line and the connection to the line will be via drop-down conductors. If the facility cannot be connected directly to an exisiting power line, a new power line will be constructed to connect to the nearest substation.

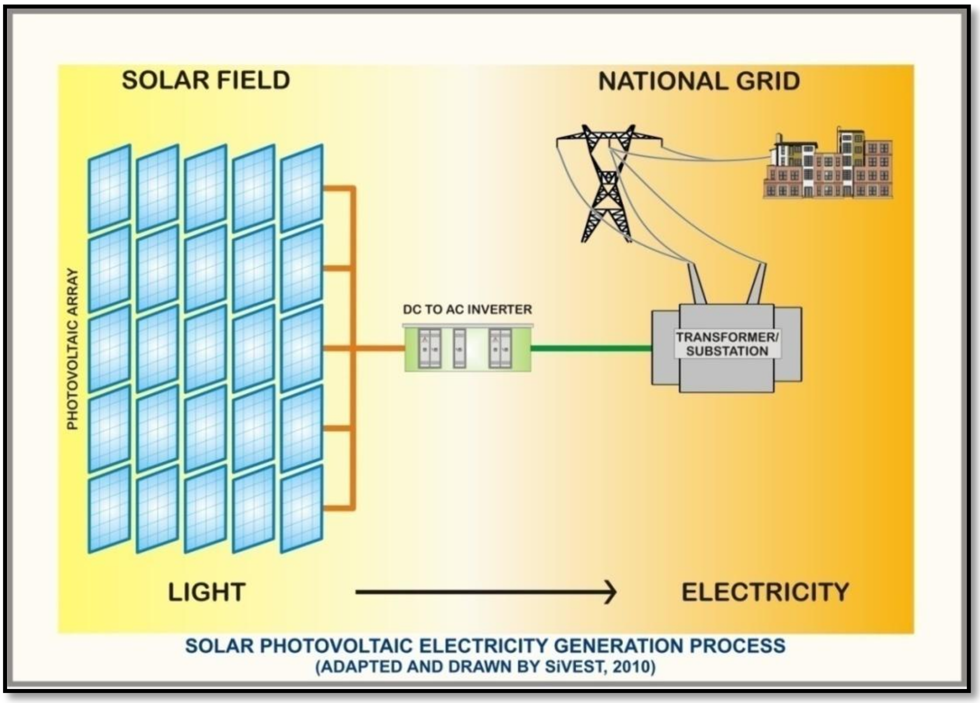

Figure 4: CPV/PV process

b. Roads

An access road with a gravel surface from the public road onto the site will be required. An internal site road network to provide access to the solar field, power block & other infrastructure (substation & buildings) will also be required. Existing farm roads will be used where possible. The site road network will include turning circles for large trucks, passing points and where necessary, may include culverts over gullies and rivers/ drainage lines. All site roads will require a width of approximately 10m. Drainage trenches along the side of the internal road network will be installed. In addition, silt traps at the outfall of the drainage trenches to existing watercourses will be installed.

c. Fencing

For health & safety and security reasons, the plant will be required to be fenced off from the surrounding farm.

d. Solar Resource Measuring Station

A permanent solar resource measuring station which will measure 100m^2 and which will be 5m in height will be required on site to measure incoming solar radiation levels on the site. Solar irradiatiance levels have been used from the BSRN station 6m south of the site and a therefore a permananet reference station will be installed during construction.

e. Temporary work areas / activities during construction

A lay down area of a maximum of 10 000m^2, adjacent to the site or access route will be required. This will be temporary in nature (unless the property owner wishes to continue using it in the long term). Associated with this will be a contractors site offices which will require a maximum of 5 000m^2.

f. Panel maintenance

The panels will require cleaning and dust will accumulate on them affecting their productivity. Cleaning will take place once every quarter (providing job creation). .It is invisgaed that water will be extracted from the Emthanjeni Municapility retriculation system for the cleaning of the panels.

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 and Grave Relocation Consultants (PGS) for the proposed Droogfontein 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 leans greatly on the Heritage Scoping Report completed by PGS for this site in September 2010.

- 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 1: Site significance classification standards as prescribed by SAHRA

FIELD RATING	GRADE	SIGNIFICANCE	RECOMMENDED MITIGATION
National Significance (NS)	Grade 1	-	Conservation; National Site nomination
Provincial Significance (PS)	Grade 2	-	Conservation; Provincial Site nomination
Local Significance (LS)	Grade 3A	High Significance	Conservation; Mitigation not advised
Local Significance (LS)	Grade 3B	High Significance	Mitigation (Part of site should be retained)
Generally Protected A (GP.A)	-	High / Medium Significance	Mitigation before destruction
Generally Protected B (GP.B)	-	Medium Significance	Recording before destruction
Generally Protected C (GP.A)	-	Low Significance	Destruction

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 2**.

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.

- Rating System Used To Classify Impacts

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

Table 2: 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.

The 2010 regulations also specify that alternatives must be compared in terms of impact assessment.

4 CURRENT STATUS QUO

4.1.1 Site Description

The site is situated north east of the Town of De Aar and is characterised by flat undulating karoo vegetation (**Figure 5 and Figure 6**). Large sections of the site are exposed to sheet erosion, specifically the eastern sections.

Figure 5 – View of to the east of the study area close to the Hydra Perseus Transmission line

Figure 6 – View of study area where proposed Solar Park is planned to be constructed

4.1.2 Archival findings

Evaluation of archaeological work completed on the Perseus Hydra Transmission line that runs to the east of the study area have produced some ground truthed information on archaeology to be expected in the study area.

Initial desktop studies completed created a map indicating that area exposed to sheet erosion produced more Stone Age finds as deflated site was exposed during erosion (**Figure 7**).

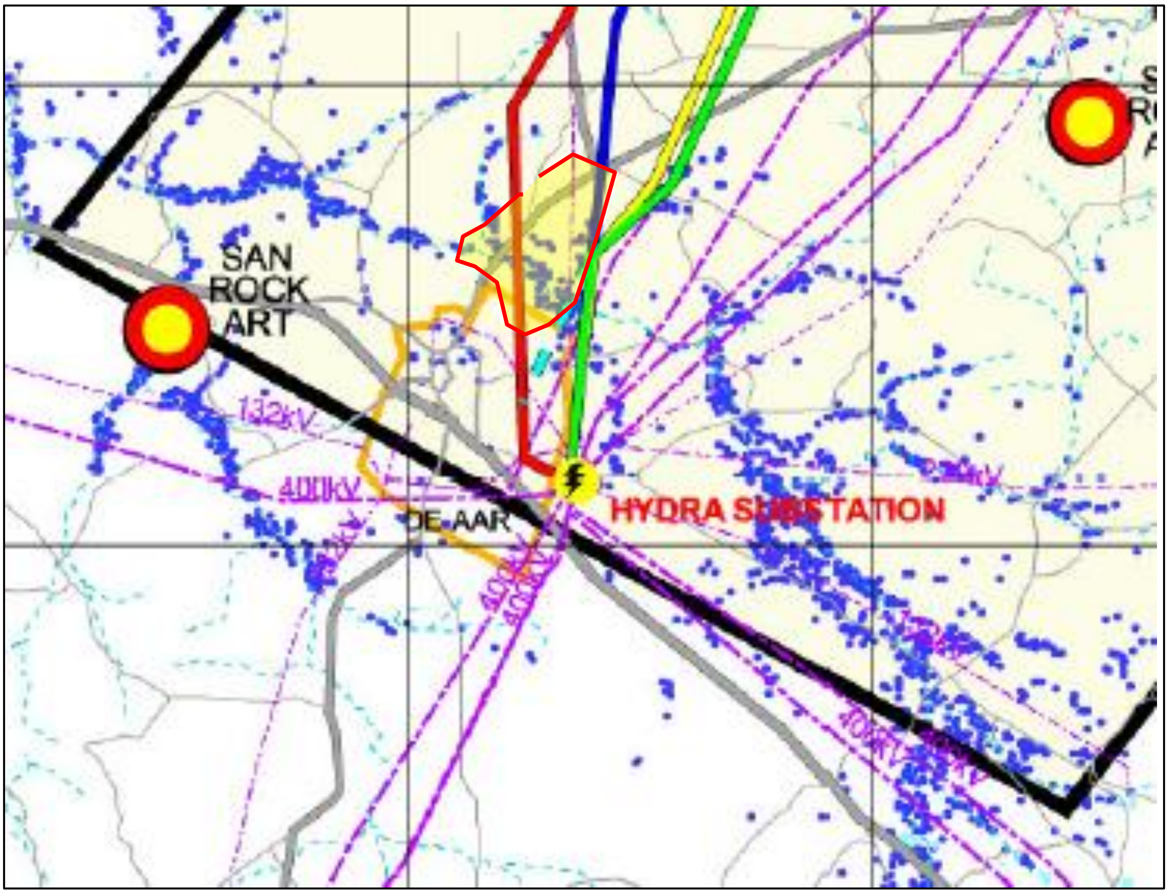

Figure 7 – Area around De Aar indicating San Rock Art finds – Blue spot indicate areas of sheet erosion (Red outline study area) (Van Jaarsveld, 2006)

Previous field work by PGS Heritage & Grave Relocation Consultants, have provided some valuable information on the archaeology and palaeontology of the general area to the east of the proposed development area where the Perseus Hydra line traverses the study area.

- Palaeontology

  During the 2010 survey a find of silicified wood were found just outside the study area and is of high palaeontological interest as expressed by paleontologists contacted around the find (**Figure 8**).

  The palaeontological desktop study done for the proposed Solar park indicated that, The Ecca and Beaufort Group sediments in the general vicinity of the study area generally have a moderate to high palaeontological sensitivity. Given the limited effective palaeontological potential of rocks in the region due to nearby dolerite intrusions, the comparatively small footprint of the proposed developments and the shallow excavations envisaged here, no further palaeontolgical mitigation is recommended for this development. Should substantial fossil remains be exposed during construction, however, the ECO should alert SAHRA so that appropriate action (e.g. recording, sampling or collection) can be taken by a professional palaeontologist.

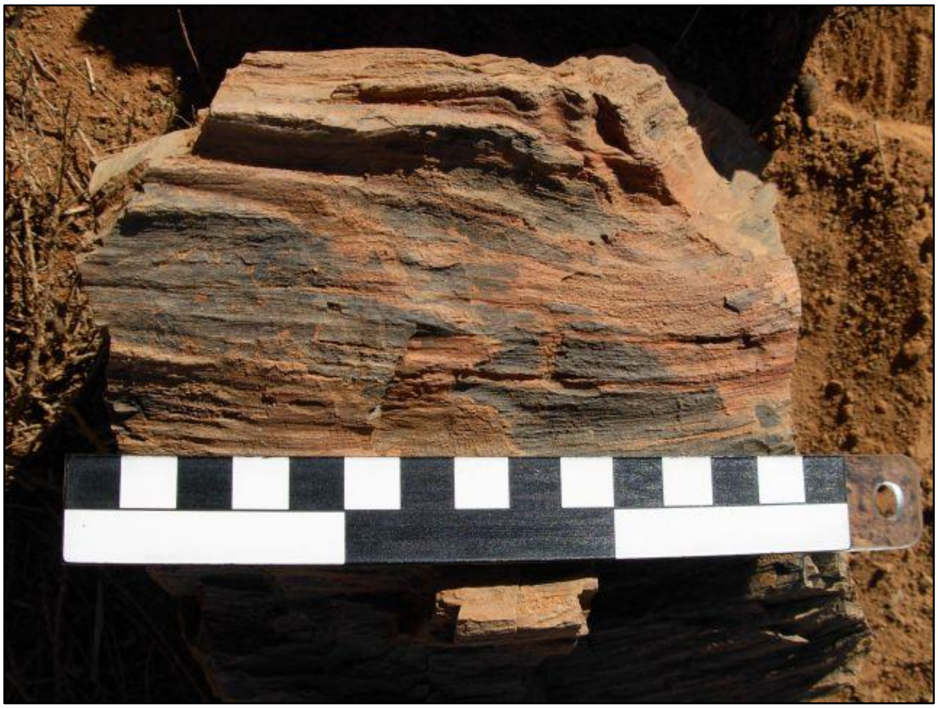

Figure 8 – Silicified wood found just outside the current study area

- Archaeology
  The PGS (2010) revealed numerous find spots from single low concentration Stone Age finds (**Figure 9**) in eroded areas to larger significant Middel Stone Age Scatters (**Figure 10**) in the sections of the study area impacted by the Perseus Hydra Transmission line.

Figure 9 – Low density scatter of MSA finds

Figure 10 – Area scattered with eroded MSA artefacts

- Historical Context

  De Aar Junction played key strategic role during the South Africa War (Anglo-Boer War) and specifically two battles: the Battle of Stormberg and the Battle of Colenso. It acted as both the supply strategic place between Cape Town and the west central regions of South Africa through the Karoo, which remained devoid of any battles during the war. It is located central western region of the country, South Africa.

  The town of De Aar was established just after the South African War after two Friedlander brothers, Isaac and Wolf, surveyed the land on farm De Aar which they had purchased during the construction of a junction in the late 1800's when the railway line between Cape Town and Kimberley was built. The site for the construction of the junction was first identified in 1881 and by 1899 the Friedlander brothers were already operating a trading store and a hotel at the junction. It is during this time that they purchased the farm De Aar which the later built the town of De Aar in 1900. However, it took another 5 years after the war had ended (1902) and 6 years after the creation of the town municipality (1900) for the town to elect its first municipal mayor in 1907. The name, De Aar, means 'Artery' after the underground water supply and is the second most important South African rail junction.

  The 1:250,000 Reconnaissance Topographical Map of Philipstown (surveyed 1910 and drawn in 1913) (**Figure 11**) indicates that the Brak River was previously known as the Carolus Poort River.

Understanding the Importance of De Aar during the Second South Africa War

Two South African war battles become important in the history of De Aar; the Battle of Stormberg and the Battle of Colenso. The Battle of Stormberg was one of the famous encounters between the Boers and the British in the South African war. This skirmish/battle took place when the Boers were triumphant and it formed part of a chain of disasters which the British termed the 'The Black Week' (Meintjes, 1969).

The first involvements of De Aar in the war can be dated to November 1899 when the Boers moved southward from the areas of their strong hold the Orange Free State and the Transvaal. On the 1st of November 1899 a small detachment of Boers from the Orange Free State, had seized the railway bridge over the Orange River at Norvalspont. This bridge was at the time guarded by only six policemen who were quickly overcome by the Boers. On the same day Hans Swanepoel of Smithfield and Floris du Plooy of Bethulie with a combined commando of 900 men and two guns crossed the Bethulie bridges over the Orange River and headed from Naauwpoort and Stormberg (Meintjes, 1969). Up until this time the Boers are argued to have deliberately avoided and neglected to occupy some of the principal railway junctions in the Colony, notably: De Aar, Naauwpoort and Stormberg (ibid).

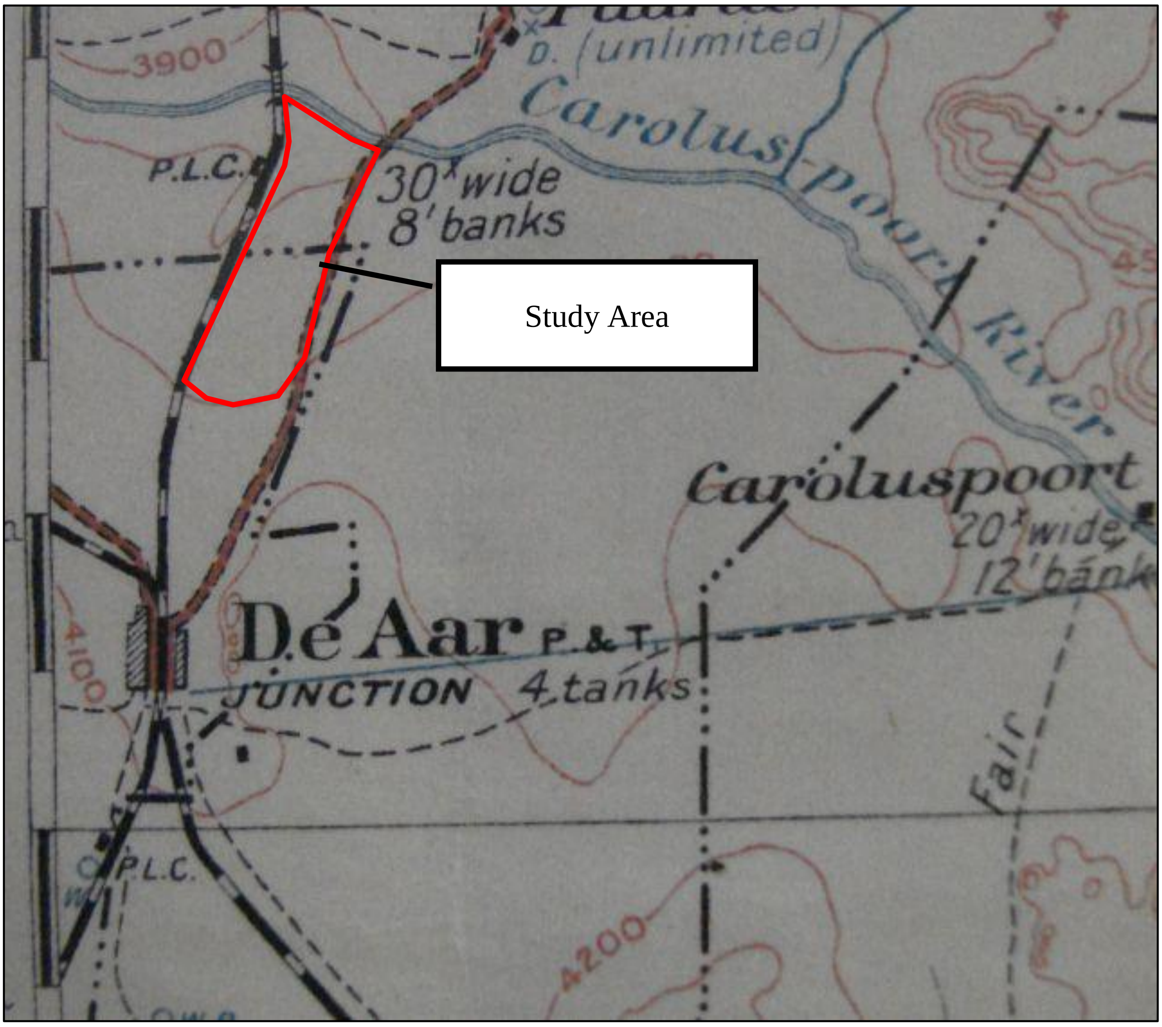

Figure 11 – 1907 Map of De Aar area (Study area in red)

Idea to deliberately neglect these junctions is argued to have been aimed at offending the Schreiner Ministry based on an agreement made between Steyn and Schreiner, which Steyn withdrew in consultation with President Kruger of the Transvaal after it became apparent that the Cape could play a significant role in the war. Steyn then issued proclamations in which parts of the British Bechuanaland and the Northern Cape were annexed to the two Boer Republics, the Transvaal and the Orange Free State. The reason behind these annexations is that, they were made to "...permit commandeering of men and supplies as well as to protect rebels who annexed territories of the Cape Colony and the Protectorate would be guilty of High Treason and perhaps be punishable by execution" (Meintjes, 1969).

When hostility between the British and the Boers across the Orange River commenced, the British had small garrisons at Stormberg Junction, Albert Road, Aliwal North, Norvalspont, Colesberg, Arundel and Naauwpoort (Meintjes, 1969). However, they had no garrison in De Aar which was one of the key strategic supply and distribution junctions. The garrisons along some of the railway line and stations were strategic as the railway lines formed an integral part of the British offensive. During the war they therefore played a significant role throughout South Africa and their disruption became a major target for the Boers; for example, during the capture of armoured train at Kraaipan by De le Ray where the first shots of the war were fired.

Stormberg Junction was chosen as a target junction of annexation, over De Aar Junction, by the Boers advancing south because of its link-up with East London and was an important strategic point for a sprong up through the eastern Cape to Bloemfontein and Kimberley.

De Aar did, however, play a role during the war times as a stop and transfer junction with the transportation of British brigades and Naval Police from Cape Town to the central interior and for the transportation and transfer of supplies. The Naval Brigades who fought in the Stormberg skirmish pass through the large railway junction De Aar then described as a '...dreary sight of platforms and dusty trains, tin shanties and corrugated iron houses, gray boulders and ashy sky...' (Meintjes, 1969).

The De Aar junction further acted as a major stockpile for stores to be sent forward to the British forces. Doyle (1902) noted that "immense" supplies were gathered at De Aar (**Figure 12**). Danes (1903) writes, "…*De Aar was a wonderful sight in those days. Hundreds of mules and oxen were there. Countless wagons, packages and cases of food and ammunition, ambulances, hospitals, medical stores…*"

Figure 12 – Stockpiles of oats at De Aar (ca. 1900)

This stock piling was due to De Aar being a stopover and staging post for troops and supplies towards the Free State and access point from the Cape and Port Elizabeth. A large Remount Depot (Horse and Mule replenishment) was also present at De Aar, which provided much needed fresh horses and mules for the war effort (**Figure 13**).

Figure 13 – The Remount Depot Garrison at De Aar (December 1899)

Among the people of Note who passed through De Aar during the war is Winston Spencer Churchill. This is during the time when various war correspondents were travelling between the Cape, the Eastern Cape, Northern Cape and the Transvaal. It is suggested that, after staying at the Mount Nelson Hotel in Cape, Churchill travelled by rail to East London, via Matjiesfontein, De Aar, Stormberg, Molteno and Queenstown.

During the Colenso Battle, De Aar was used by the British to transfer guns between the Cape Town, the central interior and the Natal region such as, the long Tom-tom guns. The reason for this is that they were encountering hostile enemy lines along the east coast regions of the country (Martins, 1988). Nasson (1999: 135), for example, argues that "the failure of Black Week had prised things open, almost inviting a capitalizing counterstroke from some bold and resolute Boer leadership. Exposed to a broader offensive, the Cape Colony virtually asked for deeper penetration to throttle the strategic junction of De Aar, thereby severing Methuen's supply lines. On the eastern front, almost all of Natal remained under the enemy thumb, with the British confined or paralysed by the Orange Free State commandos who, in their most southerly groupings, had pegged out substantial swathe of land running down to within 120miles of the Indian Ocean".

4.1.3 Findings of the Heritage Scoping Document

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

- Archaeological walk through of the areas where the project will be impacting, with specific attention given to the areas around pans and outcrops;

4.1.4 Field work findings

A follow up visit to the study area was conducted in March 2011 with the aim of conducting an archaeological survey of the development area and giving particular attention to the areas identified during the Scoping phase as being potentially sensitive. Due to the size of the total study area field work focused on the areas identified in **Figure 2** as the foot print areas of the development.

The study area for this project covers approximately 740 hectares in total. 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. A controlled-exclusive surface survey was conducted over a period of 2 days on foot by two archaeologists of PGS.

The site is predominantly covered in Savanna grassland, falls within Northern Cape Savanna Biome and it is generally flat dominated by sands (**Figure 14**). Towards the Brak River the vegetation cover changes to more riverine with some large tree thickets (**Figure 15**).

Figure 14: Type of grass cover at the site (note the flatness of the landscape)

Figure 15: Type of vegetation cover closer to Brak River

4.1.5 Archaeological Sites

The survey yielded eight archaeological sites of which 4 fall directly in the development area. Refer to ***Appendix B*** for positions relative to the development.

Site 1

GPS: 30° 35,828 S (eastern extent)
24° 02,411 E

30° 35,645 S (western extent)
24° 02,332 E

A medium to high density scatter of Middel Stone Age (MSA) tools consisting of cores and blades was identified (± 5-10 artefacts in 10m x10m) (**Figure 16**). The site was situated on the summit and the slopes of a small hill overlooking the Brak River at the northern extent of the study area. The artefacts were identified scattered all over the slopes of the small hill (**Figure 17**). The scatter of artefacts extended to the north to the banks of the Brak River and to the east beyond the extent of the study area. The spread of artefacts ended towards the south at the edge of an orchard which was placed in a floodplain which extended further to the west.

The scatter of stone tools extended further to the west of the small hill across the undisturbed sections of the floodplain and along the course of the Brak River. The alluvial deposits of the floodplain covered most of the artefacts on the floodplain. Small clearings in the floodplain were exposed by erosion and further scatters of stone tools were visible. These scatters of stone tools were of a low density (± 2-5 artefacts in 10m x10m).. A small quarry was found on the western slopes of the small hill (**Figure 18**).

Figure 16: MSA cores and blades

Figure 17: General view of Site 1

Figure 18: Quarry in the area of Site 1 exposing MSA material

The quarry activities disturbed and destroyed a section of the extended site and further quarrying will cause even more damage and destruction.

The site is Graded as General Protected A and mitigation of the site will be required if impacted by the development.

Site size: Approximately 500m x300m.

The site falls outside the footprint area of the development and no further mitigation will be required.

Site 2

GPS: 30° 35,789 S
24° 02,389 E

The remains of four circular stone walled enclosures were identified here (**Figure 20**). The enclosures were found on the summit of the same small hill described at **Site 1**. The largest enclosure measured approximately 3m in diameter and the walls were approximately 0,75m high and 0,5m thick (**Figure 19**). The other three enclosures were similar in size and measured approximately 2m in diameter and the walls were approximately 0,5m high and 0,5m wide. Interconnecting sections of packed stone walls were found in between the enclosures. The enclosures were most probably used as goat/sheep pens. A few bricks, fragments of cement and a few metal artefacts (such as cans and wire) were also identified associated with the enclosures.

The layout and arrangement of the structures indicates possible linkages with herder activity and could also later have been utilised in historical times by other groups. The site can provide significant information on the pastoral activities in the area dating back to the Later Stone Age (LSA).

Figure 19: Stone enclosure on hill

Figure 20: View of interlinked enclosures

The site is graded as **General Protected A** and mitigation of the site will be required if impacted by the development.

Site size: Approximately 20m in diameter.

The site falls outside the footprint area of the development and no further mitigation will be required.

Site 3

GPS: 30° 35,524 S
24° 01,724 E

The foundations and the remains of an old railway station were identified at this location approximately 50m east of the existing railway line (**Figure 21**). The demolished structure measured approximately 15m x 15m and building rubble and other metal artefacts (such as cans and wire) were found scattered around. The remains of the structure were identified amongst a cluster of Eucalypti trees. The structures are located in the area of the map in **Figure 11** indicated just west of the study area with the abbreviation "P.L.C", and most probably dates to 1910.

Figure 21: View of old railway structure

The site is situated just outside the north-western border of the project and will not be affected by the project.

Site size: Approximately 40m x 40m.

Site 4

GPS: 30° 35,693 S
24° 01,742 E

A low density scatter of MSA blades and scrapers was identified here (± 2-5 artefacts in 10m x10m) (**Figure 23**). The artefacts were identified in a clearing which was by sheet erosion (**Figure 22**). This site was identified in the alluvial floodplain and formed part of the extended spread of artefacts as described in **Site 1**.

Figure 22: View of site with exposed soil in foreground

Figure 23: MSA tools found on site

*The site is graded as **General Protected B** and is of low significance*

The site falls outside the footprint area of the development and no further mitigation will be required.

Site size: Approximately 40m in diameter.

Site 5 and 6

GPS: Site 5: 30° 36,805 S 24° 01,614 E
Site 6: 30° 36,725 S 24° 01,696 E

Unidentified circular shaped mounds of packed rocks were identified at both sites (**Figure 24 and Figure 25**). The function, origin and age of this mound of rocks are unknown. The mound of rocks measured approximately 4m in diameter and no other artefacts or features were found associated with the mound of rocks. It could possibly be the remains of a stone walled enclosure which was demolished.

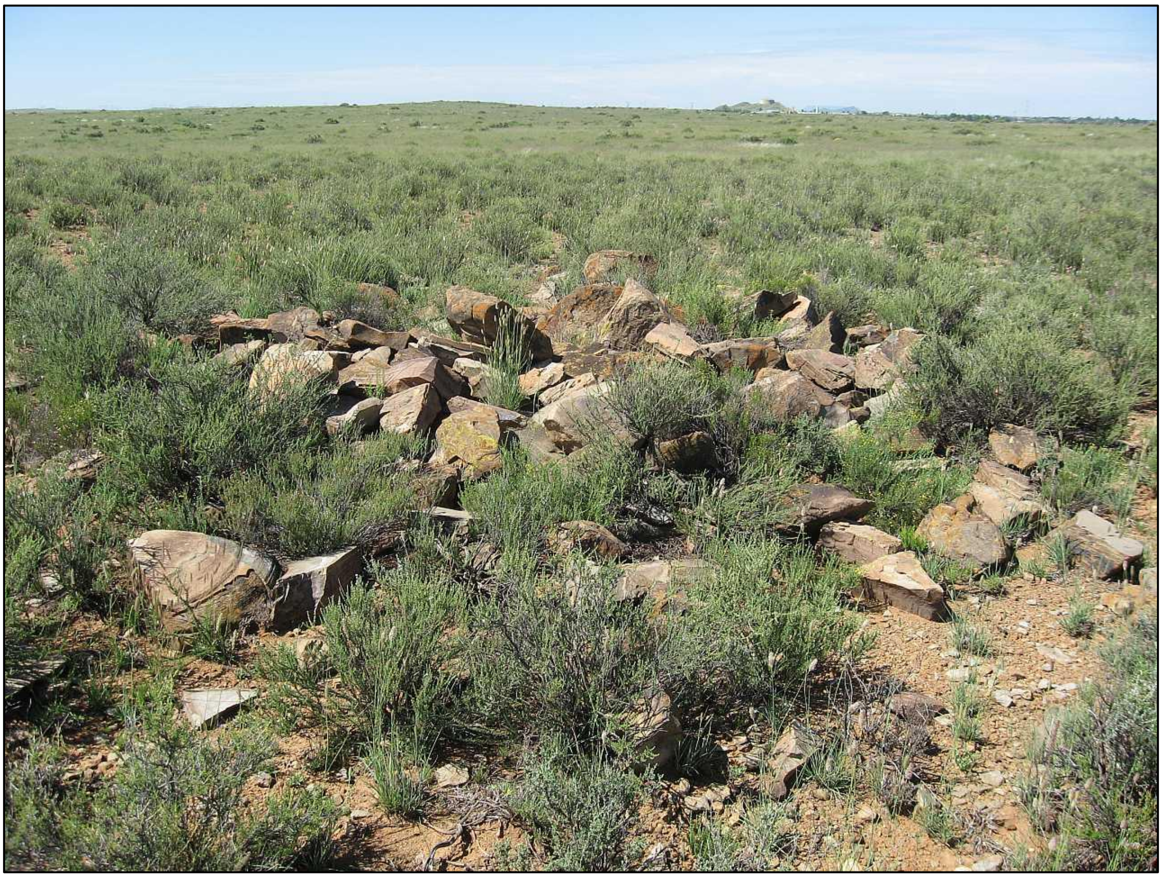

Figure 24: Stone structure at Site 5

Figure 25: Stone structure at Site 6

The sites are rates as **General Protected B** and are of medium to low significance.

The site falls within the footprint area for the project. Impacted by Options 1 and 2. *Mitigation of the impact of the development on the site will entail:*

- *Preservation of the site in situ and fencing of the site during construction, if this is not possible;*
- *Documentation of the site layout and test excavations to determine the cultural context before an application for a destruction permit can be lodged with SAHRA.*
- *Monitoring during construction*

Site size: Approximately 4m in diameter.

Site 7

GPS: 30° 37,186 S
24° 01,703 E

The foundations and the remains of a small stone-built structure were identified here (**Figure 26**). The remains of the structure were found on the summit of a small elongated hill. The foundations of the structure were square in shape and measured approximately 4m x 4m. A flat rock on the eastern side of the structure had a smoothened surface which indicated that it was used. An unknown, but repetitive action across the surface of this rock caused it to be smoothened. No other artefacts or features were found associate with the identified structure.

Figure 26: remains of stone structure at Site 7

Identifying the use of the site is difficult and only deductions can be made from its position. The structure is situated on a small hill overlooking the road from De Aar to Philipstown, as such the structure could have been a fortification during the South African War that guarded the access road to De Aar. The shape of the structure is possibly the remains of a type of block house referred to as the Rice Blockhouse (**Figure 27**) that was constructed with a double row corrugated iron sheeting which was then filled with rocks (shingle) as protection.

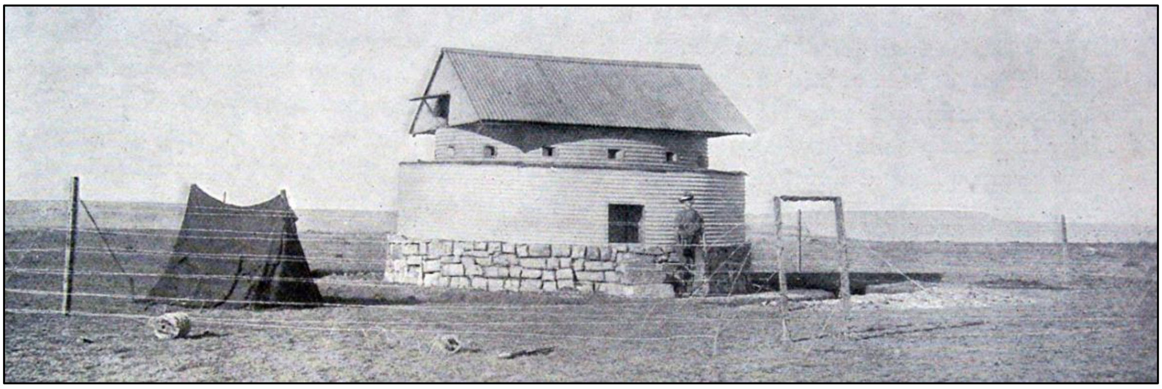

Figure 27: Rice pattern blockhouse with barrbed wire fencing

The site is provisionally **graded as 3B** of local significance and must be preserved where possible.

The site falls just outside the footprint area for the project in both Options*. Mitigation of the impact of the development on the site will entail:*

- *Preservation of the site in situ and fencing of the site during construction,*
- ***If the site is to be impacted*** *- Further research into the structure will be required through, documentation of the site layout and test excavations to determine the cultural context before an application for a destruction permit can be lodged with SAHRA.*
- *Monitoring during construction*

Site size: Approximately 10m in diameter.

Site 8

GPS: 30° 37,017 S
24° 01,118 E

The remains of a circular stone walled enclosure were identified here. The enclosure was found on the edge of a ridge which overlooked the railway line (**Figure 28**). The stone walled enclosure measured approximately 10m in diameter and the walls were approximately 0,5m high and 0,5m thick. No other artefacts or features were identified associated with the enclosure.

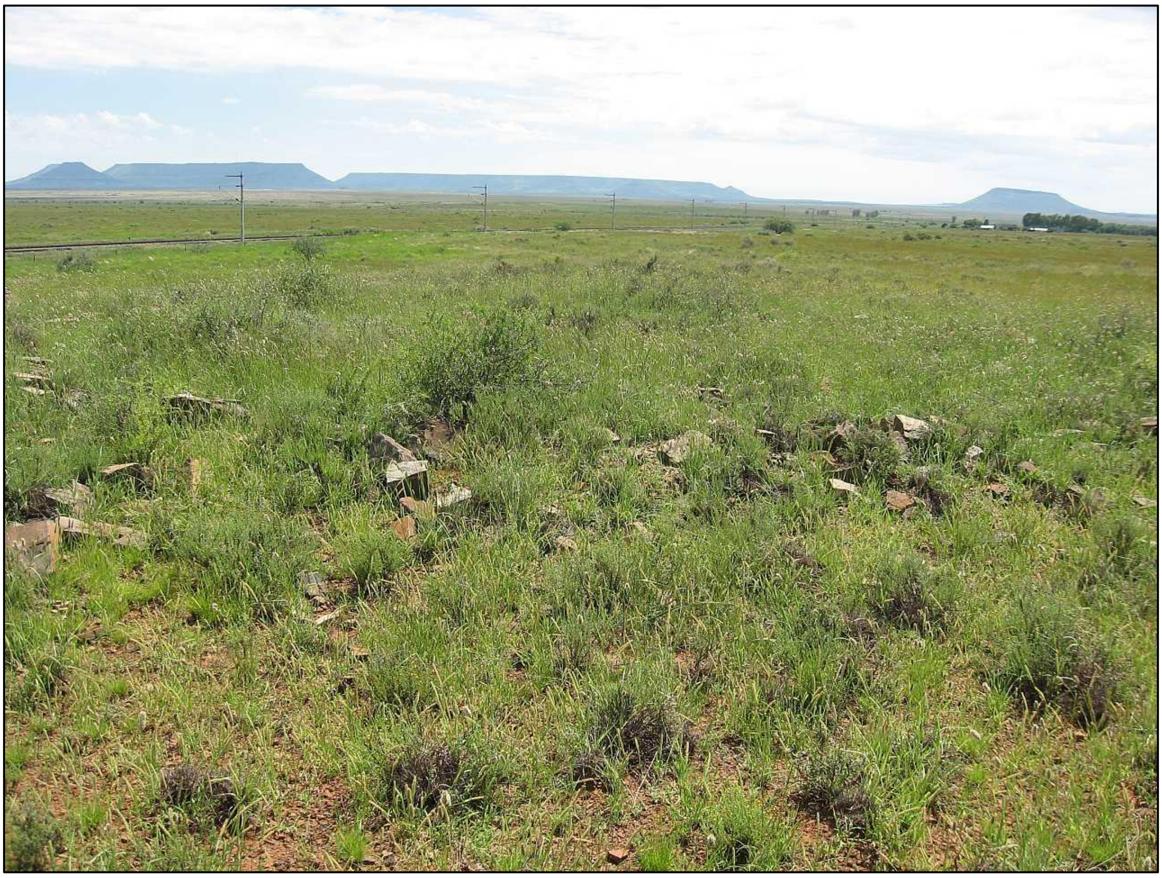

Figure 28: Remains of stone walling with railway track in background

Identifying the use of the site is difficult and only deductions can be made from its position. The structure is situated on a small hill overlooking the rail line from De Aar to Britstown, as such the structure could have been a fortification during the South African War that guarded the rail line to De Aar. The shape of the structure is possibly the remains of a type of block house referred to as the Rice Blockhouse (**Figure 27**) that was constructed with a double row corrugated iron sheeting which was then filled with rocks (shingle) as protection.

The site is provisionally **graded as 3B** of local significance and must be preserved where possible.

The site falls within the footprint area for the project of Option 1 but outside for Option 2 *Mitigation of the impact of the development on the site will entail:*

- *Preservation of the site in situ and fencing of the site during construction,*
- ***If the site is to be impacted*** *- Further research into the structure will be required through, documentation of the site layout and test excavations to determine the cultural context before an application for a destruction permit can be lodged with SAHRA.*
- *Monitoring during construction*

Site size: Approximately 15m in diameter.

5 IMPACT ASSESSMENT

5.1 Potential Impacts during Construction

ISSUE	**Impact on archaeological sites**
POTENTIAL IMPACTS	Unidentified archaeological sites and the discovery of such sites during construction can seriously hamper construction timelines. Destruction of identified archaeological sites during construction
EMP	Management measures to be included in the EMP for chance finds Recommended mitigation measures for each site to be adhered to

ISSUE	**Impact on palaeontological sites**
POTENTIAL IMPACT	Unidentified palaeontological sites and the discovery of such sites during construction can seriously hamper construction timelines.
EMP	Management measures to be included in the EMP for chance finds

ISSUE	**Impact on historical sites**
PREDICTED IMPACT	No sites identified during field work
EMP	Management measures to be included in the EMP for chance finds.

ISSUE	**Impact on graves and cemeteries site**
POSSIBLE IMPACT	Unidentified graves and cemeteries and the discovery of such structures during construction can seriously hamper construction timelines.
EMP	In the event that these graves and cemeteries could not be avoided a grave relocation proses needs to be started. Such a process

	impacts on the spiritual and social fabric of the next of kin and associated communities. Management measures for such finds must be included in the EMP

5.2 Potential Impacts during Operation

Same as construction

5.3 Impact Matrix

Table 3: Rating Matrix for impacts in the Construction phase

Chance finds

IMPACT TABLE FORMAT		
Environmental Parameter	*Discovery of previously unidentified heritage sites (archaeological, palaeontological, 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*	
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	2	1
Intensity/magnitude	2	1
Significance rating	-24(Low negative)	-11 (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 Archaeological Sites

IMPACT TABLE FORMAT

IMPACT TABLE FORMAT		
Environmental Parameter	*Identified archaeological 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 in large scale sites like the proposed site*	
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	*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	3	2
Intensity/magnitude	2	1
Significance rating	-32 (Medium negative)	-13 (low negative)
Mitigation measures	*Mitigation measures as recommended with each identified site and,* *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.*	

Table 4: Rating Matrix for impacts on decommissioning phase

IMPACT TABLE FORMAT	
Environmental Parameter	*Discovery of previously unidentified heritage sites (archaeological, palaeontological, historical or grave*

IMPACT TABLE FORMAT		
	sites)	
Issue/Impact/Environmental Effect/Nature	*During decommissioning 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*	
Intensity/magnitude	*Magnitude dependent on type of finds made – however in most cases 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	2	1
Intensity/magnitude	2	1
Significance rating	-24 (Low negative)	-11 (low negative)
Mitigation measures	*A heritage monitoring program that will identify finds during decommissioning will be able to mitigate the impact on the finds through scientific documentation of finds and provide valuable data on any finds made.*	

5.4 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.

5.5 Cumulative Impacts

None foreseen

5.6 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.

PGS can be contacted on the way forward in this regard.

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 design are discussed, and liaise with SAHRA.	The client	Archaeologist and a competent archaeology supportive team
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	The client	Environmental

cultural heritage regulations on management plans for identified sites.		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

Based on the findings of the HIA, all stakeholders and key personnel should undergo an archaeological 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 survey yielded eight archaeological sites of which 4 fall directly in the development area. Refer to Appendix B for positions relative to the development. In Appendix B, Figure B1 indicates the heritage sites in relation to the original proposed layout. Figure B2 shows the proposed layout after implementation of management measures on all environmental issues raised, including heritage.

Archaeological Site – Mitigation
Sites 1-4 and 7
No further mitigation required as they fall outside the development footprint.

Site 5 and 6

- *Preservation of the site in situ and fencing of the site during construction, if this is not possible;*
- *Documentation of the site layout and test excavations to determine the cultural context before an application for a destruction permit can be lodged with SAHRA.*
- *Monitoring during construction*

Site 8 (**Impacted by Option 1 but not Option 2)**

- *Preservation of the site in situ and fencing of the site during construction,*
- ***If the site is to be impacted*** *- Further research into the structure will be required through, documentation of the site layout and test excavations to determine the cultural context before an application for a destruction permit can be lodged with SAHRA.*
- *Monitoring during construction*

Palaeontology

The Ecca and Beaufort Group sediments in the general vicinity of the study area generally have a moderate to high palaeontological sensitivity. Given the limited effective palaeontological potential of rocks in the region due to nearby dolerite intrusions, the comparatively small footprint of the proposed developments and the shallow excavations envisaged here, no further palaeontological mitigation is recommended for this development. Should substantial fossil remains be exposed during construction, however, the ECO should alert SAHRA so that appropriate action (e.g. recording, sampling or collection) can be taken by a professional palaeontologist.

The following general mitigation measures are recommended:

d. 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.
e. 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.
f. 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.
g. 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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Appendix A

PALAEONTOLOGICAL DESKTOP STUDY

PALAEONTOLOGICAL DESKTOP STUDY:

Proposed Mainstream Solar Park at De Aar, Northern Cape Province

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April 2011

1. SUMMARY

The proposed Mainstream solar park at De Aar, Northern Cape Province is situated on municipal lands on the north-eastern outskirts of town that are underlain by sparsely fossiliferous, non-marine basinal sediments of the Early to Middle Permian Tierberg Formation (Ecca Group) as well as by unfossiliferous intrusive Karoo dolerites (Early Jurassic). Much of the Palaeozoic bedrock is mantled by a thin veneer of soil and gravel of low palaeontological sensitivity. Only shallow bedrock excavations are envisaged for this project. The overall impact of the proposed development on local fossil heritage is considered to be *low* and specialist palaeontological mitigation for this project is not considered to be necessary.

Should substantial fossil remains be exposed during construction, however, such as well-preserved fossil fish, reptiles or petrified wood, the ECO should 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.

2. INTRODUCTION & BRIEF

The company Mainstream Renewable Power South Africa (MRP) is proposing to construct a solar power plant on municipal lands land on the north-eastern outskirts of De Aar, Northern Cape Province. The solar park study site occupies flat-lying (gradients 2˚ or less), low-relief terrain at *c*. 1220-1240m amsl. situated between the railway line to Kimberley in the west and an eastern boundary just to the east of the R48 Hopetown road (Figs. 1 & 2). The northern boundary is formed by the intermittently flowing Brakrivier. A 132kV transmission line crosses the southern part of the study area. The location of the proposed development is shown in the map Fig. 1 and the layout in satellite image Fig. 2. Phase 1 of the solar power plant will comprise a 50MW photovoltaic (PV) plant in the southern portion of the solar park as well as along its eastern edge. Phase 2 of the development envisages a 150MW concentrated solar (CSP) plant spread over the central and northern portions of the park.

Components of the Phase 1 PV solar plant of relevance to the present study include:

- a photovoltaic (PV) panel array comprising *c*. 160 000 panels over an area of approximately $2km^2$. Each array is 15m x 4m in area and supported by concrete or screw pile foundations.
- building infrastructure including an office and a warehouse.

- electrical infrastructure including buried or pole-mounted cables and a central substation (*c*. 90m x 120m) or new overhead powerline or poles or pylons to an existing power line.
- new or upgraded gravels roads for access to the site as well as an internal road network. Site roads will be 10m wide and there will be drainage trenches along their sides with silt traps at the outfall of the drainage trenches into existing watercourses.
- a solar resource monitoring station ($100m^2$).
- a temporary lay down area of *c*. 10 $000m^2$ adjacent to the site or access route.
- possible new borrow pits (to be separately permitted); existing borrow pits are to be used as far as possible. Borrow pits will be backfilled after construction of the PV plant.

Components of the Phase 2 CSP solar plant of relevance to the present study include:

- a solar field of parabolic trough mirrors covering an area of approximately 600 hectares. These will require foundations of no more than 1m depth.
- power block comprising solar steam generators, a steam turbine and a wet cooling tower.
- a 350mm diameter water pipeline from the municipal sewage treatment plant (pipeline route not yet determined)
- evaporation ponds (shallow) adjacent to the solar field.
- building infrastructure including offices, a control room, a fabrication building and warehouse.
- thermal storage tanks containing salt.
- a water treatment plant.
- electrical connections, including a new distribution substation (90m x 120m) close to existing power lines; a short new overhead powerline with pylons or poles may be required.
- upgrading of existing public roads, *plus* new gravel access road and internal site road network (roads 10m wide); existing farm roads will be used as far as possible.
- solar resource monitoring station.
- temporary lay down area of up to 10 $000m^2$ plus temporary contractors site offices ($5000m^2$ or less).
- possible new borrow pits, to be infilled after construction; existing borrow pits will be used as far as possible.

The proposed solar power plant overlies potentially fossiliferous sediments of the Ecca Group (Karoo Supergroup). Fossils preserved within the Palaeozoic bedrock or superficial deposits may be disturbed, damaged or destroyed during the construction phase of the proposed project. 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

This desktop palaeontological study has accordingly been commissioned by PGS - Heritage & Grave Relocation Consultants.

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.

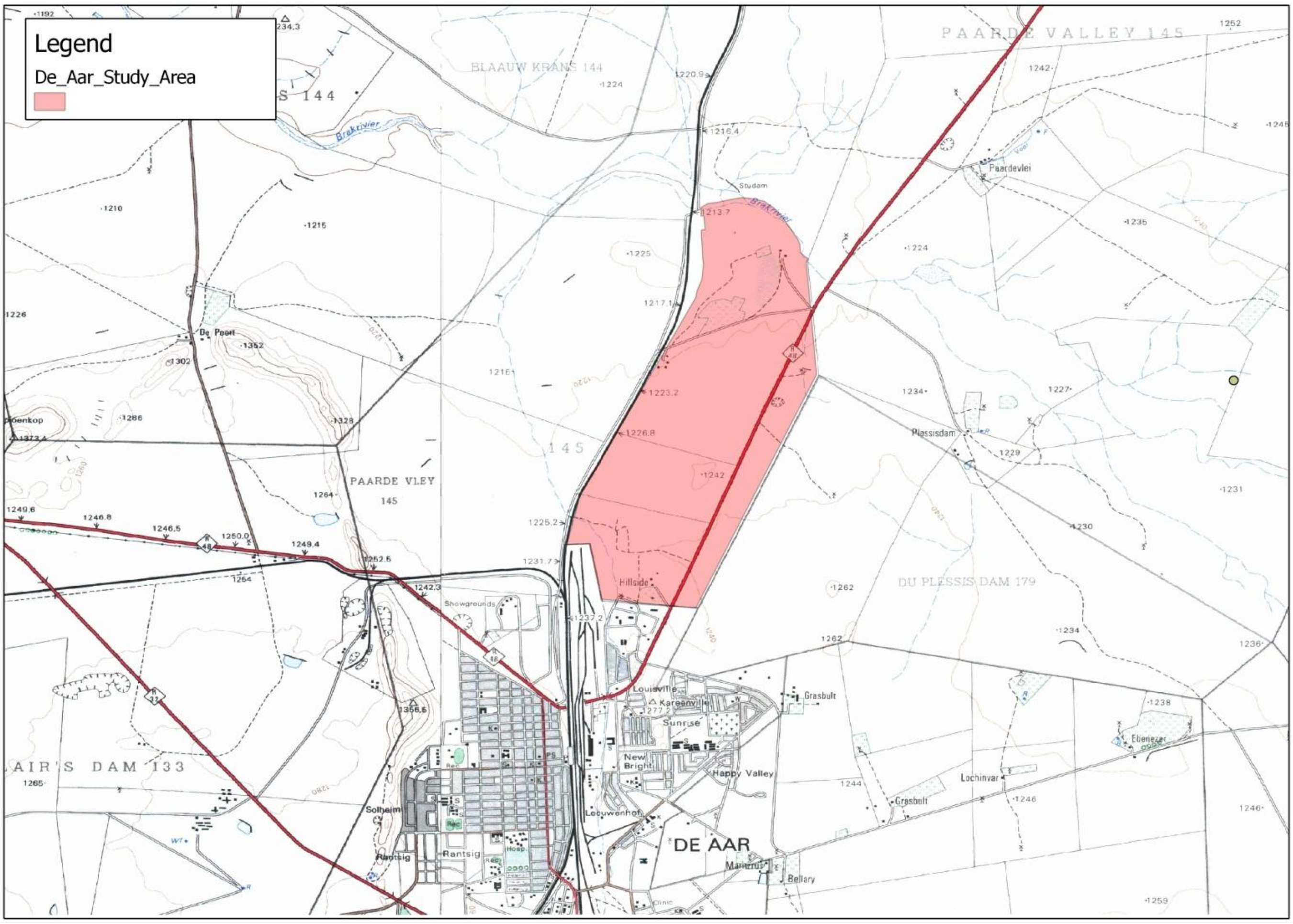

Fig. 1. Extract from 1: 50 000 topographical map 3024CA (Courtesy of the Chief Directorate of Surveys & Mapping, Mowbray) showing location of the proposed solar park project on municipal lands on the north-eastern outskirts of De Aar, Northern Cape Province (pink polygon). See also satellite image in Fig. 2.

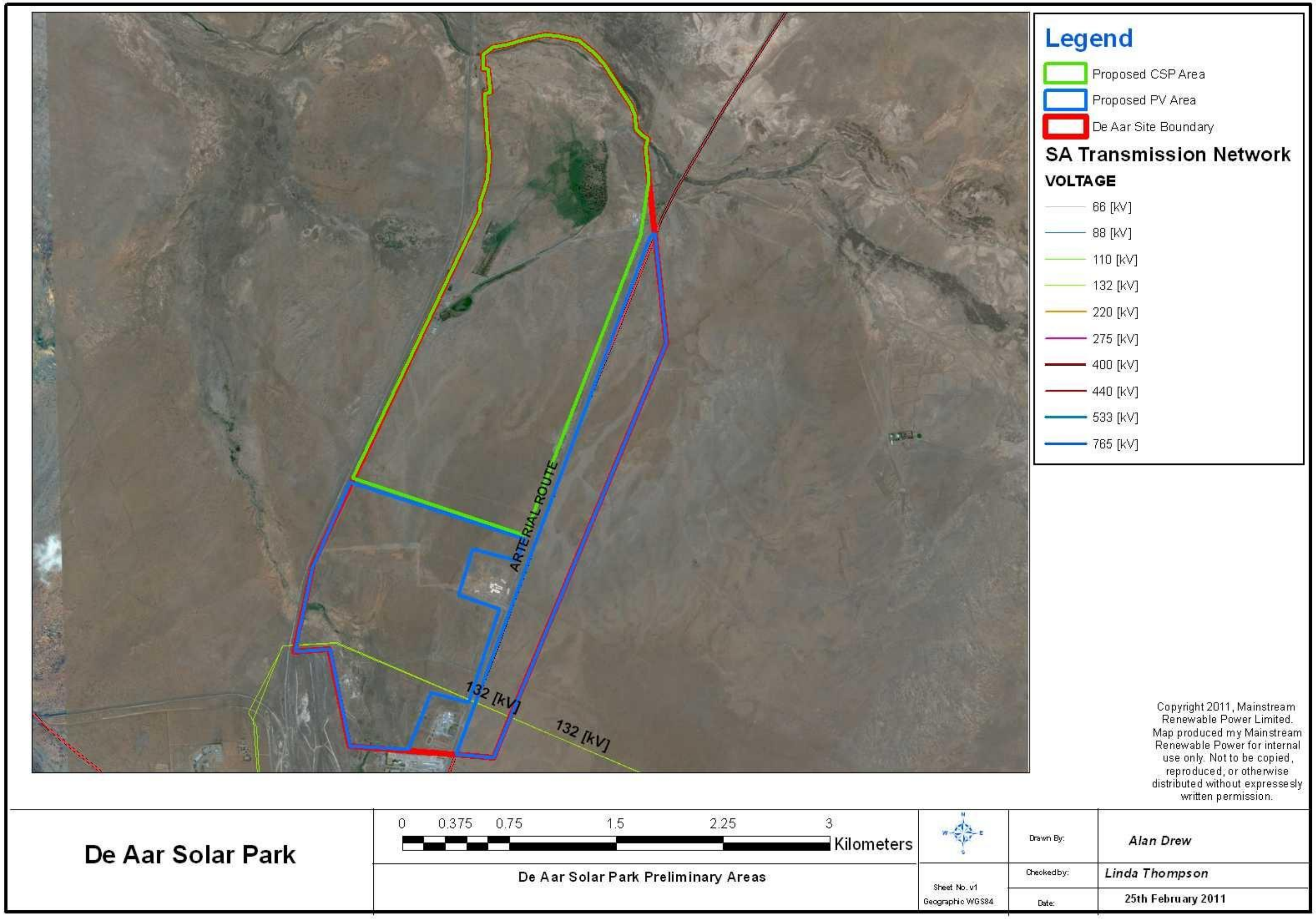

Fig. 2. Satellite image of the proposed De Aar Solar Park, Northern Cape Province (Image provided by Mainstream Renewable Power Ltd).

2.2. General approach used for palaeontological 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 study 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, most effectively, 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

3. GEOLOGICAL BACKGROUND

The geology of the study area near De Aar is shown on the 1: 250 000 geology sheet 3024 Colesburg (Le Roux 1993) (Fig. 4). Most of the site is underlain by dark basinal mudrocks of the Tierberg Formation (Pt) (Ecca Group, Karoo Supergroup) with a thin cover of soil, alluvial and sheet wash gravels. The Tierberg shales appear grey on satellite images (Fig. 2). In the eastern-central sector of the study area they are extensively intruded by Early Jurassic sills of the Karoo Dolerite Suite (Jd). These intrusions show up in rusty-brown colours in satellite images and will have baked (thermally metamorphosed) the adjacent Karoo mudrocks to hornfels, and any sandstones to quartzites. Dolerite colluvial rubble extends beyond the intrusions themselves to blanket adjacent slopes and *vlaktes*. The site is transacted by small ephemeral streams that are tributaries of the Brakrivier. The main river course in the north is bordered by silty alluvium (pale on satellite images).

Useful recent geological accounts of the Ecca Group are given by Johnson *et al.* (2006) and Johnson (2009). The **Tierberg Formation** is a recessive-weathering, mudrock-dominated succession consisting predominantly of dark, well-laminated, carbonaceous shales with subordinate thin, fine-grained sandstones (Prinsloo 1989, Le Roux 1993, Viljoen 2005, Johnson *et al*., 2006). The Tierberg shales are Lower to Mid Permian in age and were deposited in a range of offshore, quiet water environments below wave base. These include basin plain, distal turbidite fan and distal prodelta in ascending order (Viljoen 2005, Almond 2008a). Thin coarsening-upwards cycles occur towards the top of the formation with local evidence of soft-sediment deformation, ripples and common calcareous concretions. A restricted, brackish water environment is reconstructed for the Ecca Basin at this time. Close to the contact with Karoo dolerite intrusions the Tierberg mudrocks are baked to a dark grey hornfels with a reddish-brown crust (Prinsloo 1989).

The **Karoo Dolerite Suite** is an extensive network of basic igneous bodies (dykes, sills) that were intruded into sediments of the Main Karoo Basin in the Early Jurassic Period, about 183 million years ago (Duncan & Marsh 2006). These dolerites form part of the Karoo Igneous Province of

Southern Africa that developed in response to crustal doming and stretching preceding the break-up of Gondwana. Hard cappings of blocky, reddish-brown to rusty-weathering dolerite are a very typical feature of the flat-topped *koppies* in the Great Karoo region.

Quaternary to Recent superficial deposits ("drift") cover a substantial portion of the Palaeozoic bedrock outcrop area, including dry river courses such as the Brakrivier along the northern edge of the study area. Various types of superficial deposits of geologically young, Late Caenozoic (Miocene / Pliocene to Recent) age (< 5 Ma) occur throughout the Great Karoo region (Prinsloo 1989, Le Roux 1993, with more extensive discussion in Holmes & Marker 1995, Cole *et al.* 2004, Partridge *et al*. 2006). They include pedocretes (*e.g.* calcretes), colluvial slope deposits (dolerite, sandstone and hornfels scree *etc*), sandy, gravely and bouldery river alluvium, as well as spring and pan sediments. These colluvial and alluvial deposits may be extensively calcretised (*i.e.* cemented with soil limestone), especially in the neighbourhood of dolerite intrusions. Numerous test pits within the study area expose shallow (60cm or less) brown soils with sparse surface gravels (probably in part downwasted) overlying grey laminated shales of the Tierberg Formation (Fig. 3).

Fig. 3. Field photos of test pits from the geotechnical report for the De Aar solar park development site showing shallow brown soils and sparse surface gravels overlying grey shaly bedrock of the Tierberg Formation (Extracted from geotechnical report by Mainstream Renewable Power, 2011).

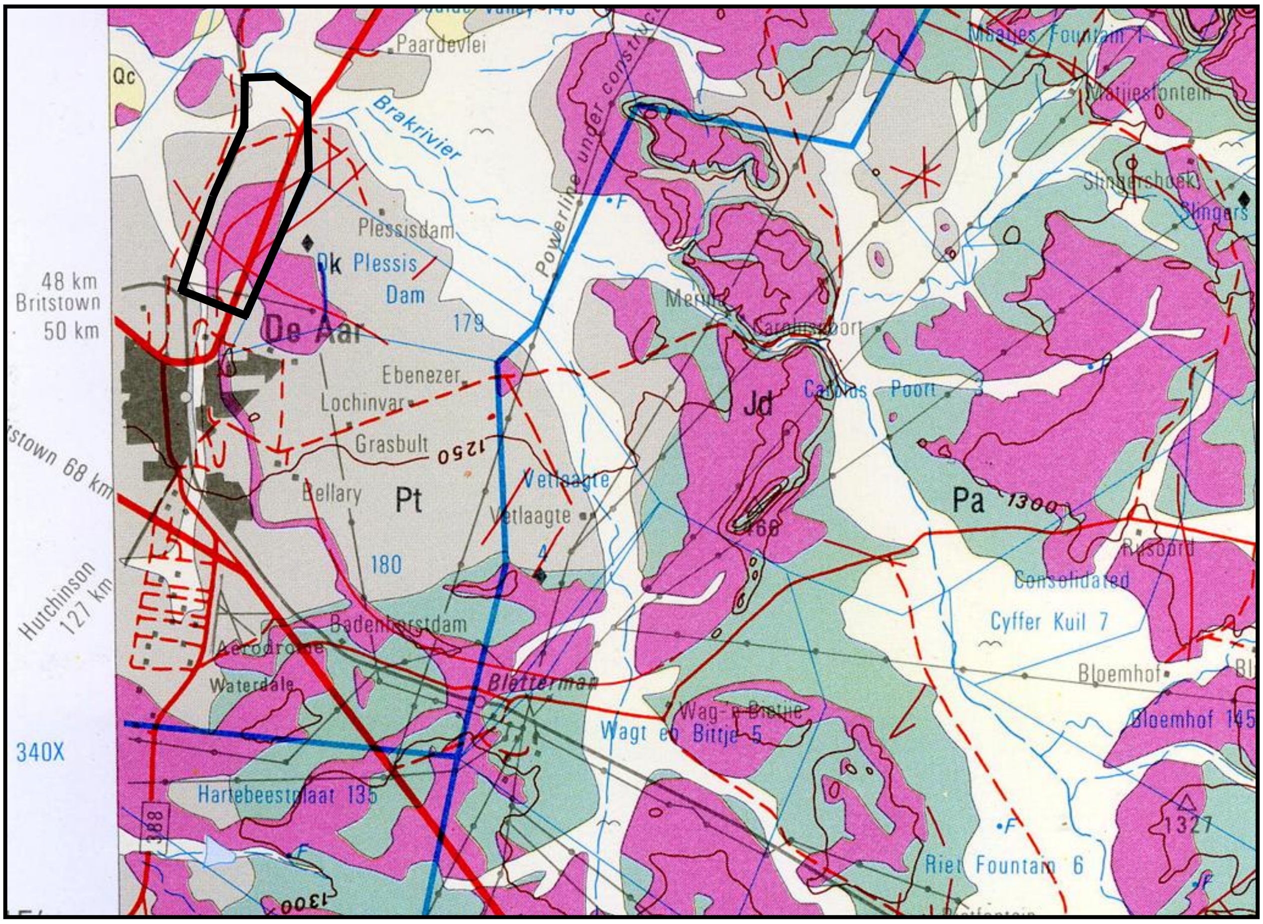

Fig. 4. Extract from the 1: 250 000 geological map 3024 Colesberg (Council for Geoscience, Pretoria) showing the location of the proposed solar park on the north-eastern outskirts of De Aar, Northern Cape Province (black polygon). The following rock units are mapped in or close to the study area:

grey (Pt) = Tierberg Formation (Ecca Group)
pale green (Pa) = Abrahamskraal Formation (Lower Beaufort Group)
pink (Jd) = intrusive sills of the Karoo Dolerite Suite
pale yellow (T-Qc) = Neogene to Quaternary calcretes
white = Quaternary to Recent superficial deposits (alluvium, colluvium *etc*)

4. PALAEONTOLOGICAL HERITAGE

The fossil heritage recorded within each of the main sedimentary rock successions represented within the solar park study region northeast of De Aar is outlined here. See also the summary of fossil heritage provided in Table 1 below. Bedding dips of the Karoo Supergroup sediments in the study region are generally shallow. Low levels of tectonic deformation and cleavage development are expected here, favouring good fossil preservation. However, extensive dolerite intrusion has compromised fossil heritage in the Ecca sediments due to resulting thermal metamorphism.

4.1. Fossils within the Tierberg Formation

The fossil record of the Tierberg Formation has been reviewed in detail by Almond (2008a). Rare body fossil records include disarticulated microvertebrates (*e.g.*fish teeth and scales) from calcareous concretions in the Koffiefontein sheet area (Zawada 1992) and allochthonous plant remains (leaves, petrified wood). The latter become more abundant in the upper, more proximal (prodeltaic) facies of the Tierberg (*e.g.* Wickens 1984). Prinsloo (1989) records numerous plant impressions and unspecified "fragmentary vertebrate fossils" within fine-grained sandstones in the Britstown sheet area. Dark carbonaceous Ecca mudrocks are likely to contain palynomorphs (*e.g.* pollens, spores, acritarchs).

The commonest fossils by far in the Tierberg Formation are sparse to locally concentrated assemblages of trace fossils that are often found in association with thin event beds (*e.g.*distal turbidites, prodeltaic sandstones) within more heterolithic successions. A modest range of ten or so different ichnogenera have been recorded from the Tierberg Formation (*e.g.*Abel 1935, Anderson 1974, 1976, Wickens 1980, 1984, 1994, 1996, Prinsloo 1989, De Beer *et al*., 2002, Viljoen 2005, Almond 2008a). These are mainly bedding parallel, epichnial and hypichnial traces, some preserved as undertracks. Penetrative, steep to subvertical burrows are rare, perhaps because the bottom sediments immediately beneath the sediment / water interface were anoxic. Most Tierberg ichnoassemblages display a low diversity and low to moderate density of traces. Apart from simple back-filled and / or lined horizontal burrows (*Planolites, Palaeophycus*) they include arthropod trackways (*Umfolozia*) and associated resting impressions (*Gluckstadtella*), undulose fish swimming trails (*Undichna*) that may have been generated by bottom-feeding palaeoniscoids, horizontal epichnial furrows (so-called *Scolicia*) often attributed to gastropods (these are also common in the co-eval Collingham Formation; Viljoen 1992, 1994), arcuate, finely striated feeding excavations of an unknown arthropod (*Vadoscavichnia*), beaded traces ("*Hormosiroidea*" or "*Neonereites*"), small sinusoidal surface traces (*Cochlichnus*), small star-shaped feeding burrows (*Stelloglyphus*) and zigzag horizontal burrows (*Beloraphe*), as well as possible narrow (<1cm) *Cruziana* scratch burrows. The symmetrical, four-pronged trace *Broomichnium* (= *Quadrispinichna* of Anderson, 1974 and later authors) often occurs in groups of identical size (*c*. 3.5cm wide) and similar orientation on the bedding plane. This trace has frequently been misinterpreted as a web-footed tetrapod or arthropod trackway (*e.g.*Van Dijk *et al*. 2002 and references therein). However, Braddy and Briggs (2002) present a convincing case that this is actually a current-orientated arthropod resting trace (cubichnion), probably made by small crustaceans that lived in schools of similar-sized individuals and orientated themselves on the seabed with respect to prevailing bottom currents. Distinctive broad (3-4cm), strap-shaped, horizontal burrows with blunt ends and a more-or-less pronounced transverse ribbing occur widely within the Tierberg mudrocks. They have been described as "fucoid structures" by earlier workers (*e.g.*Ryan 1967) by analogy with seaweeds, and erroneously assigned to the ichnogenera *Plagiogmus* by Anderson (1974) and *Lophoctenium* by Wickens (1980, 1984). Examples up to one metre long were found in Tierberg mudrocks near Calvinia in 1803 by H. Lichtenstein, who described them as "eel fish". These are among the first historical records of fossils in South Africa (MacRae 1999). These as yet unnamed burrows are infilled with organized arrays of faecal pellets (Werner 2006). Sandstone sole surfaces with casts of complex networks of anastomosing (branching and fusing) tubular burrows have been attributed to the ichnogenus *Paleodictyon* (Prinsloo 1989) but may more appropriately assigned to *Megagrapton* (Almond 1998). These so-called graphoglyptid burrows are associated with turbidite facies from the Ordovician to Recent times and have been interpreted as gardening burrows or *agrichnia* (Seilacher, 2007). Microbial mat textures, such as *Kinneyia*, also occur in these offshore mudrocks but, like the delicate grazing traces with which they are often associated, are generally under-recorded.

4.2. Karoo Dolerite Suite

The dolerite outcrops in the central-eastern part of the study area are in themselves of no palaeontological significance. These are high temperature igneous rocks emplaced at depth within the Earth's crust so they do not contain fossils. However, as a consequence of their proximity to large dolerite intrusions in the Great Escarpment zone, some of the Ecca and Beaufort Group sediments in the broader study region will have been thermally metamorphosed or "baked" (*ie*. recrystallised, impregnated with secondary minerals). Embedded fossil material of phosphatic composition, such as bones and teeth, is frequently altered by baking – bones may become blackened, for example - and can be very difficult to extract from the hard matrix by mechanical preparation (Smith & Keyser 1995). Thermal metamorphism by dolerite intrusions therefore tends to reduce the palaeontological heritage potential of Beaufort Group sediments. In some cases (*e.g.* fossil moulds of mesosaurid reptiles and palaeoniscoid fish) baking may enhance the quality of preservation of Ecca fossils while other fossil groups (*e.g*. carbonaceous remains of plants, organic-walled palynomorphs) are more likely to be compromised.

4.3. Quaternary to Recent superficial deposits

The central Karoo "drift deposits" have been comparatively neglected in palaeontological terms. However, they may occasionally contain important fossil biotas, notably the bones, teeth and horn cores of mammals as well as remains of reptiles like tortoises. Good examples are the Pleistocene mammal faunas at Florisbad, Cornelia and Erfkroon in the Free State and elsewhere (Wells & Cooke 1942, Cooke 1974, Skead 1980, Klein 1984, Brink, J.S. 1987, Bousman *et al.* 1988, Bender & Brink 1992, Brink *et al*. 1995, MacRae 1999, Meadows & Watkeys 1999, Churchill *et al*. 2000 Partridge & Scott 2000). Other late Caenozoic fossil biotas from these superficial deposits include non-marine molluscs (bivalves, gastropods), ostrich egg shells, trace fossils (*e.g.* calcretised termitaria, coprolites), and plant remains such as peats or palynomorphs (pollens) in organic-rich alluvial horizons (Scott 2000) and diatoms in pan sediments. In Quaternary deposits, fossil remains may be associated with human artefacts such as stone tools and are also of archaeological interest (*e.g.* Smith 1999 and refs. therein).

5. SIGNIFICANCE OF IMPACTS ON PALAEONTOLOGICAL HERITAGE

A brief assessment of the significance of the impact of the De Aar solar park development on local fossil heritage resources is presented here.

- **Nature of the impact**

Bedrock excavations for the proposed PV panel and CSP mirror supports, buildings, buried cables and pipelines, electrical substation and monitoring station as well as the access and internal site roads, drainage channels, evaporation ponds and powerline infrastructure may adversely affect potential fossil heritage 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. In such flat terrain lay down areas are unlikely to involve bedrock excavation. It is currently unclear if exploitation of potentially fossiliferous bedrock from new or existing borrow pits will be necessary.

- **Extent and duration of the impact**

Significant impacts on fossil heritage are limited to the construction phase when excavations into fresh, potentially fossiliferous bedrock may take place. No further significant impacts are anticipated during the operational phase of the De Aar solar park development.

- **Probability of the impact occurring**

Given that the potentially fossiliferous Ecca Group bedrock within the study area is (a) extensively mantled in fossil-poor superficial deposits (*e.g.* soils, surface gravels), (b) weathered near-surface and (c) possibly baked by nearby dolerite intrusions, while large scale bedrock excavations are not envisaged for this project, a significant impact on palaeontological heritage is considered unlikely.

- **Degree to which the impact can be reversed**

Impacts on fossil heritage are generally irreversible. Well-documented new records of fossils represent a positive impact from a scientific viewpoint.

- **Degree to which the impact may cause irreplaceable loss of resources**

The fossil heritage recorded from the Tierberg Formation is generally sparse and low indiversity, while fossils do not occur within igneous rocks such as dolerites. The proposed development therefore does not pose a serious threat to local or regional fossil heritage and its impact is therefore rated as of *low significance* in palaeontological terms.

- **Degree to which the impact can be mitigated**

Specialist palaeontological mitigation is *not* regarded as warranted for this project. Should substantial fossil remains be exposed during the construction phase of the development, these should be safeguarded, preferably *in situ*, by the ECO and reported to Heritage Western Cape so that appropriate mitigation measures can be considered.

- **Cumulative impacts**

Cumulative impacts cannot be assessed in the absence of reliable data on other development projects approved or proposed in the study region. The author is aware of other alternative power projects proposals for the northern and eastern outskirts of De Aar.

6. CONCLUSIONS & RECOMMENDATIONS

The proposed Mainstream solar park at De Aar, Northern Cape Province is underlain by sparsely fossiliferous sediments of the Tierberg Formation (Ecca Group) as well as by unfossiliferous Karoo dolerites. Much of the Palaeozoic bedrock is mantled by a thin veneer of soil and gravel of low palaeontological sensitivity. Only shallow bedrock excavations are envisaged for this project. The overall impact of the proposed development on local fossil heritage is considered to be *low* and specialist palaeontological mitigation for this project is not considered necessary.

Should substantial fossil remains be exposed during construction, however, such as well-preserved shells, fossil fish, reptiles or petrified wood, the ECO should 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.

7. ACKNOWLEDGEMENTS

Mnr Wouter Fourie of PGS - Heritage & Grave Relocation Consultants is thanked for commissioning this study and for kindly providing all the necessary background information. The anonymous geotechnical report by Mainstream Renewable Power was a very useful additional resource for this palaeontological study.

TABLE 1: FOSSIL HERITAGE IN THE DE AAR AREA				
GEOLOGICAL UNIT	ROCK TYPES & AGE	FOSSIL HERITAGE	PALAEONT-OLOGICAL SENSITIVITY	RECOMMENDED MITIGATION
Superficial deposits (“drift”)	Alluvium, colluvium (scree), pan sediments *etc* NEOGENE / QUATERNARY TO RECENT	Sparse remains of mammals (bones, teeth), reptiles, ostrich egg shells, molluscs shells, trace fossils (calcretized termitaria, rhizoliths), plant remains, palynomorphs, diatoms stone artefacts	LOW	Any substantial fossil finds to be reported by ECO to SAHRA
Karoo Dolerite Suite (Jd)	Intrusive dolerite sills & dykes EARLY JURASSIC	NONE	ZERO	None Baking of country rocks by dolerite intrusions may variously compromise fossil heritage or enhance fossil preservation
Tierberg Formation (Pt) ECCA GROUP	Dark basinal, prodelta and submarine fan mudrocks with minor sandstones EARLY TO MIDDLE PERMIAN	Locally abundant trace fossils, petrified wood, plant debris, microvertebrates	MEDIUM	Any substantial fossil finds to be reported by ECO to SAHRA

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9. QUALIFICATIONS & EXPERIENCE OF THE AUTHOR

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 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 for SAHRA and HWC. Dr Almond is an accredited member of PSSA and APHAP (Association of Professional Heritage Assessment Practitioners – Western Cape).

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 development project, 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.

Dr John E. Almond

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Appendix B

MAP OF HERITAGE SITE RELATIVE TO DEVELOPMENT AREAS

Figure B1 – Option 1 with heritage sites

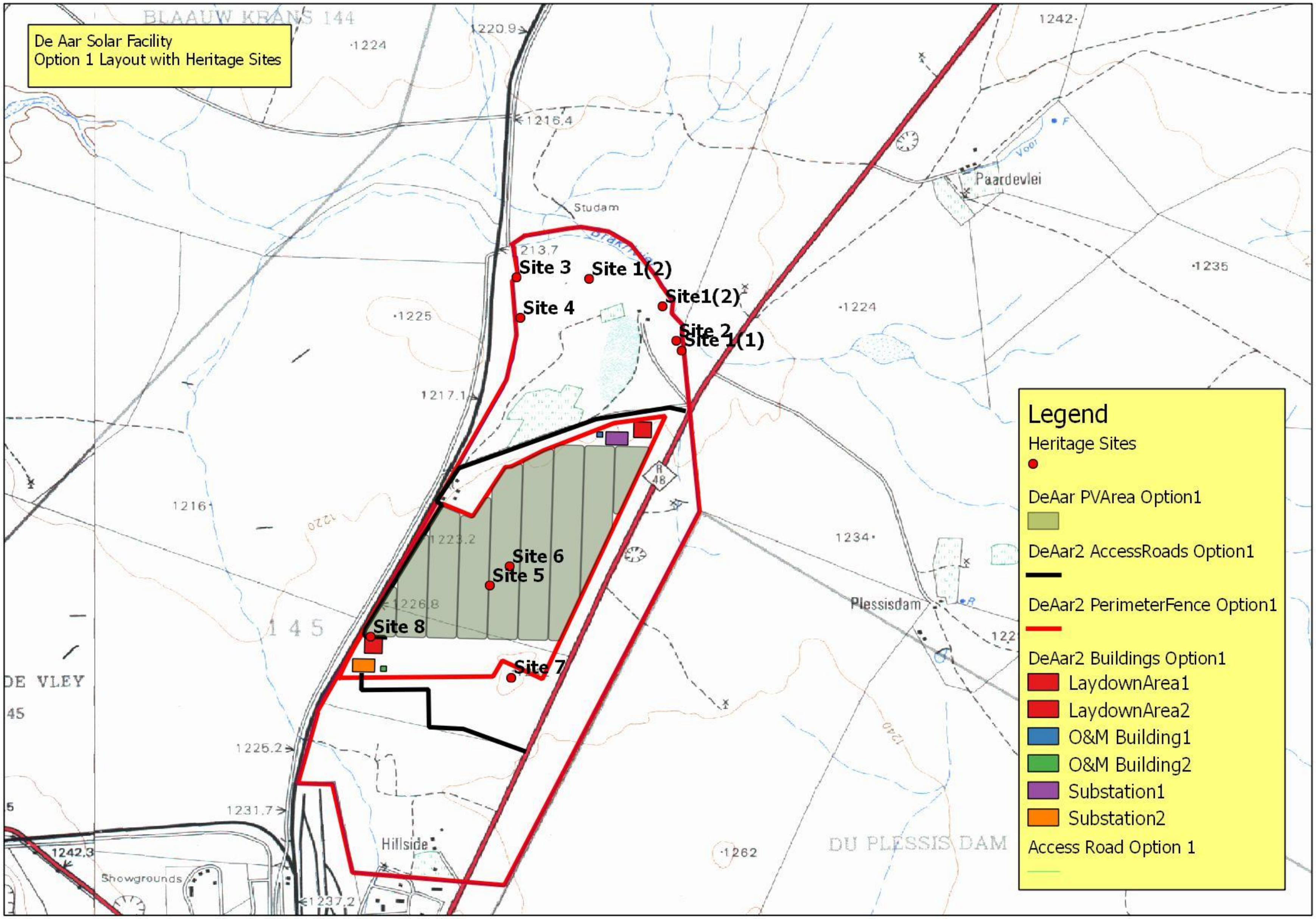

Figure B2 – Option 2 with heritage sites